THE PERCEPTION OF RIDDEN VIDEO FOOTAGE BY RIDERS AND NON-RIDERS AND ITS VALUE FOR EQUESTRIAN CROSS COUNTRY.

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ABSTRACT

Video feedback is widely used for performance analysis in sport for its convenient, accessible, and objective measure of behaviour, but there is very little evidence of its use in equestrian eventing. The cross country phase of eventing poses risk to both horse and rider. Incorporating video footage gives researchers access to behavioural information, enabling a deeper exploration of the causes and mechanisms behind falls and faults in equestrian sport. This thesis identified that having purchased ridden video footage in the past was associated with greater intention to watch such footage in the future, as was the perception that video footage held value in multiple scenarios and to multiple people. Employment in the equestrian industry also related to respondent intention to analyse ridden video footage. Riders appeared to consider inconsistency in rein aids and upper body position particularly likely to predict a cross country jumping fault. The thesis then illustrates that there are some differences between rider and non-rider visual strategy when watching eventing video footage, which may have implications for fence-judge ability to identify faults. The project culminates by demonstrating that experiential factors, such as the frequency of riding, may contribute to a greater ability of riders to correctly predict the outcome of cross country video footage. The use of pre-recorded video footage enabled the inclusion of non-riders, who were not significantly worse at predicting the outcome of jumping efforts. It is hoped that this thesis forms the basis for future studies to determine specific behavioural risk-factors for cross country riding, and demonstrates the value that video footage holds for identification of these factors. The results of this project have implications for the safety and performance of riders, coaches, and officials, who have a duty of care to members of the equestrian industry and the horses involved.

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1.1. INTRODUCTION:

Sport at all levels is documented in some way, which means there exists an extensive database of sporting information that can be used to research, develop, and improve sporting ability and performance (Jayal, *et al.* 2018). While there are many technologies available for performance analysis (Kos, *et al.* 2018), one of the most accessible is videography. Video footage provides an objective means of recording behaviours, which can then be stored, watched, and analysed for the purposes of performance analysis (Schenk and Miltenberger 2019). In sports like football, where pitch markings are visible, video analysis can be used to make reasonably accurate measurements (Alcock, *et al.* 2009). However, there are sports in which the dimensions and topographical characteristics of the competition area vary, such as many of the equestrian disciplines. Extracting useful data from video footage of such variable sports is much more challenging. Equestrian sport involves the complex interaction between horse (*Equus ferus caballus* Linnaeus, 1758) and rider, who are likely to be at different stages of their training (Williams and Tabor 2017). The sport of equestrian eventing is widely regarded as one of the most dangerous equestrian sports, and has been for many years (Whitlock 1999; Nylund, *et al.* 2021; O'Brien 2016; Paix 1999). Eventing consists of dressage, show jumping, and cross country phases, and is described as "the most complete combined equestrian competition" (Fédération Equestre Internationale 2021). The cross country phase is run over a wide area of varying terrain and in all but the worst environmental conditions.

Animal behaviour can be defined as "the way in which an animal works, functions or responds to a particular situation" (Wilson, et al. 2018; Tinbergen 1960). For the purposes of this project, the term 'behaviour' will also apply to any action, position, aid, or other influence the rider may have on a horse. The relationship between a human and non-human participant, combined with the logistics of data collection in such wide-ranging competition grounds, make cross country a difficult sport in which to monitor behaviour by observation. However, equestrian eventing is often video recorded, broadcast, and viewed by a wide-ranging and varied audience, particularly at the elite level. As video technology has become more accessible there has been a resulting increase in the number of cross country video providers. This means that recordings of competitive performance at all levels of the sport are now commercially available to competitors, officials, and the general public. One of the most famous eventing competitions in the world for example, Badminton Horse Trials in the UK, was available to watch through a subscription service, and a highlights programme was shown on the BBC (Roome 2023). Broadcast footage such as this is viewable by the equestrian and non-equestrian population alike. As a result, horse and rider behaviour and welfare is under close scrutiny (Furtado, et al. 2021). To retain its social licence to operate, equestrian sport needs to consider how it is being portrayed through video media.

Ridden horse behaviour is often discussed with reference to “unwanted” behaviour which may negatively impact the safety of the rider (Romness, *et al.* 2020), and indicate poor welfare (Luke, *et al.* 2022). There is also increasing understanding of the effect of the rider on the behaviours exhibited by the horse (Normando, *et al.* 2011; Christensen, *et al.* 2021). More recently, research has begun to investigate the association between pre-competition horse behaviour and consequent competitive performance in racing (Wells, *et al.* 2022) and eventing (Dyson and Ellis 2020). Research into horse and rider behaviour during competitive cross country, however, remains sparse.

This project aims to describe the current usage of video feedback by riders, and existing perceptions of the impact that horse and rider behaviours in a cross country setting can have on performance. Using commercially available cross country video footage, the project hopes to understand which elements of the footage viewers pay most attention to. In addition, the project aims to examine how the riders' experience levels and backgrounds may influence their interpretation and analysis of cross country video footage. The ultimate goal is to demonstrate the potential for horse and rider behaviours that may be predictive of jumping faults to be identified from cross country video footage. The project will approach this goal by using the style of footage that is widely available from commercial videographers, and will report on any methodological limitations associated with this. It is anticipated that the results of this research may identify gaps in rider appreciation of video footage for behavioural and performance analysis. Furthermore, recommendations will be made for how cross country video footage may inform equitation science in the future.

1.2. LITERATURE REVIEW

1.2.1. Performance analysis in equestrian sport

Performance analysis can be defined as the process of identifying and understanding associations between performance goals and sport specific actions or behaviours (Williams 2013; McGarry 2009). To enhance performance, one must first evaluate the existing methodology, technique, or strategy to identify areas of weakness (Wilson 2008). Unambiguous operational definitions are necessary to provide objective measures of performance, which can be refined for individual sports where necessary but should be consistent within each sport to allow for comparability (Williams 2012). Performance analysis data can also be used to make predictions, such as the expected point of peak performance of an athlete, using data from other athletes in the same sport (McIntosh, *et al.* 2019). Optimum technique could also be identified through performance analysis and then used as a comparison in training to identify flaws in technique or strategy (Omkar, *et al.* 2012).

Methods of performance analysis can range from exploratory self-reporting questionnaires (Beaudoin 2006), to technology that can provide real time kinematic and dynamic data relating to performance (Bifaretti, *et al.* 2016; Harfield, *et al.* 2014). Self-reporting questionnaires, while prone to various forms of bias and error (Choi and Pak 2005), can provide a holistic and personal view that may capture information beyond the scope of the original research question. There are, however, limitations to how much information questionnaires can collect. In equestrian sport, technology is often used to collect data on the interaction between the horse and rider, such as rein tension monitors (Dumbell, *et al.* 2019) or pressure mats underneath the saddle (Martin, *et al.* 2016). This technology has the potential to improve rider performance in training but it is generally not permitted in competitive environments (Randle, *et al.* 2017). Quantifiable performance data, such as those collected by technology or developed from retrospective data, provide the ability to focus on very specific areas of sport (Kos, *et al.* 2018). This can enable the implementation of a marginal gains strategy, used extensively in elite level sport and increasingly in business improvement, whereby small elements of performance are focussed on and improved upon (Pentecost, *et al.* 2018). There is a danger, though, that excessive scrutiny of a few small factors may lead to misinterpretation of the data and a failure to notice other more influential or important factors. In equestrian sports, any analysis must also consider the influence of the horse and rider on each other (Christensen, *et al.* 2021). Successful performance analysis needs to combine specific targeted analysis with more holistic consideration of the athlete, whether human or animal.

It is often said that effective animal training relies on timing and consistency of cues, but without objective analysis of the outcome, it is difficult to determine the success of the interaction (Wolframm, *et al.* 2013). There has been considerable research into horse behaviour and its connection to physiological measures which may indicate stress (Hall, et al. 2014a; Norton, et al. 2018; Górecka-Bruzda, et al. 2015). These possible signs of stress have historically been attributed to aversive procedures or environments, but some studies have investigated the influence of the rider (Williams and Tabor 2017). It is therefore important that effective performance analysis in the field of equestrianism should not focus purely on either the horse or the rider, but on the way the two interact and influence each other (Williams 2013; Wolframm, *et al.* 2013). It is also important to consider that individuals of both horse and human will have varying ability to cope with stress (Budzyńska 2014). This adds further complexity to the relationship between horse and rider, and means that research findings should be considered within the context of individual situations.

1.2.2. Video for sports performance analysis

Live extrinsic feedback is often used, usually from a coach or trainer, but this can be limited by the information they are able to synthesise and communicate (Wilson 2008). In those circumstances, video footage is particularly beneficial because the information can be recorded and stored indefinitely. Consequently, a large quantity of data can be extracted and analysed beyond what the trainer was able to perceive, remember, and recount (Vignais, *et al.* 2015). Digital video footage also offers advanced analysis techniques that are not achievable through visual observation alone (Wilson 2008; Jayal, *et al.* 2018). These include the ability to selectively occlude certain parts of the footage either temporally or spatially, as well as the capability to review videos frame-by-frame or in slow motion (Randle, *et al.* 2017). These functions enable greater understanding of the interaction between the competitor and their environment, such as match analysis tools (Sarmento, *et al.* 2014), or understanding how a horse and rider fell (Nylund, *et al.* 2022; Nylund, *et al.* 2021). It is important to consider that high specification video equipment is not necessarily accessible to everyone. A recent report by Ofcom found that 87% of people used a smartphone (Ofcom 2023), and it is therefore likely that most people have access to low-level video equipment. The value of equitation research is reflected in its applicability to riders, coaches, and officials. Demonstrating the use of conveniently available video technology, therefore, has implications for many equestrian stakeholders. Video footage is, however, limited by the visual field of the camera, so if a distraction were to occur behind the camera for example, it may not be recorded. This can be controlled to some degree by manually recording events that occur during filming, as mentioned by Tien *et al.* (2015), but this does add to the labour requirements of data collection (Randle, *et al.* 2017). Video is also unlikely to capture anything but the most obvious of environmental conditions. Ground conditions are of particular interest to the equestrian industry, and softer ground conditions have been suggested to increase the risk of a cross country horse fall (Murray, *et al.* 2006). Ground conditions are not measurable through video footage alone, especially when the take-off or landing is obscured by the fence.

Recent literature has begun combining existing knowledge of behavioural indicators of distress with video footage of those behaviours being demonstrated in a ridden environment (Dyson 2021; Wells, *et al.* 2022). Additionally, video recordings of horse and rider behaviour are being used to draw associations between behaviour and competitive outcomes (Parkin, *et al.* 2006), as well as injury risk when falling (Clark, *et al.* 2020; Nylund, *et al.* 2021; Nylund, *et al.* 2022; Licht 2011). Due to the logistical difficulties associated with collecting data "in the field", there is very little research into what information can be gleaned from video footage filmed during competition, as opposed to pre- or post- competition behaviour. Much of the eventing research has focussed on the risk of injury from falls but, for performance analysis, non-fall jumping faults should also be considered (Stachurska, *et al.* 2010). Video footage provides objective records of behaviour, including falls, faults, and clear jumps.

1.2.3. Expertise in sport

The concept of sports expertise is multi-faceted; generally sports require not only a knowledge of the theory, but also an understanding of the dynamic and tactical elements (McPherson 1994). Many experimental interventions have used decision-making success as a measure of experience in sport and sport coaching (García-González, *et al.* 2013; Vergeer and Lyle 2009). Equestrian sport does not present the same decision making challenges as other sports because, though the horse and rider are team mates of sorts, the physical interspecies interaction is unique (Davies, et al. 2022b). The expert-novice paradigm has been used repeatedly by researchers to investigate what makes someone successful in a specific field (McPherson 1994; Allerdissen, *et al.* 2017), but the definitions of expert and novice vary between studies. To make comparisons between expert and novice participants researchers must first seek to define what classifies as “expert” or “novice” (Swann, *et al.* 2015). Analyses of optimum technique often use expert subjects as representatives of the highest level of a sport. Hierarchical ranking has been employed in the literature to distinguish between expert and novice participants in various fields (Bassement, *et al.* 2010; Murray, *et al.* 2018). Elite athletes tend to be defined by their recognised rankings and participation in high-level competitions, as demonstrated by a study on pole-vaulters (Bassement, *et al.* 2010), and precision rifle shooters (Deeny, *et al.* 2009). Another method of measuring expertise is to assess the amount of time a subject spends practising their skill. One comparison, between expert and intermediate dancers, classified experts as being professional dancers, and intermediates as non-professional dancers (Munzert, *et al.* 2019). As well as their employment status, the professionals and non-professionals showed a distinct difference in number of hours per week spent training, rehearsing, and performing (Munzert, *et al.* 2019). When interpreting the results of expert versus novice studies, it should be noted that there may also be considerable intra-group variation. In a study investigating attack recognition in a sample of experienced and novice fencers, for example, some of the expert group had three times as many years of experience than others (Allerdissen, *et al.* 2017). It should also be considered that the number of hours spent training does not necessarily indicate that the training is beneficial or appropriate (Elferink-Gemser, *et al.* 2018). It is not always possible to determine whether the differences demonstrated by the data are due to the research-defined experiential groups, or if variation within the groups had an effect. Scales of experience are sometimes used, rather than a binary measure of expert or novice.

Horse-riding skill is commonly determined by the rider's ability to optimise the horse's performance, or to minimise the occurrence of faults or penalties (Baxter, *et al.* 2022). In equestrianism, experience has been measured using confidence and perceived skill questionnaires (Hall, *et al.* 2009), competency level with reference to competition standards (Bye and Lewis 2021), or total hours of riding experience (Williams and Tabor 2017). Such measures refer to the skill of the athlete, but some studies have also investigated the experience of the observer, such as the judges and coaches (Pajek, et al. 2013; Ziv, et al. 2020). Expertise in these areas is often classified according to official sport-specific qualifications such as judging licenses for gymnastic judges (Pizzera, *et al.* 2018) and coaching certificates for badminton coaches (Lorimer and Jowett 2010). Experiential measures should be specific to the subjects under investigation, according to their role within the sport. In some cases, a combination of experiential measures is warranted to avoid effects being undetected.

Arguably, it is more difficult to define an appropriate "novice" group, than it is to categorise elite participants. Often, the novice participants are convenience samples of willing volunteers, such as in a study investigating bimanual coordination skills of slackliners (Kodama, *et al.* 2021), the rifle shooting study mentioned previously (Deeny, *et al.* 2009), and a study investigating the mental rotation ability of basketball players (Weigelt and Memmert 2021). Sufficient consideration should be given to defining the experiential groupings because, as discussed in a dance context by Munzert *et al.* (2019), using totally naïve participants who are unable to perform relevant tasks may limit the practical applications of the study. Participants with no horse riding experience have been used to demonstrate postural differences between advanced and beginner riders (Kang, *et al.* 2010), but it is not common. Skill should be described using context-specific definitions or measurements. For example, categorising a sample into advanced and novice riders based on whether they regularly performed the shoulder-in movement in competition is only useful when the measurements being collected are related to this skill (Baxter, *et al.* 2022). Sometimes it is necessary to use novice groups that have no experience of the specific task being investigated, but do have some transferable skills (Lyons, *et al.* 2006). Expert and novice participants must be selected and define based on the research goals of the project to enable the collation of appropriate data.

1.2.4. The equestrian sport of eventing

Horse riding is a popular activity in Britain, with an estimated 1.8 million people riding at least once a month for the past 12 months. and a horse population of around 847,000 (BETA 2019a). Horses are kept for a number of reasons, and while one study estimates the British horse population at around 847,000 (BETA 2019a), another suggests that 600,000 of those are kept as companion animals (Pet Food Manufacturers Association 2022). Despite equestrian disciplines being the only Olympic sport to allow men and women to compete against one another, research from the past 20 years suggests a heavily female equestrian population (Beauchamp and Whinton 2005; Bye and Chadwick 2018; Wolframm and Micklewright 2009). It should be noted, however, that the sex demographics in competitive equestrian sport tend to vary between discipline and across competitive levels (Dumbell, et al. 2018). A meta-analysis investigating the 1988 and 1990 world championship three-day events reported a heavily male-skewed sample, with only 20% female riders in 1988 and 23% in 1990 (Deuel and Russek-Cohen 1995). In contrast, a recent study looking a fall statistics in a sample of 187,602 international level cross country starters found that almost 60% were female (Bennet, *et al.* 2021). At the elite level of equestrian sport, there appears to be a greater proportion of male riders (Dumbell, et al. 2018). It is possible that while females may dominate equestrianism more widely, they are also more likely to take career breaks for childrearing than males (Dashper 2012). Overall, although equestrian sport practices sex integration, imbalances still exist between the numbers of males and females depending on the discipline and competitive level in question. As a result, it is best practice to use a sample that is representative of the target population to limit the potential effect of sex bias. Unfortunately, response rate and data collection mode often limit the representativeness of survey samples (Cornesse and Bosnjak 2018). Generalisation of survey results is cautioned, though the data can serve as an introduction to the research topic.

Eventing is a three-phase equestrian sport consisting of dressage, show-jumping and cross country. Since the Barcelona Olympic Games in 1992 which saw several incidents in the cross country phase of eventing, there has been growing concern over the safety of both horse and rider (de Haan and Johnson 2010). Safety is of particular concern during the cross country phase where the pair negotiate up to 45 obstacles, at speed, across varying terrain (Fédération Equestre Internationale 2021; Whitlock 1999). The cross country area must be large enough to safely enable the running of courses nearly 7000m long at the top level, meaning that it is very difficult to see all areas of the course with sufficient detail at all times (Fédération Equestre Internationale 2021). At every numbered obstacle, which can include several jumpable elements, there will be a fence-judge allocated, who are almost exclusively volunteers (British Eventing 2022). The fence-judges are responsible for recording penalties at their fence and reporting incidents to the cross country control centre, particularly when medical or veterinary attention is required. They fulfil a similar role to that of a referee or umpire in other sports in that they must use relevant information to make decisions based on instantaneous visual data (Ziv, *et al.* 2020). The role of fence-judge is an important one and should not be understated but, at present, there is minimal assessment or training of fence judges. There will also be appointed officials at every affiliated event, and if there is official video footage available it may be utilised to make the final decision (Fédération Equestre Internationale 2021). Under FEI rules, only pre-determined official video footage may be used as evidence, but there is no rule to say that video footage must be available (Fédération Equestre Internationale 2021). When it is available, cross country video footage can be used to review performance, safety, and welfare of horse and rider on the day of the competition.

The field of equestrianism is broad and so, as a result, is the literature. Interactions between humans and animals are complex due to the numerous biological, physiological, and behavioural differences. Safe interactions between species, therefore, require careful risk assessment and management such as the implementation of personal protective equipment. Horses are much larger, faster, and heavier than humans meaning that injuries can, and do, occur (Shahan, *et al.* 2012). Despite these preventative measures, equestrian sport is still considered one of the most dangerous sports in terms of serious injury, alongside motor sports, and power boat sports (Gabbe, *et al.* 2005). The complexity of the relationship between horse and rider means that equitation science is often influenced by the fact that the horses used in equine science studies will also have varying temperaments, training, and ability (St. George, *et al.* 2021; Williams and Tabor 2017). In fact, stakeholders in para dressage have suggested that the horse is the greatest predictor of competitive success, even if ridden by a less experience rider (St. George, *et al.* 2021). Live horses used in ridden studies are also likely to require differing tack, such as those in one dressage-based study where only two of the 10 advanced horses wore a double bridle (Baxter, *et al.* 2022). This means that direct comparisons between multiple horse and rider combinations can be very difficult.

Eventing is scored on penalty points, and both national and international level competitions start with the dressage phase. The dressage phase is scored by up to three judges, who award marks out of 10 for each numbered movement, plus a mark for harmony between horse and rider (FEI 2024). The average percentage between the judges is calculated and then subtracted from 100 and converted to penalty points rounded to one decimal place (FEI 2024). At national level, the show-jumping phase usually follows the dressage (British Eventing 2023), and penalties can be accumulated for knocking show-jump poles down, disobedience, or exceeding the time allowed. The cross country phase has the potential for the greatest penalties, with 20 penalties for the first refusal or run-out, compared to 4 penalties for the equivalent fault in the show-jumping phase (British Eventing 2023; FEI 2024). There are elimination criteria in the dressage, show-jumping, and cross country phases. In particular, a fall of either rider or horse in any of the three phases results in elimination from the competition. Table 1.1. presents an overview of the possible performance outcomes in a UK national eventing competition.

Table 1.1: Descriptions of possible faults in British Eventing competition grouped by phase of competition and indicating the possible penalties for each fault. Adapted from the British Eventing rules and member's handbook (2024).

Phase	Description of fault	Possible penalties
Dressage	First error	2 penalties
	Second error	4 penalties
	Third error	Elimination
	Fall of rider or horse	Elimination
	Entering the arena with a whip	6 penalties per judge
	Entering the arena with the horse wearing boots or bandages	6 penalties per judge
	Entering the arena before the bell	2 penalties per judge
	Not entering the arena within 45 seconds of the bell but within 90 seconds	2 penalties per judge
	Not wearing gloves or other minor breaches of dress rules	2 penalties per judge
Show-jumping	Starting before the bell	Elimination
	Knocking a pole down	4 penalties
	First disobedience	4 penalties
	Second disobedience across the whole course	8 penalties
	Third disobedience across the whole course	Elimination
	Fall of horse or rider	Elimination
	Resistance exceeding 20 seconds	Elimination
	Failing to jump the next obstacle within 45 seconds	Elimination
	For every commenced second in excess of the time allowed	1 penalty
	Exceeding the time limit of twice the time allowed	Elimination
	Exceeding 24 penalties at obstacles	Compulsory retirement
	Error of course not rectified	Elimination
	Jumping an obstacle which does not form part of the course	Elimination
Cross country	Exceeding the optimum time per commenced second over the optimum time.	0.4 penalty points
	More than 15 seconds below the optimum time per commenced second in excess of 15 seconds under the optimum time.	0.4 penalty points
	Exceeding the time limit of twice the optimum time	Elimination
	First refusal, run-out or circle at obstacle	20 penalties
	Second refusal, run-out or circle at the same obstacle	40 penalties
	Third refusal, run-out or circle on cross country course (Novice and above)	Elimination
	Fourth refusal, run-out or circle on cross country course (BE105 and below)	Elimination
	Fall of athlete or horse on cross country course	Elimination
	Error of course not rectified	Elimination
	More than two minutes of continuous disobedience	Elimination

Existing research into the safety of eventing has consisted mostly of large-scale meta analyses of eventing fall data with the aim of identifying risk factors on the cross country course (Singer, *et al.* 2003; Murray, *et al.* 2006; Murray, *et al.* 2005; Hennessy 2017; Bennet, *et al.* 2021; Fédération Equestre Internationale and Barnett 2016; Stachurska, *et al.* 2010). Similar research has been conducted into the sport of equestrian endurance (Zuffa, *et al.* 2021), and racing (Williams, *et al.* 2013). What has not yet been investigated, is how cross country horse and rider behaviour is perceived, and how video technology might be used to analyse performance and safety.

1.3. AIMS AND OBJECTIVES

The sport of cross country as part of equestrian eventing, is challenging to assess objectively because of the distance it covers and the variation in terrain and environmental conditions. Additionally, the complex relationship between the horse and rider in any equestrian activity means it is a difficult discipline in which to measure and compare performance. Recording video footage of sporting events builds a reliable and consistent database of objective behavioural data and is achievable irrespective of conditions whilst being accessible to all. The mixed-methods thesis carried out here aims to demonstrate where viewer attention lies while watching ridden video footage. The results of this project have implications for understanding rider decision-making, and how video could be a valuable tool for riders and officials alike. A brief overview of the aims of each study is provided below:

- **Chapter 3**: To best understand the potential influence that ridden video footage has within the equestrian industry, it is necessary to identify current rider attitudes. Chapter 3, therefore, aims to describe rider attitudes towards video footage of their own riding. Furthermore, this chapter will investigate associations between existing attitudes and participant intention to engage with self-subject ridden video footage in the future.
- **Chapter 4**: The equestrian industry is rooted in tradition and knowledge is often transferred via word-of-mouth. Understanding current rider perceptions is a valuable tool for bridging the gap between stakeholder knowledge and scientific evidence. Of particular interest are factors which contribute to faults or falls on the cross country course, due to their importance from safety and performance perspectives. Chapter 4, therefore, aims to explore rider perception of how specific horse and rider behaviours influence the outcome of a jumping attempt.
- **Chapter 5:** It has been recognised that gaze behaviour varies between individuals, and often this variation is attributed to expertise within a given field. Cross country video footage is widely available in a commercial format, providing eventing stakeholders the opportunity to watch their competitive round from the perspective of a spectator. It is reasonable to suggest that the visual strategies employed while watching such video footage may vary between individuals. Chapter 5 aims to investigate and compare visual strategies of riders and non-riders while watching cross country video footage.
- **Chapter 6:** As well as differences in visual strategy, it is thought that experts in a field may be better able to identify and interpret situational indicators, enabling them to correctly predict the outcome of a scenario. Chapter 6 aims to assess the ability of participants to correctly predict the outcome of a cross country jumping effort. This chapter will then attempt to elucidate associations between participant predictive success and some demographic and experiential factors.

This project aims to provide links between current usage of self-subject ridden video footage, perceptions of behaviours which may increase the likelihood of faults, and the potential for predictive analysis in cross country riding. By exploring the elements viewers pay attention to in cross country video footage, and identifying behaviours that may indicate jumping faults, this research can contribute to safer and more effective training practices.

CHAPTER 2:
GENERAL METHODS:

To maintain consistency, every study included in the thesis used the same base survey to collect information regarding demographics and equestrian experience. Furthermore, a sub-sample of the 22 video clips of cross country jumping selected for use in **chapter 6** were also used for **chapter 5**. The methods behind the development of the survey and selection of the videos are described here, while any methods specific to the individual studies are identified in their relevant chapter.

2.1. SURVEY DESIGN

Surveys were developed and administered using Qualtrics (Qualtrics 2023) because of its ability to embed and display video links within an easy-to-navigate questionnaire. They were then distributed using the Facebook pages (https://www.facebook.com/) of the researcher and the funding collaborators. The surveys included a question about country of residence which, though not included in further analysis, indicated an international viewership. Facebook was chosen as the distribution method due to its international reach and the fact that the funding collaborators had a considerable following of approximately 50,000 Facebook followers (Facebook 2024). The privacy settings of the post were set to public, which allowed sharing by others. The post was not shared by the researcher beyond the initial posting so as to not influence the response rate, but it was voluntarily shared by other followers. The viewership of the survey will have been influenced by the demographic who followed the researcher and the funding collaborators on Facebook. It is possible that this limited the number of non-rider participants, but non-riders were perhaps unlikely to engage with an eventing survey even if they did see the Facebook post. The inclusion of non-riders enabled the consideration of a somewhat naïve control group, but the distribution methodology may have impeded recruitment of such participants. The overall aim of the project was to investigate how ridden video feedback might be useful to the equestrian industry so, although non-riders provided an interesting comparison, the results apply predominantly to riders or those involved in horse riding. Using

Facebook as a distribution channel can therefore be considered an appropriate method of recruiting stakeholders for whom the results of this project were most applicable.

Engagement with the surveys was entirely voluntary, and agreement with six rationale statements constituted consent for the collection of anonymous survey data (**Appendix 1**). No incentive was offered for participation in any of the studies included herein. In every instance participants were able to request their data be withdrawn from the study before the given date by providing a unique code they entered at the end of the survey. The code was constructed using the last three digits of the participant's phone number, and the first three letters of their mother's maiden name. In this way no identifying information needed to be supplied by either the researcher or the participant in order to be removed from the project. To enable age and gender to be considered as factors, multiple-choice single-response questions were included at the beginning of the survey. To comply with the ethical requirements of the university, "prefer not to say" options were provided for all demographic questions, and an "other" category was provided for gender.

Sporting expertise research often defines experts based on their regional, national, or international competitive level; training or development programs; professionalism; or sport specific measures (Hüttermann, et al. 2018). However, due to the multifaceted nature of the equestrian industry, it is possible to have some experience of horses without ever having ridden one. As a result, using just one measure of sporting experience, such as professionalism, may not provide sufficient information. For example, Smyth and Dagley (2015) found that the majority of their horse-owning sample earnt less than 10% of their income from the equestrian industry, meaning that professionalism alone would not have been an appropriate measure of experience. Equally, there may be people who are not horse riders, but who do receive a considerable proportion of their income from the equestrian industry. As a result, experience in the equestrian industry was measured in a number of ways. Table 2.1 shows the equestrian experience questions used for analysis after grouping of small frequencies. Full surveys are available in **APPENDICES 2, 3, and 4**.

Table 2.1: Survey questions investigating respondent riding experience and involvement in equestrian sport, with a particular focus on eventing.

Are you employed within the equestrian industry? If yes, please specify.			
Yes (please specify)		No	
Do you participate in equestrian sport in any way? You may select more than one option.			
Rider	Owner	Coach	Family or friend of a rider/owner
Official	Volunteer	Sponsor	EHOA* member
Not at all	Other (please specify)		
Do you regularly ride a horse? (At least once a month)			
Yes, at least once a month	No		
I have in the past (please indicate how long ago this was)			
On average, how many times per month do/did you ride a horse? (if you ride two horses in one day, this is two times)			
1-10	11-20	21-30	More than 30
Which disciplines do you partake in? (please tick all that apply)			
Leisure riding	Dressage	Show-jumping	Eventing
Other (please specify)			
Have you ever evented at any level?			
Yes	No		
What is the highest level to which you have evented?			
80cm or less	90cm	100cm	110cm
110cm	115cm	120cm or more	120cm
Do you primarily event affiliated or unaffiliated?			
Affiliated (please specify which organisation you are affiliated with)			
Unaffiliated (please explain why you choose not to affiliate)			

* EHOA = The Event Horse Owners Association.

Questions were developed to investigate respondent participation in equestrian sport, and whether they were employed within the equestrian industry. Respondents were asked whether they regularly rode a horse, which was defined as at least once a month, and included people who had at one time ridden regularly but no longer did so. To determine the amount of riding done by each participant, they were asked to indicate how many times per month they rode a horse on average, and they were provided with options ranging from 1-5 times per month to more than 30 times per month. Participants were asked to tick which disciplines they took part in.

The considerable resources required, as well as the ethical and safety complications of pairing inexperienced riders with live horses, means that non-riders as a control group are often not considered in equitation science. In some instances, a riding simulator is a possible alternative (Temcharoensuk, et al. 2015), but this still incurs a cost and requires participants to be within reachable distance of the test location. This project utilised cross country video footage, meaning that no live horses were required and therefore non-riders could be included in **chapters 5** and **6**. Additionally, the online surveys for **chapters 3, 4,** and **6** enabled participation from anyone with access to the internet. This meant that riding experience could be compared to no riding experience, as well as different modes of involvement in equestrian sport, could be considered as factors. Non-rider groups were defined as individuals who had never ridden a horse as regularly as once a month. These non-rider participants were automatically directed past the riding-specific questions using survey routing. Riders were asked more specific questions about the frequency with which they rode, what disciplines they took part in, and whether they had competed in the sport of eventing. Any participant who had not taken part in eventing was routed past the eventing-specific questions. Highest competitive level of eventing was recorded as a measure of eventing specific experience.

Equestrian sports are internationally governed by the Fédération Equestre Internationale (FEI), and many nations have their own governing body affiliated to the FEI, such as British Equestrian in the UK. The FEI governs five different equestrian sports: jumping, dressage including para dressage, driving including para driving, endurance, and vaulting. It is important to note that there are a growing number of equestrian sports that are not governed by the FEI, and an even larger number of unaffiliated competitions. Preference towards affiliated or unaffiliated competitions was included as a measure of equestrian experience.

2.2. VIDEO SELECTION

Video clips were selected from eventing video footage filmed by the same organisation (An Eventful Life) in the UK during 2018. All video clips were filmed on one of two Panasonic camera models (HC-V180 or HX-WA30) at a resolution of 1280x720dpi and a frequency of 30fps. Cameras were mounted on static tripods in locations deemed acceptable and unobtrusive by British Eventing officials at each event. Video clips were only selected from video footage that provided good visibility of the horse, the rider, and the fence.

To represent the view most commonly available in commercial eventing video footage, all video clips used in the final survey were filmed from an oblique angle from the horse's direction of travel (Figure 2.1 and 2.2). To standardise the amount of visual information available to the participants, all videos included at least five strides of approach before the fence and were edited to a duration of 8000ms.

Figure 2.1: Example of oblique camera angle used to record cross country video footage.

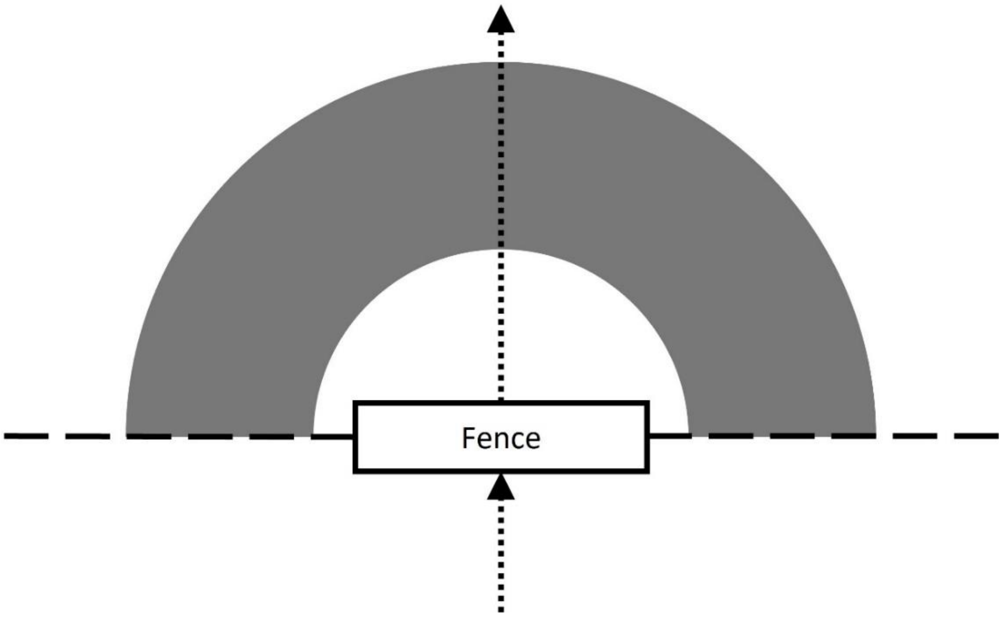


Figure 2.1: Schematic of usual camera positioning around a cross country fence. Dotted arrow shows direction of travel of horse and rider, dashed line is perpendicular to the direction of travel, and the shaded area demonstrates possible location of static camera.

In eventing, there are variation in the types, and dimensions of fences; the length of approach to a fence; the number of jumping efforts required in a combination fence; the line of approach; and the terrain (O'Brien 2016). The BE100 class was one of the most well populated classes in 2018, averaging approximately 130 competitors per event (British Eventing and Transport Research Laboratory 2019) Additionally, the BE100 class attracts entries from a combination of professional and amateur riders (British Eventing and EquiRatings 2022) making it a valuable and representative source of video data for the purposes of this study. To ensure that the fences shown were of the same approximate size and difficulty, only video footage from BE100 classes in the year 2018 was used. Some obstacles in eventing, hereafter referred to as combination fences, can have more than one element, labelled as A, B, C etc., which must be jumped in the correct order (British Eventing 2022). Successive elements of combination fences have been associated with increased risk of cross country jumping faults (Stachurska, *et al.* 2010). To reduce the influence of combination fences on participant response, video clips showed only singly numbered fences, i.e. fences that were not part of a combination, and were edited such that no footage of the previous jumping effort was included. British Eventing rules differentiate between obstacles that are in excess of 30 cm and those of 30 cm or less; the latter has a slightly more lenient definition of a "refusal" whereby the hesitation must be prolonged or include a step backwards (British Eventing 2022). Consequently, all the videos used were of fences at least 30 cm in height meaning that drop fences, open ditches, and simple water entries were not included. Table 2.2 presents a summary of the inclusion criteria for video clips.

Table 2.2: Inclusion criteria for video clips used to investigate perception of cross country video footage.

Inclusion criteria for video clips	
Fence related	**Video related**
Only singly numbered fences, none that were part of a combination	No excessive condensation on the lens
Only fences that were at least 30 cm in height	Always filmed from the front of the fence between 0° and 90° from the direction of travel
No drop fences, open ditches, or water entries	
Only BE100 in 2018 in the UK	

Where participants were required to select a potential jumping fault outcome (**chapters 4** and **6**) they were provided with the four options described by the governing body of international equestrian sport (FEI *et al.*, 2018, Table 2.3). The final 20 videos selected consisted of 10 successful and 10 unsuccessful jumping efforts; seven of which were refusals, two were horse falls, and one was a run-out. An additional two videos were used as demonstrations, they were of one successful jump and one rider-fall.

Table 2.3: Description of the possible outcomes of a cross country jumping effort (adapted from FEI *et al.*, 2018)

Outcome	Description
Clear jump	The horse and rider jump the obstacle successfully.
Refusal	The horse stops before the obstacle.
Run out	The horse avoids the obstacle without stopping.
Rider fall	The rider is separated from the horse but the horse remains upright.
Horse fall	The horse falls such that its body touches the floor.

2.3. IMPACT OF COVID-19

The onset of COVID-19 restrictions after it was declared a global pandemic on 11th March 2020 had a considerable impact on this project. Data collection for Chapter 5 required that the researcher and participant were both present in the same room and the same gaze-tracking equipment was used by subsequent participants. The lockdown measures which came into force on the 26th March 2020 forced this data collection to halt prematurely. As the COVID-19 restrictions continued, the possibility of being able to collect further gaze data was uncertain, so the decision was made to analyse the existing data only. As a result, the sample size was limited to 18 participants consisting of 8 riders and 10 non-riders. It is possible that this resulted in underpowered analysis (Schweizer and Furley 2016), but samples of this size are not uncommon within the field of gaze-tracking in sport (Kredel, et al. 2023). Due to the limited sample size, it was not possible to investigate differences between rider experience. To maintain validity in the data analysis it was decided that only differences between riders and non-riders would be assessed.

As the government restrictions continued to evolve, there was considerable uncertainty regarding the likelihood of carrying out in-person research (Camerlink, et al. 2021). This was particularly relevant in the case of ridden equestrian research because, though social distancing may have been achievable, the risk of injury was significant and it was not appropriate to put the National Health Service under unnecessary pressure (Williams, et al. 2020). As a result, an overwhelming proportion of the research project presented herein relies on self-reporting survey data collected online. Using online surveys enabled the continuation of the project while complying with COVID-19 government restrictions and was resistant to future changes in the guidelines.

2.4. DATA ANALYSIS

Statistical significance was reached when $p \leq 0.05$. Results were considered very significant if $p<0.01$, and extremely significant if $p<0.001$. Where odds ratios were stated, they provide a measure of how far from independence the 2x2 table was, which can be interpreted as an effect size. Odds ratios were calculated using the conditional maximum likelihood estimation method (R Core Team 2022). In instances where all respondents selected a certain outcome on a survey question, meaning that the corresponding cell in a 2x2 table presented a sampling zero, this may have resulted in an odds ratio of 'Inf' or 0.00. One possible solution to this was to add 0.5 to each cell, thereby removing the sampling zero, but this has implications for interpretation of the odds ratios (Subbiah and Srinivasan 2008). It was decided that sampling zeros would be left in place, but it should be noted that odds ratios of either 0.00 or 'Inf' are indicative of data that were unanimously clustered to one outcome.

2.5. GENERAL METHODOLOGICAL LIMITATIONS

Pre-recorded commercially available video footage was utilised for this study, so that any results could be applicable to users of similar footage. The video clips used were of BE100 fences during 2018. This class was chosen to be representative of British eventing entries, while assuming the inclusion of both professional and amateur riders. It is possible that different competitive levels may have elucidated different results, but the likelihood of participants recognising the rider may have increased with competitive level. There were no reports that any participants recognised the rider in any of the video clips, though this factor was not specifically investigated. Future studies may wish to utilise video footage of more than one fence, or multiple videos of the same fence, in case familiarity with either the horse and rider combination, or the obstacle, demonstrates an influence.

The order of the survey questions was the same for every participant, but in the studies that require the viewing of video footage, the order that the videos were presented was randomised by the respective software. This means that though there could have been some subject-fatigue throughout the studies, the effect of this should have been diminished by the randomisation of video order (Randle, *et al.* 2017). On the other hand, randomisation of the video order meant that any effect of video order could not be measured.

CHAPTER 3: DID YOU PRESS RECORD? PERCEIVED VALUE OF SELF-SUBJECT RIDDEN VIDEO FOOTAGE IN EQUESTRIANISM.

3.1. INTRODUCTION

Sport provides the opportunity to collect enormous quantities of data that can be utilised for performance analysis (Williams 2012). Equitation science, a concept aimed at developing scientific measures of the interaction between horse and rider (McGreevy 2007), is not universally supported by the equestrian population (Thompson and Haigh 2018). As a result, performance analysis in equestrianism has taken time to gain popularity (Williams 2013), and the complex interactions between horse and rider make recording objective data difficult (Williams and Tabor 2017). Equestrian sport differs from most in that some disciplines are heavily standardised, such as dressage, while others are variable, such as show jumping and cross country. Despite these challenges, there has been an increase in the amount of commercially available video footage recorded on cross country courses. Riders can now review video footage of large sections of their cross country round, which is not generally feasible for those attempting to film solely on personal devices.

Video footage is an established method used to study performance in sporting contexts (O'Donoghue 2006). Some examples include tennis (Mecheri, *et al.* 2016) and football (Kolbinger and Knopp 2020), where video footage is regularly used to determine whether the ball remained within the boundaries of the competition area. Sports which are played in standardised arenas, courts, or fields offer the possibility of permanent and advanced video technology such as computer-based match analysis (Fuchs, *et al.* 2018; Sarmento, *et al.* 2014), video assistant referees, or television match officials (Kolbinger and Knopp 2020). On the other hand, sports that are played in a variety of environments, under varying weather conditions and across varying terrains, such as horse-riding, are more challenging to film. Recently, efforts have been made to use video footage to understand how the way in which a rider falls may influence the resulting injury in eventing (Nylund, *et al.* 2021), and racing (Nylund, *et al.* 2022). However, there is a paucity of literature evaluating how riders use video footage for their own purposes.

As technology has developed, the ability to record and share sporting events has become increasingly accessible to the general public (Weixian, *et al.* 2017). Video footage is more widely available than ever before, in both professional and amateur formats. For video footage to exist, the recorder must have been motivated to capture a moment in time, usually by emotional or functional incentives (Lux and Huber 2012). Equally, someone must be motivated to then watch the video after recording, and this motivation is dependent on the value they place on video footage. This study was part of a wider project designed to identify how ridden video footage might be useful to a variety of stakeholders within the equestrian industry. Understanding the factors associated with rider intention to engage with ridden video footage would mean that future implementation of the technology could be more targeted. The goal of this particular chapter was to investigate which factors may influence equestrians' decision to film, watch, or analyse video footage of their own riding. By highlighting values attributed to video footage of ridden performance, this research hopes to describe rider engagement with video feedback. Understanding how riders engage with video feedback, and identifying which factors are perceived as the most valuable, is important for improving the uptake of video-based performance analysis.

3.2. LITERATURE REVIEW

3.2.1. Video for performance analysis in sport

In a training session, video review can be used in conjunction with coach feedback to enable the athlete to understand the coach's perspective (O'Donoghue 2006). While horse riding, for example, comprehending and visualizing the entirety of the horse's actions can be challenging. Video footage can be used for assessment of both positive and negative aspects of performance and can be instructional, or motivational (O'Donoghue 2006). One implementation of video review is the method of video modelling, which uses observational learning to encourage positive performance. Observational learning is achieved through observation of behaviour performed by either the self or others (Middlemas and Harwood 2020). It can be used to model skills or practices that the observer is attempting to learn or improve upon (Law and Ste-marie 2005). Modelling can be implemented using videos of experts performing a target behaviour (Blagus, *et al.* 2023; Boyer, *et al.* 2009). In most cases of expert modelling, it is typically expected that the expert and novice are engaged in the same task. However, in equestrianism, due to the inherent variability among individual horses and riders, attempting to replicate an identical task is unlikely to yield valuable feedback. Another form of observational learning is the practice known as video self-modelling, whereby the observer is the subject of the video and the video presents them performing a behaviour (Middlemas and Harwood 2020; Dowrick 1999; Creer and Miklich 1970). Sometimes the video presented will have been edited to present a fictional, but aspirational, performance by the observer, known as feed-forward self-modelling (Law and Ste-marie 2005). Otherwise, the video may present actual footage of successful performances the observer has performed, known as positive self-review (Law and Ste-marie 2005). The goal of both of these methods is to provide the observer with personal mastery experiences, which are thought to enhance self-efficacy (Bandura 1978). Individual differences between athletes may influence their perception of video feedback, and in particular their ability to cope with negative feedback (Groom and Cushion 2005). Equestrian sport is repeatedly regarded as a partnership, meaning that both self-efficacy and other-efficacy beliefs will influence the cognitive processes of the rider (Beauchamp and Whinton 2005). Associations have been noted between pre-competition anxiety and lower self-confidence in riders (Wolframm and Micklewright 2009). Delivering positive self-review video immediately prior to competition may have a positive effect on feelings of efficacy. Perception of self-review using video will influence athlete intention to engage with such training methods. Understanding rider attitudes towards video footage of their own riding may enable more successful integration of video review in equestrian training.

3.2.2. Motivations for recording video

Actions stem from intentions, and intentions will be driven by a person's underlying attitudes, beliefs, and values (Rohlf, *et al.* 2010). There may be external drivers of behavioural intention too, such as tradition or social norms, the importance of which will be influenced by the belief system of the individual (Broms, *et al.* 2020). A sentimental person may place value on capturing and preserving memories, which may lead them to record and store photographic and videographic data (Lux and Huber 2012). On the other hand, a person who values pragmatism over nostalgia may also record video footage but for the purposes of future analysis or personal gain rather than for value as memorabilia. To understand the utilisation of video footage, it is necessary to first understand the behavioural motivators behind recording it in the first place.

User feature preferences have been investigated previously in technology such as mobile phones (Rashid, *et al.* 2020) and software (Trendowicz 2013), but very little is known about the functions desirable in sport videography. One of the most popular functions of mobile phones is the ability to take photos and record video footage, meaning that almost everybody has the ability to record sport to some degree (Rashid, *et al.* 2020). Whilst it is now possible for anyone to record video footage whenever and wherever they wish, their reasons for doing so are varied and often context specific. It has been proposed that motivations for recording video footage include the desire to preserve or to share affective or functional characteristics of the material that is recorded (Lux and Huber 2012). Often there is more than one reason behind having recorded a video (Lux and Huber 2012). The functional characteristics of a video could be related to a person's profession or hobby, such as when skills or performances are recorded for review or demonstration. Video recordings in sport, for example, are often shared with members of the athlete's support team such as the coach or physiotherapist to assess performance and technique (Wilson 2008). When used tactfully, video-review may provide insights into a rider's performance and areas for improvement. To engage with the practice of video self-review, riders must appreciate the value of it, but the characteristics of video footage they deem important are not yet known.

3.3. AIM AND OBJECTIVES

The aim of this study was to identify factors which may influence rider intentions to engage with video footage of their own riding by filming, watching, or analysing it. This was achieved through the following objectives:

- Describe rider intent to engage with video footage of their own riding in the future.
- Investigate the association between individual demographics, including riding experience, and rider intention to engage with video footage of their own riding.
- Examine how perception of characteristics of self-subject ridden video footage relates to future ridden video intentions.

By establishing the characteristics of ridden video footage deemed important to riders, future implementation of video self-review could be developed to optimise its perceived value. Identifying how riders currently utilise their ridden video footage may enable trainers, researchers, and professionals in the equestrian industry to better understand how to integrate video review in the assessment of performance in both training and competitive environments.

3.4. MATERIALS AND METHODS

3.4.1. Data collection

An online survey was constructed with the goal of collecting information about the equestrian population's current use of video footage of their own riding. The survey was granted a favourable ethical review by Nottingham Trent University and no identifying information was collected. Participation was entirely voluntary and there was no incentive or reward for completing the survey. The survey was created using Qualtrics (Qualtrics 2023) and distributed via the Facebook (https://www.facebook.com/) pages managed by the researcher and the funding collaborators. To ensure accessibility and clarity, the survey was piloted by a group of five volunteers (one horse owner, one coach, two friend/family of riders/owners, and one non-equestrian). Pilot testing took place between the 7th and 18th February 2022 and survey responses were collected between 25th February-10th March 2022.

3.4.2. Survey design

Questions regarding respondent demographics and equestrian experience followed the same format as described in **chapter 2**. Perceived values associated with self-subject ridden video footage were developed as a series of multiple-choice questions in which respondents could select all the options that applied to them (**Appendix 2**).

Check-all-that-apply methodology has been predominantly used in food consumer preference testing, often with lists of sensory characteristics of a product (Dooley, *et al.* 2010; Parente, *et al.* 2011; Lee, *et al.* 2013). This methodology can also be used to investigate perceived attributes of a product, such as its application to specific circumstances (Parente, *et al.* 2011). Check-all-that-apply was used here to produce a user-friendly and easy-to-complete survey for capturing respondent perceptions of self-subject ridden video footage (Dooley, *et al.* 2010). Promotional material, comments, and reviews published on social media and website pages of commercial equestrian video footage companies were collated and categorised into themes (see Table 3.1 for breakdown). The resulting themes were 'scenario' which referred to the situation in which people were likely to record their riding, and 'immediacy' which referred to how soon after recording they would want to watch the footage. Aspects of 'functionality' were noted, such as the ability to rewind, edit, and watch frame-by-frame. 'Application' was defined as the purpose of recording the video, and 'social value' was a measure of who else the rider would choose to show the video to. Lastly, the specific 'points of focus' within the video were grouped together to indicate what particular aspect of the video the rider would allocate their attention to.

Table 3.1: Categorisation of published statements from commercial equestrian video footage suppliers. Categories were then used to develop multiple-choice options for an online survey designed to investigate public perception of self-subject ridden video footage.

Category	Options
Scenario	• "Much of the lesson…will be forgotten…a video journal helps…" • "Individual coaching sessions with private trainers" • "Cross country clinics"
Immediacy	• "Vast archive of cross country videos stretching back to 2015" • "Our archives go back to 1992" • "Be able to demonstrate how well they have come on" • "I received the video today after only competing yesterday"
Functionality	• "Once you receive the video you can reply with editing requests" • "Watch their video over and over again just to see what went right, what went wrong and how they can do better next time" • "…the slow mos at the end are brilliant." • "A bespoke video of you and your horse can then be edited" • "We also operate a commercial video service"
Application	• "You can watch and download the video…No one else can watch it. You have the ability to make the video Private and Public at any time on the website" • "View and download the video…Everyone else can view it" • "…drive awareness, recognition, engagement and loyalty…" • "Promotional videos for equestrian centres" • "Super useful"
Social value	• "…review and share your … ride with friends, family, coaches and the rest of the world!" • "Such a lovely thing to have and to be able to show others"
Focus	• "Keep your video private…or review with your coach" • "Improve your performance … better understanding of how you ride" • "…captured such an amazing round for us we had the best day…" • "…a wonderful video from which I can learn from. It was my mare's first ever event, so it was great to actually see her go round." • "We were unable to watch our horse event in the week but seeing his full round … feel like we were there" • "As the spectator I don't get to see all the jumps in a course when it's being ridden so seeing each one in the video was great". • "Such a lovely reminder of a great weekend!" • "I didn't think they rode as well as the video shows!" • "Great to have … training purposes … memories of the event"

The perceived values were categorised into six categories: scenario, immediacy, functionality, application, social value, and points of focus (Table 3.2). Each category was constructed using a check-all-that-apply methodology (Parente, *et al.* 2011; Lee, *et al.* 2013). The goal of this methodology was to quantify the respondent's perception of the six values attributed to video footage of their own riding. The outcome of this approach was the creation of metrics that represented the respondent's perception of the importance of the six categories.

Table 3.2: Categories of perceived values attributed to video footage of own horse riding performance. CATA=check-all-that-apply. These were presented in an online survey designed to investigate public perception of self-subject ridden video footage.

Category	Options	Maximum CATA score
Scenario	Training at home Training away from home Competition	3
Immediacy	Immediately A day after filming A week after filming A month after filming A year after filming	5
Functionality	Pause Slow-motion Frame-by-frame Edit Zoom Ability to play a specific section Replay ability	7
Application	Show to coach or trainer Promotional purposes Advertise a horse Share my riding on social media Watch by myself Choose who could watch	6
Social value	Friends Family Coach/trainer	3
Focus	Riding errors Riding highlights Falls Jumping faults Rider behaviour and position Horse behaviour and position Particular achievements or occasions	7

In addition to assessing perceived values, the survey also recorded respondent intentions for future engagement with ridden video footage. Six statements were constructed to indicate intent to engage with ridden video footage which were then grouped into intent to film, intent to watch, and intent to analyse (Table 3.3).

Table 3.3: Grouping of horse-rider survey respondent intention to utilise self-subject ridden video footage.

I intend to…	Grouped intent
Film my own riding in the future	**Intent to film**
Ask someone else to film my own riding in the future	
Purchase a video of my own riding in the future	**Intent to watch**
Watch previously recorded video footage of my own riding	
Analyse my own riding from video footage	**Intent to analyse**
Ask someone else to analyse my riding from video footage	

3.4.3. Data analysis

Reported intentions to film, watch, and analyse one's own riding were recorded using tick boxes. These three intentions were used to form contingency tables with each variable. A series of fisher's exact tests identified any associations that may have existed between individual variables and respondent into to film, watch, and analyse video footage of their riding in the future. Fisher's exact tests were considered more appropriate than the chi-squared tests used by Lee, Findlay and Meullenet (2013), or the Cochran's Q test used by Parente, Manzoni and Ares (2011) due to the small frequencies. In this way, an indication of what factors may influence respondent intention to film, watch, or analyse their video footage could be presented. Post-hoc testing was undertaken when the result of the Fisher's exact test indicated an association with a significance level of $p<0.05$. Pairwise Fisher's exact tests were utilised for post-hoc testing to obtain odds ratios and 95% confidence intervals (R Core Team 2022). To control the false discovery rate, significance level was adjusted for post-hoc pairwise comparisons using the Benjamini-Hochberg method (Hervé 2022; Benjamini and Hochberg 1995).

Survey data were imported from Qualtrics into Microsoft Excel (Microsoft Corporation 2018). Incomplete responses were removed, and analysis was conducted on 66 respondents (N=66). All other analysis was conducted in R-studio (R Core Team 2022). Fisher's exact tests were conducted using the 'fisher.test' function from the stats (version 3.6.2) package provided by R-Statistics (R Core Team 2022). Pairwise comparisons were conducted using 'fisher.multcomp' from the RVAideMemoire (version 0.9-81-2) package (Hervé 2022).

3.5. RESULTS

The results present data from respondents (N=66) who agreed to answer questions about filming and watching their own riding. All respondents had ridden a horse regularly, which was defined as at least once a month. Five of the 66 respondents were not currently riding, but they had ridden regularly in the past. All responses were from female respondents. Using the method demonstrated by Vivian *et al.* (2022), a sample of 66 female respondents represents a margin of error of ±12% at the 95% confidence interval (SurveyMonkey Inc. 2023). This calculation assumes a population of approximately 1.8 million regular riders (BETA 2019a).

3.5.1. Intent to film, watch, and analyse future ridden video footage

A large proportion of respondents stated that they intended to film (N=59, 89%), watch (N=57, 86%) and analyse (N=56, 85%) future video footage of their own riding (Table 3.4). For convenience, Table 3.5 presents a summary of the factors that demonstrated significant associations with video intention outcomes after adjustment. The table also indicates the corresponding subsection where each result is described.

Table 3.4: Reported intentions to film, watch, and analyse self-subject ridden video footage by horse-rider survey respondents (N=66).

I intend to…	N	%	Intent	N	%
Film my own riding in the future	42	64	**Intent to film**	59	89
Ask someone else to film my own riding in the future	55	83			
Purchase a video of my own riding in the future	40	61	**Intent to watch**	57	86
Watch previously recorded video footage of my own riding	51	77			
Analyse my own riding from video footage	53	80	**Intent to analyse**	56	85
Ask someone else to analyse my riding from video footage	35	53			

Table 3.5: Summary of significant associations between survey categories and horse-rider respondent intent to film, watch, and analyse self-subject ridden video footage.

Factor	Intent to film	Intent to watch	Intent to analyse	Subsection
Age	-	-	-	3.5.2
Equestrian employment	-	-	X	3.5.3
Equestrian sport participation	-	-	-	3.5.4
Ride frequency	-	-	-	3.5.5
Discipline	-	-	-	3.5.6
Previously bought video	-	X	-	3.5.7
Scenario	-	X	X	3.5.8
Immediacy	-	-	-	3.5.9
Functionality	-	-	-	3.5.10
Application	-	-	-	3.5.11
Social value	-	X	X	3.5.12
Focus	-	-	-	3.5.13

3.5.2. Age

In the sample of 68 respondents, the 46-55 age group was the most well represented (N=19, 29%), with the 36-45 group being the smallest (N=9, 14%). Table 3.6. demonstrates the reasonably even spread of age groups.

Table 3.6: Age distribution of respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

Age category	N	%
18-25	13	20
26-35	17	26
36-45	9	14
46-55	19	29
Over 55	10	15

No association was identified between age and the intent to watch self-subject ridden video footage (p=0.31). However, a significant association was found between age and the intent to film ($p<0.05$, Table 3.7), as well as the intent to analyse ($p<0.05$).

None of the pairwise comparisons reached significance once the p-values were adjusted ($p>0.05$ in all cases).

Table 3.7: Association between age and intent to film, watch, and analyse self-subject ridden video footage in an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

Age	Intent to film		Intent to watch		Intent to analyse	
	N (%)		N (%)		N (%)	
	No	Yes	No	Yes	No	Yes
18-25	2 (3)	11 (17)	1 (2)	12 (18)	2 (3)	11 (17)
26-35	0 (0)	17 (26)	1 (2)	16 (24)	1 (2)	16 (24)
36-45	0 (0)	9 (14)	1 (2)	8 (12)	0 (0)	9 (14)
46-55	2 (3)	16 (24)	4 (6)	14 (21)	4 (6)	14 (21)
Over 55	4 (6)	5 (8)	3 (5)	6 (9)	5 (8)	4 (6)

3.5.3. Equestrian employment

Out of the 66 respondents, 21 individuals (32%) reported being employed within the equestrian industry. Additional information provided by these respondents included positions such as coach, groom, and working on an equestrian yard.

There was no association found between employment in the equestrian industry and the intent to film ($p=0.25$) or watch ($p=0.71$) self-subject ridden video footage. However, a significant association was observed between employment in the equestrian industry and the intent to analyse such video footage ($p<0.01$, OR:Inf, CI: 1.54-Inf, Table 3.8).

All respondents who reported being employed in the equestrian industry unanimously expressed an intent to analyse ridden video footage in the future.

Table 3.8: Association between employment in the equestrian industry and the intent to analyse self-subject ridden video footage ($p<0.01$) in an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

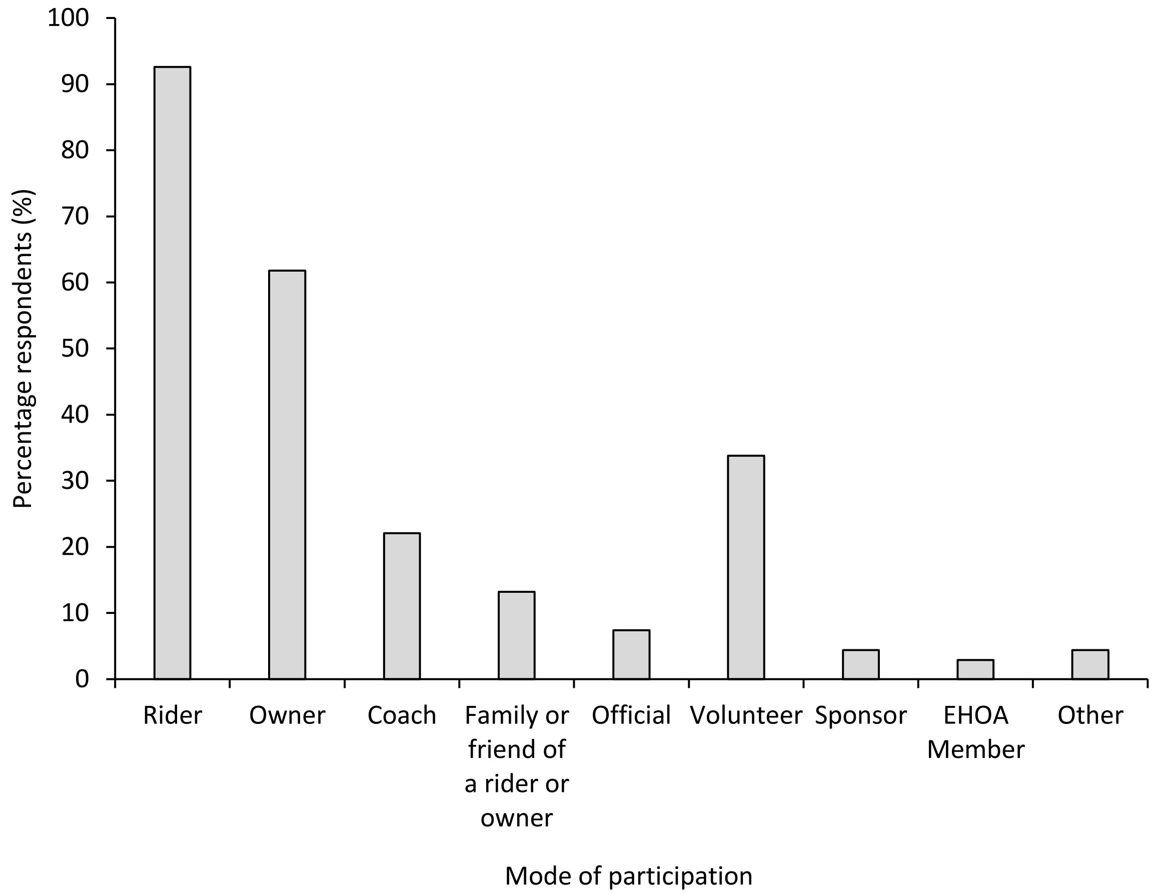
	Intent to Analyse N (%)	
Employed in equestrian industry	**No**	**Yes**
No	12 (18)	33 (50)
Yes	0 (0)	21 (32)

3.5.4. Participation in equestrian sport

Out of the total 66 respondents, a majority of 63 individuals (93%) participated in equestrian sport as riders. Among the respondents, 42 individuals (62%) were owners of horses, and 23 individuals (34%) volunteered in some capacity for equestrian sport (Figure 3.1).

For the three who reported "other" methods of participation, the additional free text information identified their participation in equestrian sport as "barn manager", "groom", and "photographer".

Among the 63 respondents who reported participating as riders, 39 individuals were also owners of horses, 22 individuals volunteered in some way, and 14 individuals were coaches.



<u>Figure 3.1:</u> Modes of participation in equestrian sport of respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66). EHOA = Event Horse Owners Association.

To quantify the level of participation in equestrian sport, the number of different options selected by each respondent was calculated. The most common result, N=27 (40%), was participating in two different roles in equestrian sport (Table 3.9). None of the respondents reported participating in seven or more different roles.

No association was identified between the number of roles in equestrian sport and respondent intent to either film (p=0.18), watch (p=0.13), or analyse (p=0.48) self-subject ridden video footage in the future.

Table 3.9: Number of different modes of participation in equestrian sport reported by respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

Number of modes of participation	N	%
1	14	21
2	27	41
3	16	24
4	7	11
5	3	5
6	1	2
≥7	0	0

3.5.5. Ride Frequency

The most common response was riding between 21 and 30 times per month (N=22, 33%, Table 3.10). No significant association was found between ride frequency and the intent to either film (p=0.95) or watch (p=0.21) future self-subject ridden video. However, a significant association was identified between respondent ride frequency and their intent to analyse video footage of their own riding (p<0.05, Table 3.11). After adjustment, no significant association could be identified. Those who rode more than 30 times per month were unanimous in their intent to analyse ridden video footage in the future.

Table 3.10: Ride frequency of respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage, defined as number of times riding a horse per month (N=66).

Ride frequency	N	%
1-10	7	11
11-20	20	30
21-30	22	33
More than 30	17	26

<u>Table 3.11:</u> Association between the number of times riding a horse per month and respondent intent to analyse self-subject ridden video footage (*p*<0.05) as recorded by an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66). (N=66).

Ride Frequency	Intent to Analyse N (%)		
	No	Yes	Total
1-10	1 (2)	6 (9)	7 (11)
11-20	7 (11)	13 (20)	20 (30)
21-30	4 (6)	18 (27)	22 (33)
More than 30	0 (0)	17 (26)	17 (26)

3.5.6. Discipline

Figure 3.2 provides an overview of the disciplines in which the respondents participated. Dressage was the most reported discipline (N=48, 73%). Among the respondents, the most common combination of disciplines reported was participating in both dressage and show jumping (N=38, 58%). No significant association was identified between participation in leisure riding, dressage, show jumping, eventing, or other disciplines, and respondent intent to either film, watch, or analyse their own riding via video footage ($p>0.05$ in all cases, Table 3.12).

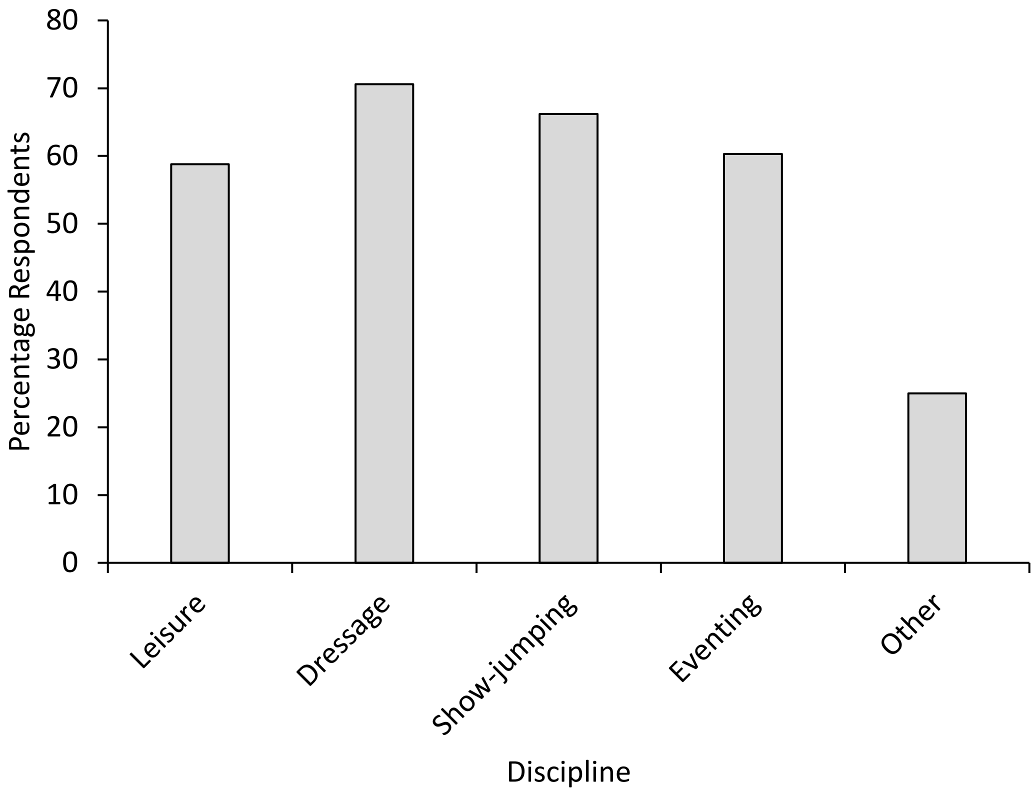


Figure 3.2: Disciplines reportedly partaken in by respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

3.5.7. Previously bought video

Approximately half of the respondents (N=31, 46%) had paid money for video footage of their riding in the past. A significant association was identified between having paid for a video before, and the respondent's intent to watch video footage in the future ($p<0.05$, OR:10.1, CI: 1.25-468.86). No association was observed between having bought a video in past, and respondent intent to either film ($p=0.27$) or analyse ($p=0.76$) future video footage.

Table 3.12: Association between survey respondent having bought ridden video previously, and intent to watch such video in the future (N=66).

Bought video previously	Intent to watch N (%) No	Intent to watch N (%) Yes
No	9 (14)	26 (39)
Yes	1 (2)	30 (45)

3.5.8. Scenario

When asked where they would film themselves riding, 52 (79%) respondents stated that they would record themselves whilst training, either at home or away. Additionally, 54 individuals (82%) stated that they would record themselves during competition. Two respondents selected "other" and specified that they use video for "online dressage at home" and while hacking.

A significant association was detected between the number of scenarios in which a rider would choose to film themselves and their intent to watch ($p<0.05$) and analyse ($p<0.05$) ridden video footage in the future (Table 3.14).

Compared to those who would only film in one scenario, riders who reported that they would film themselves in three different scenarios were significantly more likely to intend to watch ($p<0.05$, OR:9.68, CI:1.33-117.38) and analyse ($p<0.05$, OR:8.51, CI:1.46-64.29) ridden video footage in the future.

Table 3.13: Associations between the number of different scenarios in which a survey respondent would film their own riding, and their intent to watch and analyse ridden video footage in the future. (N=66).

Number of scenarios	Intent to watch N (%)		Intent to analyse N (%)	
	No	**Yes**	**No**	**Yes**
1	5 (8)	9 (14)	6 (9)	8 (12)
2	3 (5)	10 (15)	3 (5)	10 (15)
3	2 (3)	37 (56)	3 (5)	36 (55)

3.5.9. Immediacy

Most respondents (N=56, 85%) reported that they would watch their own ridden video footage immediately (Table 3.15). Interestingly, over 30% of respondents reported that they would watch their video footage a year after filming. Those who selected "other" reported that they would view their video footage multiple times, and one respondent stated that they would view their footage when they had "the time to view and learn".

Table 3.16 demonstrates that the most common result was to select only one time point for watching the video footage (N=31, 47%). However, 15 (23%) respondents selected all five options, indicating their intention to watch the footage at various time points. No significant association was identified between the number of post-filming timepoints selected, and respondent intent to film (p=0.26), watch (p=0.09), or analyse (p=0.12) future self-subject ridden video footage.

Table 3.14: Immediacy with which respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage would watch such video footage (N=66).

When	N	%
Immediately	56	85
A day after filming	37	56
A week after filming	25	38
A month after filming	22	33
A year after filming	25	38

Table 3.15: Number of selected time-points post filming respondents to an online survey, designed to investigate horse-rider perception of self-subject ridden video footage, would watch such video footage (N=66).

Number of timepoints selected	N	%
0	1	2
1	30	45
2	7	11
3	10	15
4	3	5
5	15	23

3.5.10. Functionality

When asked what functions they would use while watching their video, the majority (N=63, 95%) of respondents stated that they would watch their video more than once (Table 3.17). Table 3.18 indicates that the most common result was to select three different functions (N=17, 26%).

Significant associations were found between the number of video functions selected and respondent intent to film, watch, and analyse future video footage of their own riding ($p<0.05$ in all cases, Table 3.19). Post-hoc tests did not reach significance when investigating differences between levels ($p>0.05$ in all cases).

Table 3.16: Valuable video functions reported by respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

	N	%
I would…		
Pause my video at specific points	46	70
Watch my video in slow-motion	29	44
Watch my video frame-by-frame	16	24
Zoom in on a section of my video	28	42
Play a specific section of my video	34	52
Watch my video more than once	63	95
Edit my video	16	24

Table 3.17: Number of different video functions selected by respondents to an online survey designed to investigate horse-rider perception of self-subject ridden video footage (N=66).

Number of video functions selected	N	%
1	13	20
2	8	12
3	17	26
4	6	9
5	11	17
6	7	11
7	4	6

Table 3.18: Associations between number of video functions indicated as valuable and respondent intent to film, watch, and analyse self-subject ridden video footage. (N=66)

Number of functions	Intent To Film N (%)		Intent To Watch N (%)		Intent To Analyse N (%)	
	No	Yes	No	Yes	No	Yes
1	2 (3)	11 (17)	4 (6)	9 (14)	6 (9)	7 (11)
2	4 (6)	4 (6)	4 (6)	4 (6)	3 (5)	5 (8)
3	0 (0)	17 (26)	2 (3)	15 (23)	1 (2)	16 (24)
4	0 (0)	6 (9)	0 (0)	6 (9)	0 (0)	6 (9)
5	2 (3)	9 (14)	0 (0)	11 (17)	2 (3)	9 (14)
6	0 (0)	7 (11)	0 (0)	7 (11)	0 (0)	7 (11)
7	0 (0)	4 (6)	0 (0)	4 (6)	0 (0)	4 (6)

3.5.11. Application

The majority of respondents (N=57, 86%) stated that they would watch the video footage by themselves (Table 3.20), and 44 (67%) stated that they would show the video footage to their coach or trainer. One respondent stated that they would not use the video footage. Two respondents ticked the "other" option and provided free-text responses of "I have not considered this" and "I would ask a coach to watch the video and critique it".

Table 3.19: Ways in which horse-rider respondents to an online survey would use video footage of their own riding (N=66).

Application	N	%
Show the video footage to my coach or trainer	44	67
Use video footage for promotional purposes	4	6
Use video footage to advertise a horse	18	27
Share video footage of my riding on social media	38	58
Watch video footage of my riding by myself	57	86
Choose who could watch the video footage of my riding	35	53

The most common result was for respondents to tick three different utility options (Table 3.21). No significant association was found between the number of potential uses selected by the respondent, and their intent to film (p=0.15), watch (p=0.05), or analyse (p=0.15) future video footage of their riding.

Table 3.20: Number of different possible uses for self-subject ridden video footage as indicated by respondents to an online survey (N=66).

Number of applications	N	%
1	13	20
2	13	20
3	18	27
4	15	23
5	5	8
6	2	3

3.5.12. Social value

When asked who else would like to watch video of the respondents riding, the majority stated that their coach or trainer would like to watch (N=53, 80%, Table 3.22). One respondent selected "other".

Table 3.21: Parties, other than the subject of the footage, who would like to watch ridden video footage, as perceived by survey respondents (N=66).

Who else would like to watch it	N	%
No-one	3	5
Friends	47	71
Family	46	70
Coach/Trainer	53	80

The most common result was for respondents to state that three different parties would be interested in watching video footage of their riding (N=27, 40%, Table 3.23). The number of interested parties was considered a measure of social value attributed to ridden video footage. Significant associations were identified between the number of interested parties perceived by the respondent, and the respondent's intent to film ($p<0.05$), watch ($p<0.05$) and analyse ($p<0.05$) future self-subject video footage (Table 3.24). Post-hoc testing revealed significant associations between social value and respondent intent to watch ($p<0.05$, OR:Inf, CI:1.95-Inf), and intent to analyse

($p<0.05$, OR:Inf, CI:1.75-1054.48, Table 3.24). Those who reported a higher perceived social value, specifically three interested parties, were unanimous in their intent to watch ridden video footage, and all but one expressed an intent to analyse such footage.

Table 3.22: Number of different parties perceived to be interested in watching video footage of the survey respondent's riding (N=66).

Number of interested parties	N	%
0	3	5
1	11	17
2	25	38
3	27	41

Table 3.23: Association between number of different parties perceived to want to watch video footage of the respondent's riding and survey respondent intent to film, watch, and analyse self-subject ridden video footage (N=66).

Number of interested parties	Intent To Film N (%)		Intent To Watch N (%)		Intent To Analyse N (%)	
	No	**Yes**	**No**	**Yes**	**No**	**Yes**
0	2 (3)	1 (2)	1 (2)	2 (3)	1 (2)	2 (3)
1	0 (0)	11 (17)	4 (6)	7 (11)	5 (8)	6 (9)
2	4 (6)	21 (32)	5 (8)	20 (30)	5 (8)	20 (30)
3	2 (3)	25 (38)	0 (0)	27 (41)	1 (2)	26 (39)

3.5.13. Focus

All respondents (N=66, 100%) stated that they would assess their own behaviour and position while watching video footage of their own riding (Table 3.25). Two respondents selected the "other" category. The "other" responses provided were "all in order to improve for the future" and "to document any rides I have".

Table 3.24: Survey respondent reported areas of focus when watching self-subject ridden video footage (N=66).

Focus	N	%
Riding errors	62	94
Riding highlights	51	77
Falls	20	30
Jumping faults	26	39
My behaviour and position	66	100
The horse's behaviour and position	4	6
Particular achievements or occasions	46	70

The most common result was for respondents to select five of the seven possible motives (N=21, 32%, Table 3.26). No significant association was identified between the number of motives and the respondent's intent to film their riding in the future (p=0.10) or analyse future video footage of their riding (p=0.37). There was however a significant association between the number of motives and the intent to watch future video footage of their riding (p<0.01, Table 3.27). Post-hoc testing did not reveal any significant differences between the levels of the variable.

Table 3.25: Number of points of focus in self-subject ridden video footage selected by horse-rider survey respondents (N=66).

Number of points of focus	N	%
1	1	2
2	3	5
3	9	14
4	10	15
5	21	32
6	8	12
7	14	21

<u>Table 3.26:</u> Association between number of different points of focus selected and survey respondent intent to film, watch, and analyse self-subject ridden video footage (N=66).

Number of points of focus	**Intent To Film N (%)**		**Intent To Watch N (%)**		**Intent To Analyse N (%)**	
	No	**Yes**	**No**	**Yes**	**No**	**Yes**
1	0 (0)	1 (2)	1 (2)	0 (0)	1 (2)	0 (0)
2	2 (3)	1 (2)	1 (2)	2 (3)	1 (2)	2 (3)
3	2 (3)	7 (11)	4 (6)	5 (8)	2 (3)	7 (11)
4	0 (0)	10 (15)	2 (3)	8 (12)	2 (3)	8 (12)
5	2 (3)	19 (29)	2 (3)	19 (29)	4 (6)	17 (26)
6	0 (0)	8 (12)	0 (0)	8 (12)	0 (0)	8 (12)
7	2 (3)	12 (18)	0 (0)	14 (21)	2 (3)	12 (18)

3.6. DISCUSSION

Most respondents reported some intention to film (87%), watch (84%), or analyse (82%) video footage of their own riding in the future. Only four of the metrics designed to assess perception of ridden video footage significantly related to these outcomes. Riders who had previously purchased video footage of their own riding were significantly more likely report an intention to watch similar video footage in the future. Additionally, those who were employed in the equestrian industry intended to analyse their ridden footage more than those who were employed elsewhere. Finally, those who stated that they would film while training at home, away from home, and at competition, and those who perceived video footage of their own riding to hold considerable social value, intended to both watch and analyse it in the future.

Lux and Huber (2012) reported that people often have multiple reasons for recording video footage, but the results of the present study found no associations between any of the video perception factors and rider intent to film their own riding. The associations that did exist, appeared to indicate that perception of video may influence intent to watch, and analyse ridden video footage, rather than the intent to film it. It has long been understood that intention to perform a behaviour, such as filming one's own riding, will be influenced by a person's attitude and perception of that behaviour (Ajzen 1991). Participants who had previously purchased videos were more likely to express an intention to watch their riding videos. This suggests that past experiences with video purchases may influence individuals' attitudes and interest in utilising video footage.

Interestingly, there was an association between being employed in the equestrian industry and the intent to analyse ridden video footage. Those who were employed in equestrianism were unanimous in their report that they intended to analyse future footage of their own riding. Professional involvement in the equestrian field may contribute to a higher appreciation for the benefits of video analysis in improving riding performance. Being employed in equestrianism may imply a financial interest in improving performance, be that through riding, coaching, or grooming. There is some evidence to suggest that equestrians will take more risks when there is a financial incentive (Chapman, *et al.* 2020). Being motivated by the potential for increased business or recognition may have led to a greater desire for performance improvement which may, in turn, have led to the intent to analyse video footage. On the other hand, there is the possibility that those employed in equestrianism may have been led to report intent to analyse by the influence of social desirability bias, that is the urge to misrepresent oneself to comply with what they believe is the socially acceptable response (Kreuter, *et al.* 2008). It is hoped, however, that the online distribution may have limited the effect of this bias due to the anonymity of responses compared to alternative methods such as interviews (Kreuter, *et al.* 2008).

Frequency of riding was not found to be an influential factor. Those who reported riding more than 30 times per month were unanimous in their intent to analyse self-subject ridden video footage. This finding suggests that individuals with a higher frequency of riding may have a greater desire to assess their performance through video analysis, potentially to identify areas for improvement or track progress over time. If those respondents were riding as a professional, then they were likely to have different motivational pressures compared to an amateur rider. These respondents are likely to be subject to more severe scrutiny, and monetary risk, than novice amateurs. More generally, high-level athletes who earn most of their livelihood through sport, may suffer from greater pressure to be successful in order to continue earning money than amateur or non-athletes (Hong and Fraser 2021).

The value of sharing video footage with others has been identified in the past as one of the reasons that people may choose to record a video (Lux and Huber 2012), but the action of sharing video requires a perception that someone else would want to watch it. Most (78%) respondents in the present study stated that their coach or trainer would want to watch it, and some also reported that their friends (69%) or family (68%) would be interested. Three respondents, however, reported that they knew no-one who would like to watch video footage of their riding. The social value factor indicated the number of different interested parties, as perceived by the respondent, and there were significant associations with all three of the video related intention; to film, watch, and analyse. Those who stated that three separate groups of people (the maximum available) would have an interest in watching their ridden video footage were more likely to report an intention to film and analyse their footage than those who only selected one interested party. Intent to watch was also significantly related, but not to the point that differences between the levels could be identified. This highlights the potential influence of social factors and external validation in motivating individuals to engage in video analysis and share their riding experiences with others. When considering the practice of sharing video footage, there are a number of elements which need to be considered; the audience, the subject, and the motivation. For instance, an individual may choose to share a video of a fall they experienced, but their motivation to do so is unlikely to be the same motivation that leads them to share promotional material. The nature of sharing video footage to social media is that it is often viewed by a far larger audience than would have seen the original performance. Selective patterns of sharing media online have been investigated with respect to mass-media (Johnson and Ranzini 2018). Sharing of personal equestrian videos, however, has yet to be investigated. Equestrian sport must operate under a social licence which is being more closely scrutinised than ever with the globally increased understanding of animal welfare. Researchers must be aware of the public interest in horse welfare for competition and seek to understand ridden practices (Lemon, *et al.* 2020). Any video footage portraying equestrian sport has the potential to highlight various aspects of equestrianism which may be deemed controversial.

The majority of respondents stated that they would watch the video footage immediately, indicating some perceived value to watching the video (Lux and Huber 2012). One such benefit to watching video immediately after performing a task is that it can enable an athlete to more accurately self-assess their performance (Nowels and Hewit 2018; Horswill, *et al.* 2017). Similarly, video recordings of performance may help to counteract time-related memory decay which can cause event riders to mis-remember their scores (Murray, *et al.* 2004). Self-modelling interventions have suggested that watching footage of oneself performing the best examples of certain skills immediately prior to a competition has the potential to improve those skills (Middlemas and Harwood 2020). Similar utilisation of self-subject ridden video footage may have applications for either self-assessment, or performance enhancement of specific skills. This may be particularly applicable for disciplines which do not tend to change too much between venues, such as dressage. Disciplines such as show-jumping and cross country, on the other hand, may not be similar enough to the recorded footage to be of specific skill-related benefit. It is possible that watching one's own performance, whether that be in equestrian sport or any other field, could lead to feelings of unease (Faccio 2013). When there is a conflict between the respondent's higher order goal, and their desire to avoid discomfort, there is often a drop in motivation (Taylor, *et al.* 2020) and hence their intent to record their own performance. Consequently, there are likely to be associations between personality and their use of self-subject ridden video footage (Groom and Cushion 2005), and research has already highlighted some differences in conscientiousness between competitive level of riders (Wolframm, *et al.* 2015). The interaction between horse and rider during ridden work is so complex that training programs which can be undertaken independent of the horse may be of particular value. Video review enables psychological training of the rider without the impact of the presence of a horse. Further investigation into the various impacts that either self- or other-modelling may have on performance in equestrianism would be beneficial.

3.6.1. Applications to industry

Existing literature has identified differences in risk of faults or falls between different types of fences in the show jumping (Marlin and Williams 2020) and cross country (Singer, *et al.* 2003; Bennet, *et al.* 2021; Hennessy 2017; Murray, *et al.* 2006). What is still relatively unknown, is why these fences might be riskier than others. Interestingly, all respondents (N=66, 100%) reported that they would attend to their own behaviour and position, but only four (6%) reported that they would watch the horse's behaviour and position. Equine behaviour can provide indications as to the physical and psychological well-being of the horse, which may in turn lead to predictors of future behaviour (McGreevy and McLean 2007). Video evidence of the behaviours demonstrated immediately prior to faults and falls at high-risk fences may contribute to the understanding of poor jumping performance.

The survey presented here was limited by a reasonably small sample size (N=66) of only female respondents, meaning that the results are not able to be extrapolated to a wider population of riders. There was a reasonably even spread of age groups, and all levels of riding frequency were represented meaning that responses from a wide variety of riders were collected. The options provided for the video characteristics were developed using a review of the publicly available marketing from commercial equestrian video supplies. As a result, the results may have been targeted towards commercially produced video footage, rather than type of footage that can be recorded on mobile phones. High quality video technology for equestrians has become more available, such as robotic cameras which can track your movements, and free analysis software is also available. This means that while the options were developed based on information provided by professional video companies, many of the features included are easily available to the general riding population.

In an attempt to optimise participation, the survey was developed using check-all-that-apply methodology, meaning that data was largely categorical. Future studies may consider the use of semi-structured interviews or focus groups combined with thematic analysis to glean more insight into rider opinions. The present study serves as an introduction to rider perception of some of the characteristics of ridden video footage, and it is hoped that the information provided here can be used to develop video training programs which integrate the elements of video footage that this sample of riders appeared to find relevant.

Though the current project focussed on video use in equestrian sport, similar investigation into engagement with video footage may benefit other sports. Video footage has been valued for its use in coaching due to its ability to record performance objectively, even when the coach is not present (Wilson 2008). There have also been examples of using pre-formulated instructional video as an intervention, such as the “Rugby Ready” video used by Kerr at al. (2018). Incidentally, an instructional video suggesting good and bad cross country riding behaviours is available online (British Eventing 2012), though this author is not aware of its use in any published literature.

Employment in the equestrian industry is just one of the possible means of involvement in equestrianism and often requires a broad range of skills. Participation in equestrian activities can be dangerous even when not mounted (Davies, et al. 2022a; Davies, et al. 2021) as discussed in the context of racing grooms by Davies *et al.* (2021).

3.7. CONCLUSION

The results of this study appeared to indicate that, for this sample of horse-riders, an association existed between their perceived value of video footage of their own riding and their intent to film, watch, and analyse such footage in the future. Although this sample size was small, the data provides an initial exploration into the values held by riders with respect to video footage of their own riding. Further investigation into the visual analysis that takes place while watching ridden video footage would develop understanding of the role video can play in performance improvement. If marginal gains could be attained by exploiting relatively inexpensive and easily accessible video data, it could demonstrate the potential benefits of using video as a valuable and low-risk tool in sporting contexts more widely.

CHAPTER 4:
GO OR WOAH?
RIDER PERCEPTION OF HOW HORSE AND RIDER BEHAVIOURS AT CROSS COUNTRY FENCES MAY INFLUENCE JUMPING FAULTS.

4.1. INTRODUCTION

Equestrianism has its foundations in tradition and word-of-mouth experience (McLean and McGreevy 2010b), with the concept of ‘feel’ being reported by many equestrians as an important element of interacting with horses (Thompson and Haigh 2018). As a result, there is a disconnect between the traditional practices used in equestrianism, and equitation science (Thompson and Haigh 2018). As technology has developed, so too have methods of measuring movement (Baxter, *et al.* 2022). Although this technology which can be fitted to individual horses and riders does exist, it is rarely used in day-to-day scenarios. The implication being that equestrian stakeholders are generally reliant on their own observations of horse and rider behaviour. An understanding of the interaction between horse and rider behaviour may enable causal factors of advantageous or deleterious outcomes to be identified (McGreevy and McLean 2007). Horse and rider stress levels are likely to be higher in a competitive environment when compared to a training environment (Valera, et al. 2012; Wolframm and Micklewright 2011) which could impact behaviour and therefore performance. However, collecting data in a competitive ridden environment is challenging due to rules regarding what equipment can be worn (Fédération Equestre Internationale 2021; British Eventing 2022) and the logistics of conducting research in a busy, and often remote, environment. The increased availability of video footage of competitive performance has provided a non-intrusive and easily accessible method of collecting behavioural records in the competitive setting. The study presented here was part of a larger project aimed at investigating the value of eventing video footage, with a particular focus on commercially available cross country video.

Recently, ridden equine behaviour in competitive environments has begun to be explored (Dyson and Ellis 2020; Wells, *et al.* 2022), but thus far behaviours in a cross country setting have only been minimally investigated (Bridle, et al. 2023). Performance analysis describes the association between sport-specific behaviours or actions and their performance outputs (McGarry 2009). This is particularly complex when considering the horse-rider dyad in equestrian sport because the behaviours and actions of each could directly influence the other (Beauchamp and Whinton 2005). The word-of-mouth method of disseminating knowledge in the equestrian industry may lead to beliefs and attitudes that are based on individual experiences, rather than on scientific evidence (McLean and McGreevy 2010b). To better understand the role that performance analysis may have in the equestrian industry, it is necessary to understand current perception of sport-specific behaviours of both horse and rider and how they might influence performance outputs. This study will explore how the general rider population perceive cross country behaviours of both horse and rider using the performance outputs of refusal, run-out, rider-fall and horse-fall.

4.2. LITERATURE REVIEW

Traditional riding practices incorporate the use of negative reinforcement using points of contact primarily between the rider and the horse's back, mouth, and sides; more generally referred to as the seat, hand, and leg aids (McGreevy and McLean 2007). The observable elements of communication between rider and horse are often evaluated by non-riding parties, such as judges (Christensen, et al. 2021) or trainers. The application of stimuli by the rider have been investigated using sensors which can measure aspects of horse-riding such as rein tension (Dumbell, *et al.* 2019) and asymmetric or localised saddle pressure (Greve and Dyson 2013; Peham, *et al.* 2010). Leg aids are more difficult to monitor in-situ, but can be measured using horse-riding simulators (Eskola and Handroos 2013). It has also been reported that the different positions of sitting trot, rising trot, and the two-point seat will alter the stability of the rider (Peham, et al. 2010). A 'two-point seat' refers to the two points at which the rider's legs make contact with the saddle when the rider moves forward (Peham, et al. 2010). This position is thought to enable the rider to follow the motion of the horse more easily, particularly when the horse jumps an obstacle, and provide the most stability and the lowest amount of force on the horse's back (Peham, *et al.* 2010). Though this may be true in a controlled trot on a treadmill as demonstrated by Peham *et al.* (2010), during more dynamic riding tasks such as navigating around a cross country course, the position of the rider is likely to vary throughout the course, as it does in endurance (Williams, *et al.* 2021). Most cross country fences are jumped out of canter, which is an asymmetric gait and has a leading limb (Clayton and Hobbs 2017). As a result, fences jumped on a left-hand turn tend to be approached in canter with the left leg leading, and right-hand turns tend to lead with the right leg (Print 2011). The interaction between the horse and rider while ridden, clearly means that the biomechanical movements of each will influence the other, meaning that a change in leading leg in the canter will be felt by the rider (Williams and Tabor 2017).

Traditional training of the ridden horse is that they must be taught to distinguish between pressure on the left and right rein, and understand that they are expected to slow down or stop if pressure is applied to both (McLean and McGreevy 2010b). Variation in rein pressure is to be expected in modern equestrianism, but excessive rein pressure may be detrimental to horse welfare (Dumbell, *et al.* 2019). It should also be considered that inappropriate or untimely rein pressure could confuse the horse, potentially leading to conflict behaviours which may put the safety and competitive success of the horse and rider dyad at risk (McLean and McGreevy 2010a). Conflict behaviours are when the horse may behave in a way that is unexpected, undesirable or dangerous (Fenner, *et al.* 2020). Common conflict behaviours in ridden horses include spooking which can be considered a sudden change of direction which was not cued by the rider, and napping which can be described as a reluctance to move forwards (Dyson 2021). The other conflict behaviours often mentioned in equestrianism are rearing and bucking, where the horse takes either both front feet or both back feet off the ground respectively (Dyson 2021), which can unbalance the rider.

Such conflict behaviours on a cross country course can lead to jumping faults such as run-outs or refusals, which in competitive eventing will accumulate penalties and may lead to elimination (British Eventing 2022). Further possible jumping faults include rider-falls and horse-falls, both of which will result in immediate elimination and have the potential for injury to both horse and rider (Ekberg, *et al.* 2011). Due to the considerable risk of serious injury or death, the majority of eventing risk research has focussed on the impact of falls and how they can be reduced (Murray, *et al.* 2005; O'Brien 2016; Singer, *et al.* 2003; Foreman, *et al.* 2019; Murray, *et al.* 2006; Hennessy 2017; Bennet, *et al.* 2021). It should, however, be considered that the physical impact of sudden changes of direction or speed, such as those experienced when a horse refuses or runs-out at a fence, could also be detrimental to the horse's physical wellbeing (Yarnell, *et al.* 2019). Non-fall jumping faults have a considerable impact on competitive performance (Fédération Equestre Internationale 2021; British Eventing 2023; Stachurska, *et al.* 2010), and could contribute to feelings of anxiety or unease in riders, potentially leading to less safe riding practices (McGinn, *et al.* 2019). Accordingly, it is useful to consider non-fall outcomes such as refusals and run-outs, as well as horse and rider falls, when assessing performance.

4.3. AIM AND OBJECTIVES

Animal behaviour can be defined as “the way in which an animal works, functions or responds to a particular situation” (Wilson, et al. 2018; Tinbergen 1960). For the purposes of this study, the term ‘behaviour’ will also apply to any action, position, aid, or other influence the rider may have on a horse. The interaction between horse and rider behaviours is complex, though it is likely that riders have preconceived ideas of how those behaviours may influence performance outcomes (Thompson and Haigh 2018). The aim of this study was to investigate rider perception of horse and rider behaviours most associated with cross country jumping faults. This was achieved through the following objectives:

- Develop a list of horse and rider behaviours relevant to risk of jumping faults during the cross country phase in eventing.
- Describe horse and rider behaviours that riders perceive as risk factors for jumping faults during the cross country phase in eventing.
- Determine associations between behaviours and jumping fault outcomes as perceived by riders.

The results of this study have the potential to identify behaviours which are perceived by riders as being predictive of jumping faults. A better understanding of horse and rider behaviour in competitive cross country environments could lead to improved decision making by riders, coaches, and officials. In addition to riders, this knowledge is also applicable to event organisers, who bear a responsibility for participant safety, and fence judges, who play a crucial role in promptly assessing and addressing such risks.

4.4. MATERIALS AND METHODS

4.4.1. Data collection

An online survey (**Appendix 3**) was constructed which explored rider perception of cross country horse and rider behaviours which may result in jumping faults or falls. The survey was granted a favourable ethical review by Nottingham Trent University and no identifying information was collected. Participation was entirely voluntary and there was no incentive or reward for completing the survey. The survey was created using Qualtrics (Qualtrics 2023) and distributed via the Facebook (https://www.facebook.com/) pages managed by the researcher and the funding collaborators. To ensure that the survey was accessible and understandable, it was piloted by a group of five rider volunteers between the 7th and 18th February 2022. Responses were collected between 25th February-10th March 2022. Survey data were imported from Qualtrics into Microsoft Excel (Microsoft Corporation 2018). Incomplete responses were removed, and analysis was performed on the data provided by 73 respondents (N=73). All other analysis was conducted in R-studio (R Core Team 2022).

4.4.2. Survey design

Questions regarding respondent demographics and equestrian experience were as described in **chapter 2**. Horse behaviours were included if they had been mentioned ridden horse behavioural literature and eventing documentation (Table 4.1). Rider behaviours were included if they were refenced in the British Eventing rulebook (British Eventing 2020), or demonstrated in the British Eventing informational "safe cross country riding" video (British Eventing 2012). The 22 eventing video clips described in **chapter 2** were also played for a senior level 5 event coach and international event rider (T. Canton, personal communication, 15th September 2021) who was asked to narrate the behaviours shown by the horse and rider. Those responses were transcribed and converted into categories of behaviours. Behaviours were only included if they were deemed observable from commercially available video footage (An Eventful Life 2023) to fit with the wider project aim of creating results applicable to industry. Horse and rider behaviours were presented in categories and respondents were asked to select those that they felt would increase the risk of a cross country jumping fault occurring.

Table 4.1: Horse behaviours included in an online survey investigating perception of horse and rider cross country behaviours and their association with jumping faults.

Horse behaviour	Levels	Justification for inclusion
Head and neck	Head shaking side-to-side Head shaking up and down Lifting head on approach to fence Lowering head on approach to fence Inconsistent head carriage Turning head to the left or right on approach to fence	(Dyson 2021; Hall, et al. 2014a; Thomson, et al. 2020)
Mouth and tongue	Holding mouth open Opening and closing mouth Tongue sticking out Tongue moving in and out of the mouth	(Dyson 2021; Hall, et al. 2014a; Górecka-Bruzda, et al. 2015)
Ears	Ears pointing backwards the majority of the time Ears pointing forwards the majority of the time Ears switching between forwards and backwards One ear pointing forwards and the other ear pointing backwards	(Hall, et al. 2014a)
Tail	Tail lifted away from the quarters Tail held close to the quarters Tail held to one side Tail swishing side-to-side Tail swishing up and down	(Dyson 2021; Górecka-Bruzda, *et al.* 2015)
Gait	Horse dropping out of canter Incorrect canter lead for direction of approach	(Dyson 2021; Hockenhull and Creighton 2012)
Conflict	Rear Buck Nap Spook	(Dyson 2021; Hockenhull and Creighton 2012)
Speed	Too fast on approach Too slow on approach Speeding up Slowing down Inconsistent speed on approach	(Murray, *et al.* 2006)

The survey was designed such that respondents were first asked to select as many rider behaviours they felt increased the risk of a jumping fault on a cross country course. The behaviours selected by the respondent were then carried forward to the next set of questions which asked the respondent to indicate which jumping fault outcome they felt was most likely as a result. The FEI (Fédération Equestre Internationale 2017) and British Eventing (British Eventing 2023) describe refusals, run-outs, rider-falls and horse-falls as possible fault outcomes; these options were therefore provided for this questionnaire. To encourage respondents to compare the likelihood of each outcome and select the one they perceived to be most likely, respondents were only able to select one outcome for each behaviour carried forward. The same series of questions were repeated for behaviours shown by the horse.

4.4.3. Data analysis

Contingency tables were constructed from the behaviours and their likely respondent-selected outcomes. To test for equality between groups, exact multinomial goodness-of-fit tests were implementing using the 'multinomial.test' and the 'multinomial.multcomp functions from the RVAideMemoire (version 0.9-81-2) package (Hervé 2022). Where tables were too complex for the exact multinomial test to run, chi-squared goodness-of-fit tests were used instead.

Additional investigation was conducted to compare frequencies within levels, provided the row totals reached a minimum of 20 responses to enable expected values of at least five for each possible outcome of refusal, run-out, rider-fall, and horse-fall. This restriction was chosen based on the suggestion that chi-squared tests recommend the sample size equals at least the number of cells multiplied by five (Mchugh 2013). Although the statistical tests used in this study were almost exclusively exact binomial and multinomial tests, rather than chi-squared tests, it was necessary to implement a minimum group size to avoid either type 1 or type 2 errors.

4.5. RESULTS

A total of 73 responses were collected from people who rode a horse at least once a month either at the time of survey completion or in the past. The sample consisted of 13 (18%) people aged 18-25, 18 (25%) aged 26-35, 12 (16%) aged 36-45, 19 (26%) aged 46-55, eight (11%) ages 56-65, and three (4%) aged over 65. Twenty-three (32%) of the respondents were employed in the equestrian industry, and 17 (23%) rode a horse more than 30 times per month. The most common disciplines partaken in by the respondents were dressage (N=51, 70%), show-jumping (N=49, 67%), and leisure riding (N=44, 60%). Fifty-six respondents (77%) had evented at some level.

Using the method demonstrated by Vivian *et al.* (2022), a sample of 73 respondents represented a margin of error of ±11% at the 95% confidence interval (SurveyMonkey Inc. 2023). This calculation assumes a population of approximately 1.8 million regular riders (BETA 2019a).

When considering these results, it is important to emphasise that the behaviours included were selected by participants of an online survey as being potential precursors to a cross country jumping fault of either a refusal, run-out, rider-fall, or horse-fall. Similarly, the outcome data presented are not suggesting that these jumping faults are the most likely to happen, only that they were considered by the survey participants to be the most likely jumping fault outcome as a result of the behaviours they had previously selected. Percentages are only listed when all respondents viewed the question. Once respondents had selected a behaviour as being likely to lead to a cross country jumping fault, they were asked to specify the most likely outcome. This meant that not all respondents were able to respond to every question, meaning that percentages for individual outcomes would be misleading.

Giving inconsistent rein aids was selected by the greatest number of respondents (N=71, 97%) as being a potential precursor to a cross country jumping fault, followed by the rider having an inconsistent upper body position (N=68, 93%), and the horse demonstrating napping behaviour (N=68, 93%).

Excluding those categories which did not reach the minimum number of 20 responses which was required for further investigation, the behaviours least often identified as potential risk factors were the horse slowing down on approach to the fence (N=20, 27%), the rider kicking (N=20, 27%), and the rider having unlevel shoulders (N=20, 27%).

The behaviours most often suggested to cause a refusal were the horse napping (N=58), the horse dropping out of canter on approach to the fence (N=50), the horse's ears pointing backwards the majority of the time (N=49), and the rider not giving any leg aids (N=49).

Run-outs were thought to be most often caused by the horse spooking (N=35), the horse turning its head to the left or right (N=29), or the rider giving inconsistent rein aids (N=26).

When considering rider-falls, the behaviours most often indicated to be risk factors were the rider's foot being positioned in front of their hip (N=46), or the rider having an inconsistent upper body position (N=29). Equal third most commonly identified as being risk factors for rider-falls were the horse bucking (N=22), the rider's thigh not being in contact with the saddle (N=22), and the rider's head being positioned in front of their torso (N=22).

Horse-falls were thought to be caused most often by the horse's approach speed being too fast (N=40), the rider preparing the horse for the fence too late (N=31), or not preparing the horse for the fence at all (N=24).

4.5.1. Rider head

The rider's head being in front of their torso (N=50, 68%) was considered significantly more likely to cause a cross country jumping fault than their head being behind their torso (N=24, 33%, $p<0.01$, Table 4.2).

The rider's head being positioned in front of the torso was thought to be significantly more likely to cause either a refusal (N=24) or a rider-fall (N=22) than either a run-out (N=4) or a horse-fall (N=0, $p<0.001$ in all cases). No other pairwise comparisons within this group could be considered significantly different ($p>0.05$ in all cases).

When the rider position of having their head further back than their torso was considered, respondents deemed it significantly more likely to cause a refusal (N=12) than either a run-out (N=2, $p<0.05$) or a horse-fall (N=1, $p<0.05$). Additionally, a rider-fall (N=9) was considered significantly more likely than a horse-fall (N=1, $p<0.05$).

Table 4.2: Event rider head positions indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
Rider head…		N			N	%
In front of torso	24	4	22	0	50	68
Behind torso	12	2	9	1	24	33

4.5.2. Rider torso

Having an inconsistent upper body position (N=68, 93%) was considered a risk factor significantly more frequently than either having unlevel shoulders (N=20, 27%, $p<0.001$), leaning forward (N=30, 41%, $p<0.001$), or leaning backward (N=11, 15%, $p<0.001$, Table 4.3).

Leaning backward (N=11, 15%) did not reach the minimum number of 20 respondent selections, so this category was not investigated further.

No participants reported that the rider's shoulders being unlevel would be likely to cause either a rider-fall, or a horse-fall. Unlevel shoulders were thought to be significantly more likely to cause a run-out (N=18) than a refusal (N=2, $p<0.001$) or a fall by either the rider (N=0, $p<0.001$) or the horse (N=0, $p<0.001$). No significant difference was seen between the perception that unlevel shoulders were likely to cause a refusal (N=2) compared to a rider-fall (N=0, $p=0.5$) or a horse-fall (N=0, $p=0.5$).

No participants reported that leaning forward was likely to cause a horse-fall (N=0). Leaning forward was considered to be significantly more likely to cause a rider-fall (N=17, 23%) than a horse-fall (N=0, $p<0.001$), or a run-out (N=12, $p<0.001$), but not significantly more likely than a refusal (N=12, $p=0.55$). Leaning forward was also deemed significantly more likely to cause a refusal (N=12) than a run-out (N=1, $p<0.01$) or a horse-fall (N=0, $p<0.001$).

Having an inconsistent upper body position was considered to be significantly less likely to cause a horse-fall (N=3) than a refusal (N=17, $p<0.01$), run-out (N=19, $p<0.01$), or a rider-fall (N=29, $p<0.001$). The differences between refusal (N=17) and run-out (N=19, p=0.87), refusal and rider-fall (N=29, p=0.16), and run-out and rider-fall (p=0.23) were all non-significant.

Table 4.3: Event rider upper body positions and the cross country jumping fault outcomes they were perceived to cause as indicated by online survey responses (N=73).

	Outcome				**Total**	
	Refusal	Run-out	Rider-fall	Horse-Fall	N	%
Shoulders unlevel	2	18	0	0	20	27
Leaning forward	12	1	17	0	30	41
Leaning backward	6	2	2	1	11	15
Inconsistent	17	19	29	3	68	93

4.5.3. Rider hand

The rider's hand being above the level of the elbow (N=46, 63%) was reported as a risk factor significantly more often than the hand being below the level of the elbow (N=26, 36%, $p<0.05$, Table 4.4).

The rider holding their hands below the level of the elbow was considered to be significantly more likely to cause a refusal (N=12) or run-out (N=12) than either a rider-fall (N=0, $p<0.01$) or a horse-fall (N=2, $p<0.05$). No other pairwise comparisons within this group reached statistical significance ($p>0.05$ in all cases).

An extremely similar result was found for the rider holding their hands above the level of the elbow. A refusal (N=23) was considered significantly more likely than either a rider-fall (N=3, $p<0.001$) or a horse-fall (N=4, $p<0.001$), and a run-out (N=16) was considered significantly more likely than either a rider-fall (N=3, $p<0.01$) or a horse-fall (N=4, $p<0.05$). No other pairwise comparisons within this group reached statistical significance ($p>0.05$ in all cases).

Table 4.4: Event rider hand positions, and the cross country jumping fault outcomes they were perceived to cause, as indicated by online survey responses (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
Rider hands…	N				N	%
Below the level of the elbow	12	12	0	2	26	36
Above the level of the elbow	23	16	3	4	46	63

4.5.4. Rider leg position

The rider's foot being positioned behind their hip (N=59, 81%) was deemed to be significantly more likely to cause a cross country jumping fault than either the foot being in front of the hip (N=18, 25%, $p<0.001$) or the rider's thigh not being in contact with the saddle (N=33, 45%, $p=0.01$, Table 4.5). The thigh not being in contact with the saddle (N=33) was also thought to be significantly more likely to cause a fault than the rider's foot being in front of the hip (N=18, $p<0.05$).

The rider's foot being in front of their hip (N=18, 25%) did not reach the minimum number of at least 20 responses, so this category was not investigated further.

The rider's foot being behind the hip was thought to be a likely precursor to a cross country jumping fault by 59 respondents (81%). The majority of those respondents stated that having the foot behind the hip was likely to cause a rider-fall (N=46) which was significantly more than either a refusal (N=5, $p<0.001$), a run-out (N=8, $p<0.001$), or a horse-fall (N=0, $p<0.001$). The rider's foot being behind the hip was also deemed significantly more likely to cause a run-out (N=8) than a horse-fall (N=0, $p<0.05$).

Table 4.5: Event rider leg positions and the cross country jumping fault outcomes they were perceived to cause as indicated by online survey responses (N=73).

	Refusal	Run-out	Rider-fall	Horse-Fall	Total N	Total %
Foot in front of hip	9	2	7	0	18	25
Foot behind hip	5	8	46	0	59	81
Thigh not in contact with saddle	5	6	22	0	33	45

4.5.5. Rider prep

Preparing the horse for a fence too early (N=16, 22%) was deemed significantly less likely to cause a cross country jumping fault than either preparing the horse too late (N=54, 74%, $p<0.001$) or not preparing the horse at all (N=65, 89%, $p<0.001$, Table 4.6). No significant difference was seen between the likelihood of preparing the horse too late and not preparing the horse at all ($p=0.36$).

Preparing the horse for the fence too early (N=16, 22%) did not reach the minimum of 20 responses, so this category was not further investigated.

Not preparing the horse for the fence was thought to be significantly less likely to cause a rider-fall (N=1) than either a refusal (N=24, $p<0.001$), run-out (N=16, $p<0.001$), or a horse-fall (N=24, $p<0.001$). No significant difference was seen between the likelihood of not preparing the horse for the fence causing a refusal, run-out, or horse-fall ($p>0.05$ in all cases.

Preparing the horse for the fence too late was reported as significantly more likely to cause a horse-fall (N=31) than either a refusal (N=13, $p<0.05$), a run-out (N=9, $p<0.01$) or a rider-fall (N=1, $p<0.001$). Additionally, preparing the horse for the fence too late was thought to be significantly less likely to cause a rider-fall (N=1) than either a refusal (N=13, $p<0.01$), or a run-out (N=9, $p<0.05$). No significant difference was seen between the likelihood of preparing the horse for the fence too late causing a refusal (N=13) or a run-out (N=9, p=0.52).

Table 4.6: Variations of preparing the horse for a cross country fence and the cross country jumping fault outcomes they were perceived to cause as indicated by online survey responses (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Not preparing the horse for the fence	24	16	1	24	65	89
Preparing the horse for the fence too early	8	3	0	5	16	22
Preparing the horse for the fence too late	13	9	1	31	54	74

4.5.6. Rider leg aid

Not giving any leg aids (N=64, 88%) was thought to be significantly more likely to cause a cross country jumping fault than kicking (N=20, 27%, p<0.001, Table 4.7).

A significant difference was seen between the possible outcomes of kicking (p<0.05), but post-hoc tests did not reach significance for any combination of the outcomes (p>0.05 in all cases).

Not giving any leg aids was thought to be significantly more likely to cause a refusal (N=49) than either a run-out (N=13, p<0.001), a rider-fall (N=0, p<0.001), or a horse-fall (N=2, p<0.001). Additionally, not giving any leg aids was thought to be significantly more likely to cause a run-out (N=13) than either a rider-fall (N=0, p<0.001) or a horse-fall (N=2, p<0.01). There was no significant difference between the likelihood of not giving leg aids causing either a rider-fall (N=0) or a horse-fall (N=2, p=0.5).

<u>Table 4.7:</u> Descriptions of event rider leg aids indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Kicking	8	7	5	0	20	27
No leg aids given	49	13	0	2	64	88

4.5.7. Rein aid

Inconsistent rein contact (N=71, 97%) was deemed significantly more likely to cause a cross country fault than either pulling on the reins (N=36, 49%, $p<0.01$) or pushing the reins forward (N=35, 48%, $p<0.01$, Table 4.8). There was no significant difference between the likelihood of a cross country fault as a result of pulling on the reins (N=35) and pushing the reins forward (N=36, $p=1.00$).

Pulling on the reins was deemed significantly more likely to cause a refusal (N=29) than either a run-out (N=2, $p<0.001$), a rider-fall (N=1, $p<0.001$) or a horse-fall (N=3, $p<0.001$).

Pushing the reins forwards was thought to be significantly more likely to cause a run-out than a fall of either rider (N=2, $p<0.001$) or horse (N=2, $p<0.001$). No other pairings were found to be statistically significant ($p>0.05$ in all cases).

Inconsistent rein contact was reportedly significantly more likely to cause a refusal (N=26) or a run-out (N=26) than either a rider-fall (N=3, $p<0.001$) or a horse-fall (N=4, $p<0.001$).

Table 4.8: Descriptions of event rider rein aids indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Pulling	29	2	1	3	35	48
Pushing	10	22	2	2	36	49
Inconsistent	26	26	3	4	71	97

4.5.8. Whip use

Around half of respondents reported that using the whip more than once either in front (N=40, 55%) or behind (N=34, 47%) the saddle may lead to jumping faults (Table 4.9). Using the whip more than once in front of the saddle (N=40, 55%) was thought to be significantly more likely to cause and cross country jumping fault than either using the whip once in front of the saddle (N=11, 15%, $p<0.001$) or once behind the saddle (N=9, 12%, $p<0.001$). Additionally, use of the whip more than once behind the saddle (N=34, 47%) was thought to be significantly more likely to cause a cross country jumping fault than either using the whip once behind the saddle (N=9, 12%, $p<0.001$) or once in front of the saddle (N=11, 15%, $p<0.01$). No significant difference was seen between the likelihood of a cross country jumping fault as a result of using the whip once either in front (N=11, 15%) or behind (N=9, 12%) the saddle ($p=0.82$). Nor was there a significant difference between using the whip more than once in front of the saddle (N=40, 55%) or behind the saddle (N=34, 47%, $p=0.67$).

Using the whip once either in front of (N=11, 15%) or behind (N=9, 12%) the saddle did not reach the minimum requirement of being selected by at least 20 respondents, so post-hoc testing was not carried out for these groups.

A rider-fall as the result of using the whip more than once in front of the saddle (N=3) was found to be significantly less commonly predicted than either a refusal (N=23, $p<0.001$) or a run-out (N=13, $p<0.05$). Similarly, a horse-fall as a result of using the whip more than once in front of the saddle (N=1) was also found to be less commonly predicted than either a refusal (N=23, p<0.001) or a run-out (N=13, p<0.01). There was no significant difference between the likelihood of a rider-fall (N=3) and a horse-fall (N=1, p=0.63), or between the likelihood of a refusal (N=23) and a run-out (N=13, p=0.16) when the whip was used more than one in front of the saddle.

An extremely similar pattern was seen for the use of the whip more than once behind the saddle. Refusals (N=18) were deemed significantly more likely than either rider-falls (N=2, p<0.01) or horse-falls (N=2, p<0.01), and run-outs (N=12) were significantly more likely than rider-falls (p<0.05) or horse-falls (p<0.05).

Table 4.9: Descriptions of event rider whip use indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Once in front of saddle	4	5	1	1	11	15
More than once in front of saddle	23	13	3	1	40	55
Once behind saddle	5	3	0	1	9	12
More than once behind saddle	18	12	2	2	34	47

4.5.9. Horse head and neck

The horse lifting their head on approach to the fence (N=10, 14%) was deemed significantly less likely to cause a cross country jumping fault than either head shaking side-to-side (N=41, 56%, p<0.001), head shaking up and down (N=32, 44%, p<0.01), inconsistent head carriage (N=31, 42%, p<0.01), or turning the head to the left or right on approach to the fence (N=39, 53%, p<0.001, Table 4.10). There was no significant difference between the likelihood of a cross country jumping fault as a result of the horse lifting its head on approach to a fence (N=10) and the horse lowering its head on approach (N=24, 33%, p=0.07). All other combinations of horse head and neck behaviour were not significantly different in terms of their likelihood of causing a cross country jumping fault ($p>0.05$ in all cases).

The option of the horse lifting its head up on approach to the fence (N=10, 14%) did not reach the minimum number of at least 20 responses, so this category was not further investigated.

The horse shaking its head from side-to-side was thought to be significantly more likely to cause a run-out (N=24) than either a rider-fall (N=0, $p<0.001$), or a horse-fall (N=4, $p<0.001$). Additionally, side-to-side head shaking was also thought to be significantly more likely to cause a refusal (N=13) than a rider-fall (N=0, $p<0.001$). No other pairings could be considered statistically significant ($p>0.05$ in all cases).

The horse shaking its head up and down was considered significantly more likely to result in a refusal (N=17) than either a rider-fall (N=2, $p<0.01$) or a horse-fall (N=4, $p<0.05$). None of the other pairings within this group could be considered statistically significant ($p>0.05$ in all cases).

The only significant difference found within the behaviour of the horse lowering its head on approach to the fence was between the outcome of refusal (N=13) and rider-fall (N=1, $p<0.05$).

Having an inconsistent head carriage was perceived to be significantly more likely to result in a refusal (N=15) or a run-out (N=13) than either a rider-fall (N=0, $p<0.001$ in both cases) or a horse-fall (N=3, $p<0.05$ in both cases). No significant differences were seen between this behaviour causing either a rider-fall or a horse-fall ($p=0.3$) or between the outcome of refusal or run-out ($p=0.85$).

The horse turning its head to the left or the right on approach to the fence was deemed to be significantly more likely to cause a run-out (N=29) than either a refusal (N=8, $p<0.01$), a rider-fall (N=1, $p<0.001$), or a horse-fall (N=1, $p<0.001$). No other pairings within this category of behaviour could be deemed significantly different.

Table 4.10: Descriptions of horse head and neck behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	**Run-out**	**Rider-fall**	**Horse-fall**	**Total**	
	N				N	%
Head shaking side-to-side	13	24	0	4	41	56
Head shaking up and down	17	9	2	4	32	44
Lifting head on approach to fence	4	1	1	4	10	14
Lowering head on approach to fence	13	3	1	7	24	33
Inconsistent head carriage	15	13	0	3	31	42
Turning head to the left or right on approach to fence	8	29	1	1	39	53

4.5.10. Horse oral behaviours

The horse holding its mouth open (N=33, 45%) was considered to be significantly more likely to cause a cross country jumping fault than the horse sticking its tongue out (N=13, 18%, $p<0.05$, Table 4.11). The horse holding its mouth open was also the only category to reach the minimum of at least 20 responses, so this was the only category to undergo further investigation. Holding the mouth open was considered to be significantly more likely to cause a refusal (N=10) than either a rider-fall (N=1, $p<0.05$) or a horse-fall (N=0, $p<0.01$). This behaviour was also thought to be more likely to cause a run-out (N=22) than either a rider-fall (N=1, $p<0.001$) or a horse-fall (N=0, $p<0.001$).

Table 4.11: Descriptions of horse oral behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total N	Total %
Horse holding mouth open	10	22	1	0	33	45
Horse opening and closing mouth repeatedly	7	11	0	1	19	26
Horse sticking tongue out	7	6	0	0	13	18
Horse moving tongue in and out of mouth	9	10		0	19	26

4.5.11. Horse ears

The horse's ears pointing backwards the majority of the time (N=54, 74%) were reported as significantly more likely to predict a cross country jumping fault than either the ears pointing forwards (N=1, 1%, $p<0.001$), ears switching between backwards and forwards (N=4, 5%, $p<0.001$), or one ear pointing forward and the other pointing backwards (N=2, 3%, $p<0.001$, Table 4.12).

The categories of horse's ears either pointing forwards the majority of the time (N=1, 1%), ears switching between forwards and backwards (N=4, 5%), and one ear pointing forwards and the other pointing backwards (N=2, 3%) did not reach the minimum requirement of being selected by at least 20 respondents, so post-hoc testing was not carried out on these groups.

When the behaviour of the ears pointing backwards the majority of the time was considered alone, this was thought to be significantly more likely to cause a refusal (N=49) than either a run-out (N=4, $p<0.001$), rider-fall (N=0, $p<0.001$), or a horse-fall (N=1, $p<0.001$). None of the other pairings could be considered significant.

<u>Table 4.12:</u> Descriptions of horse ear behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total N	Total %
Ears pointing backwards the majority of the time	49	4	0	1	54	74
Ears pointing forwards the majority of the time	0	1	0	0	1	1
Ears switching between forwards and backwards	3	1	0	0	4	5
One ear pointing forward and the other ear pointing backwards	0	2	0	0	2	3

4.5.12. Horse tail

The horse holding its tail lifted away from the quarters (N=3, 4%) was considered significantly less likely to cause a cross country jumping fault than either holding the tail close to the quarters (N=26, 36%, $p<0.001$), holding the tail to one side (N=16, 22%, $p<0.01$), swishing the tail from side to side (N=39, 53%, $p<0.001$), or swishing the tail up and down (N=32, 44%, $p<0.001$, Table 4.13).

The horse lifting its tail away from its quarters (N=3, 4%) and holding its tail to one side (N=16, 22%) did not reach the minimum requirement of being selected by at least 20 respondents, so post-hoc testing was not carried out on these groups.

When the tail being held close to the quarters was considered, it was thought to be significantly more likely to cause a refusal (N=24) than either a run-out (N=1, $p<0.001$), and rider-fall (N=0, $p<0.001$), or a horse-fall (N=1, $p<0.001$).

The horse swishing its tail from side to side was considered to be significantly more likely to cause a refusal (N=23) than a fall by either the rider (N=3, $p<0.001$) or the horse (N=1, $p<0.001$). The only other significant difference that existed within this group was between the likelihood of a run-out (N=12) and a horse-fall (N=1, $p<0.01$).

The horse swishing its tail up and down was considered to be significantly more likely to result in a refusal (N=22) than either a run-out (N=8, $p<0.05$), a rider-fall (N=1, p<0.001), or a horse-fall (N=1, p<0.001). The likelihood of a run-out (N=8) was also considered significantly greater than a fall of any kind (N=1, p<0.05 in both cases).

Table 4.13: Descriptions of horse tail behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
					N	%
Tail lifted away from the quarters	2	1	0	0	3	4
Tail held close to the quarters	24	1	0	1	26	36
Tail held to one side	7	8	0	1	16	22
Tail swishing side-to-side	23	12	3	1	39	53
Tail swishing up and down	22	8	1	1	32	44

4.5.13. Horse gait

Dropping out of canter on approach to the fence (N=59, 81%) was considered to be significantly more likely to cause a jumping fault than having the incorrect canter lead (N=28, 38%, p<0.01, Table 4.14).

Dropping out of canter was thought to be significantly more likely to cause a refusal (N=50) than either a run-out (N=2, p<0.001), a rider-fall (N=3, p<0.001), or a horse-fall (N=4, p<0.001). Having the incorrect canter lead was thought to be significantly more likely to cause a run-out (N=13) than either a rider-fall (N=1, p<0.05) or a horse-fall (N=3, p<0.05). Additionally, having the incorrect canter lead was also thought to be significantly more likely to cause a refusal (N=11) than a rider-fall (N=1, p<0.05).

Table 4.14: Descriptions of horse gait-related behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total N	Total %
Dropping out of canter	50	2	3	4	59	81
Incorrect canter lead	11	13	1	3	28	38

4.5.14. Horse conflict behaviours

A chi-squared test was used for these data due to the complexity of the contingency table (Table 4.15). The conflict behaviours of rear (N=58, 79%), buck (N=44, 60%), nap (N=68, 93%), and spook (N=62, 85%) were all deemed to be potential precursors to jumping faults. The results of the chi-squared test suggested that there was no significant difference between the four conflict behaviours (X^2 (3)= 5.38, p=0.15).

Rearing was thought to be significantly more likely to result in a refusal (N=30) than either a run-out (N=4, p<0.001), or a horse-fall (N=6, p<0.001). Rearing was also thought to be significantly more likely to result in a rider-fall (N=18) than either a run-out (N=4, p<0.01) or a horse-fall (N=6, p<0.05).

Bucking was thought to be significantly more likely to result in a refusal (N=13) than a horse-fall (N=2, p<0.05). Bucking was also thought to be significantly more likely to cause a rider-fall (N=22) than either a run-out (N=7, p<0.05) or a horse-fall (N=2, p<0.001).

Napping was considered to be significantly more likely to cause a refusal (N=58) than either a run-out (N=4, p<0.001), a rider-fall (N=2, p<0.001), or a horse-fall (N=4, p<0.001). No other pairings were statistically significant (p>0.05 in all cases).

Spooking was considered to be significantly more likely to cause a run-out (N=35) than either a refusal (N=7, p<0.001), a rider-fall (N=17, p<0.05), or a horse-fall (N=3, p<0.001). Additionally, spooking was thought to be more likely to cause a rider-fall (N=17) than a horse-fall (N=3, p<0.01).

Table 4.15: Descriptions of horse conflict behaviour indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Rear	30	4 (5)	18 (25)	6 (8)	58	79
Buck	13 (18)	7 (10)	22 (30)	2 (3)	44	60
Nap	58 (79)	4 (5)	2 (3)	4 (5)	68	93
Spook	7 (10)	35 (48)	17 (23)	3 (4)	62	85

4.5.15. Horse speed

A chi-squared test was used for these data due to the complexity of the contingency table and indicated a significant different between the five categories (X^2 (4) =46.39, p<0.001, Table 4.16). The exact multinomial post-hoc test then revealed that both speeding up (N=15, 21%) and slowing down on approach to the fence (N=20, 27%) were considered significantly less likely to cause a jumping fault outcome than approaching too fast (N=60, 82%), too slow (N=59, 81%), or having an inconsistent approach speed (N=51, 70%, p<0.001 in all cases). All other pairwise combinations could not be considered statistically significant (p>0.05 in all cases).

Approaching the fence too fast was considered significantly more likely to cause a horse-fall (N=40) than any of the other possible outcomes of refusal (N=3, p<0.001), run-out (N=11, p<0.001), or rider-fall (N=6, p<0.001).

Approaching the fence too slowly was considered significantly more likely to cause a refusal (N=36) than any of the other possible outcomes of run-out (N=2, p<0.001), rider-fall (N=4, p<0.001), or horse-fall (N=17, p<0.05). Additionally, approaching too slowly was thought to be more likely to cause a horse-fall (N=17) than either a run-out (N=2, p<0.01) or a rider-fall (N=4, p<0.05).

Speeding up on approach to the fence (N=15, 21%) was not investigated further because this group did not reach the minimum requirement of being selected as a potential risk factor by at least 20 respondents.

Slowing down on approach to the fence was considered significantly more likely to cause a refusal (N=15) than either a run-out (N=0, p<0.001), a rider-fall (N=1, p<0.01), or a horse-fall (N=4, p<0.05).

Having an inconsistent speed on approach to the fence was considered significantly more likely to cause a refusal (N=19) than a rider-fall (N=5, p<0.05), but none of the other pairwise comparisons reached significance (p>0.05 in all cases).

Table 4.16: Descriptions of horse speed on approach to a fence indicated by online survey respondents as being predictive of a cross country jumping fault, and the outcomes they were perceived to cause (N=73).

	Refusal	Run-out	Rider-fall	Horse-fall	Total	
	N				N	%
Too Fast	3	11	6	40	60	82
Too Slow	36	2	4	17	59	81
Speeding up	0	3	0	12	15	21
Slowing down	15	0	1	4	20	27
Inconsistent speed	19	15	5	12	51	70

4.6. DISCUSSION

4.6.1. Discussion of methodology

The aim of this study was to provide an introductory overview of current rider perception of how certain behaviours, actions, and positions may influence the outcome of a jumping effort. As a result, this survey made use of common terminology within the equestrian industry which was extracted from personal communications with eventing stakeholders. There are inherent limitations with this methodology, because the selection of terminology was heavily reliant on existing biases in the equestrian industry. Of particular note is the term 'preparing the horse for the fence' which is a common concept within equestrian jumping disciplines but is difficult to define and is likely to be a combination of individual behaviours, rather than a behaviour in its own right. It was, however, a theme that came out of the personal communications with eventing stakeholders and was therefore included. Anecdotal feedback on the survey design was that there are variations in rider position throughout the cross country course, such as the forward riding position often adopted in the faster gaits and over fences. The way the questions were posed, however, was specific to rider and horse behaviours on approach to the fence, as opposed to the galloping stretches between fences. A traditional explanation provided to riders is that their elbow, wrist, and the horse's mouth should be in alignment (Print 2011). Accurate measures of pressure applied to the bit would be a quantitative method of measuring rein tension, but in a competitive environment this is largely impossible. This survey attempted to categorise rein aids using visible, mutually exclusive categories defined by the presence or absence of slack in the reins. Leg and whip aids were also described in such a way that they could be identified from video footage. Horse-riding is a complex system of interactions, so considering isolated behaviours may not provide results that represent the holistic nature of equestrianism. It is acknowledged that the results of this study cannot be generalised across the whole riding population, but they do elucidate some of the existing attitudes towards cross country behaviour. Exploratory surveys have value in identifying areas for future research, such as the study investigating equestrian perception of safety conducted by Chapman, Thomas, and Thompson (2020). It is therefore recommended that the results of the present study are considered in the context of an exploratory survey which may improve understanding of rider attitudes, opinions, and perceptions.

The possible deleterious outcomes of refusal, run-out, rider-fall, and horse-fall were used because they are the possible jumping-fault outcomes listed in the rules for eventing at both national and international level (Fédération Equestre Internationale 2021; British Eventing 2023). It is, however, difficult to differentiate between refusals and run-outs, particularly when considering the influence of the type of fence on the likelihood of each outcome. For example, it is much easier for a horse to run-out, defined as "the horse avoids the obstacle without stopping" (Fédération Equestre Internationale 2021) when the fence is very narrow. On the other hand, a wide obstacle is more likely to result in a refusal rather than a run-out, because a run-out would necessitate the horse navigating around the side of the fence. Similarly, a rider-fall and a horse-fall have separate definitions, but the reality is that they may look very similar to an uninformed viewer. Additionally, behaviours such as refusing or running-out at a fence may be the cause of a rider or horse fall, so it is perhaps difficult to determine how the jumping fault should be categorised. For convenience, the outcomes provided were those listed in the rule book in the hope that this would be an inclusive methodology which would be easily recognisable by riders, but it should be considered with caution.

4.6.2. Discussion of results

The results of this study demonstrated that there was variation in the jumping fault outcome expected by the respondents (N=73) depending on the specific characteristics of each rider and horse behaviour identified. The behaviours deemed to be most likely to cause a jumping fault were inconsistent rein aids (N=71, 97%), inconsistent upper body position of the rider (N=68, 93%), and the horse napping (N=68, 93%). It could be suggested that all three of these behaviours have some relationship to the forward momentum of the horse. Napping, for example, can be described as an unwillingness to go forward (Hall and Heleski 2017). Rein aids and upper body position of the rider are key points of communication between rider and horse (Peham, et al. 2010), so inconsistency in this communication is likely to have a considerable impact on the horse. It is possible, however, that the wording of this terminology had an impact on the responses provided. Negative connotations around the word "inconsistency" may have encouraged participants to select these options as potential risk factors for cross country jumping faults. The additional investigation of differences between most likely outcome was deliberately implemented to try to negate the impact of this answer bias. It was hoped that, although certain responses might be over-represented, a significant difference in the distribution of likely outcomes would indicate a deeper relevance. A distribution that was not significantly different from equality may suggest that while respondents believed this behaviour to be of concern, they were not able to provide an indication of the type of outcome it might predict.

Interestingly, napping remained an important behaviour when the distribution of outcomes was considered, because it was most often identified as being a predictor of a refusal (N=58). A refusal as a result of napping behaviour was also considered to be significantly most likely, compared to the other possible outcomes. Refusals were also considered likely as a result of the horse dropping out of canter (N=50), the horse's ears pointing backwards the majority of the time (N=49), and the rider not giving any leg aids (N=49). A refusal is defined as the horse stopping in front of the fence (British Eventing 2023), and napping may be an indication of resistance to the cue to go forward (Hall and Heleski 2017). It is therefore not surprising that napping, a lack of leg aids, and dropping out of canter were all identified as being risk factors for refusals and may indicate a broader perception that lack of forward momentum for any reason may be a predictor of refusals on the cross country course. The implication of horse ear position is an interesting one and has been the subject of much discussion within equitation science. Ear position has been associated with pain (Gleerup, et al. 2015), discomfort (Torcivia and McDonnell 2021), and stress (Hall and Heleski 2017) in horses. The results of these studies, combined with the ears being a very visible potential indicator of equine affective state, may lead observers to rely on ear position to draw their conclusions. For example, dressage judges have been noted to award higher marks to horses with their ears forward (Hamilton, et al. 2022). The respondents of the present survey appeared to consider ear position as a valuable indicator and potential predictor of cross country refusals. It is difficult to determine whether this is a genuine risk factor, or simply a product of common belief within equestrians. Greater opportunity to provide additional information, perhaps through a semi-structured interview methodology, may be beneficial to future research in this field.

Run-outs were suggested to be predicated by the horse spooking (N=35), the horse turning its head to the left or right (N=29), or the rider giving inconsistent rein aids (N=26). Spooking can be defined as a sudden and unexpected change in direction, and a run-out is defined as the horse running past the fence instead of jumping it. Both definitions could be considered to indicate a lateral movement, as could the behaviour of the horse turning its head to the left or right. Though not one of the most common results, the horse shaking its head side-to-side was also thought to be significantly more likely to cause a run-out than a fall of any type. It is therefore suggested that the results presented here demonstrate a perception that lateral behaviours of the horse are more likely to cause a run-out than any other outcome.

Inconsistent rein aids were considered one of the most likely predictors of a run-out, but there was no significant difference between the likelihood of a run-out (N=26) and a refusal (N=26) when the behaviour was considered in isolation. It is possible that inconsistent rein aids could be interpreted as both forward and backward, as well as side-to-side, inconsistencies. It is proposed that a forward and backward inconsistent rein aid may relate to the forward momentum theme associated with refusals, as discussed above. Similarly, side-to-side inconsistencies may relate to the lateral theme of run-outs that this data appears to allude to.

Rider-falls were most commonly associated with the rider's foot being positioned in front of their hip (N=46), and the rider having inconsistent upper body position (N=29). Additional rider position factors were also implicated, including the rider's thigh not being in contact with the saddle (N=22), and the rider's head being in front of their torso (N=22). Bucking was also commonly identified as a rider-fall risk factor (N=22). The points of contact between the rider and horse include the legs and seat (Peham, et al. 2010), so it is unsurprising that factors that may disrupt these points of contact were thought to lead to the rider being separated from the horse.

Horse-falls, on the other hand, were thought to be caused most often by the horse's approach speed being too fast (N=40), the rider preparing the horse for the fence too late (N=31), or not preparing the horse for the fence at all (N=24). Rather than being related to the horse or rider position, these factors appear to all relate to more complex behaviours on approach to the fence. Cross country riding has optimum average speeds associated with each level of competition which will dictate how long the entire course should take to complete (British Eventing 2023), but this is calculated on the understanding that the speed will vary through the course. Understanding the appropriate speed for each fence is likely to be something that is linked to the experience of the observer, and is very difficult to measure in non-standardised settings. Preparing the horse for the fence may involve a number of different actions on the part of the rider which indicate to the horse that there is an obstacle ahead and they may need to adjust themselves accordingly. It could be suggested that approach speed and preparedness are interlinked. Approaching too fast and not preparing for the fence appropriately may both result in a reduction in the time afforded to the horse to cognitively process what is required of them. Cognitive processes in both horse (Miranda, et al. 2016) and rider (Lewis and Baldwin 2018) are impeded during physiological fatigue. It is vital, therefore, to highlight the importance of appropriate communication between rider and horse on approach to a fence. If further research continues to demonstrate the association between communication of horse and rider on approach to cross country fences and the potential for horse-falls, this aspect of horsemanship should be prioritised.

4.6.3. Application

Identifying that there was variation the expected jumping fault outcome within behavioural categories suggests that not only are riders allocating their attentional focus to certain areas of the horse and rider, but that they are interpreting the behaviours being displayed. Equine behaviour is thought to provide indicators as to the horse's mental and physical state (Sarrafchi and Blokhuis 2013). As such, behaviours in cross country competition could be utilised by riders and coaches as measures for equine mental state, particularly when the horse's normal behaviour is known and can therefore provide a baseline comparison. Further investigation into the power of riders to correctly recognise horse and rider behaviour to predict jumping fault outcomes may contribute to greater appreciation of equine behaviour.

The close interaction between horse and rider means that any change in the balance of either one is likely to influence the other (Peham, *et al.* 2010). There is a common assumption within the equestrian community that looking at the ground while riding is a risk-factor because the weight of the rider's head is such that looking downward causes their head and shoulders to move forwards thereby unbalancing themselves and their horse (Print 2011). One of the difficulties present in cross country behavioural research is the paucity of existing literature on cross country biomechanics, demonstrated by the fact that every biomechanics paper included in the systematic review conducted by Douglas, Price and Peters (2012) was dressage-based.

The frequency with which inconsistency in various forms was identified as a potential risk factor is important for the application of these results. Identifying inconsistency in position or behaviour necessitates repeated observations over a period of time. Recording behavioural data, particularly in a non-standard environment such as a cross country course is challenging. This challenge becomes greater in competitive environments where it is not possible to implement repeats. The wider goal of this study was to investigate the value that ridden video footage might provide to equestrianism, and the ability to record behavioural data in a competitive cross country environment is one of its main strengths. If inconsistency in rider behaviour and position is implicated as a potential risk factor for cross country jumping faults, as these data appear to suggest, then video footage provides a method of assessing these inconsistencies.

The distinction between refusal and run-out is based around whether the horse stops to avoid jumping the obstacle, or continues forward momentum while avoiding the obstacle (Fédération Equestre Internationale 2018). While falls are an important research topic for the benefit of the safety of horses and riders, refusals and run-outs are a performance measure. Equipping riders and event officials with greater knowledge regarding the behaviours that might lead to jumping faults may enable earlier detection of those behaviours. Additionally, behaviours that may be perceived as negative by the general public have the potential to damage eventing's social licence to operate. By investigating topics which are of particular public interest, such as whip use, research can contribute to development of sport-specific regulations. This study identified a difference in perception between using the whip once and using the whip more than once, either in front of or behind the saddle. Understanding and communicating the reasons behind these attitudes has the potential to inform riders about how their actions are being perceived. Behavioural change requires a change in motivation, so perception studies such as these are beneficial to equestrian sport.

4.6.4. Rider decision making

The aim of this study was to investigate rider perception of how horse and rider behaviours may influence cross country jumping faults. It is hoped that by encouraging awareness of behaviours as predictive factors, riders may be better able to assess their horse's mental state and evaluate the risk of continuing on the cross country course. It is unlikely, however, that riders can notice, interpret, and alter these behaviours in a competitive environment when undergoing physical and mental fatigue. Mental fatigue in sports can impact performance, though athlete knowledge of the topic has been found to be lacking (Russell, et al. 2023). The results of the present study introduce rider perception of behaviours that may be precursors to jumping faults, but what is not yet known is whether these behaviours have a statistical impact on the likelihood of deleterious outcomes. Existing research into cross country risk-factors has focussed on demographic and course-related data (Bennet, et al. 2021) but as competitive video footage becomes more available, so does behavioural data. It is therefore proposed that this study be viewed as an introduction to which behaviours are being perceived by riders as potential risk-factors, which can then be built upon using video records.

4.7. CONCLUSION

The results of this study identified that some behaviours are perceived as indicative of a cross country jumping fault, and that there is variation in the perceived most likely jumping fault outcome. It is hoped that the results of this study highlight some behaviours warranting further investigation with respect to their likelihood of predicting poor performance on the cross country course. Better understanding of cross country horse and rider behaviour may enable the early detection of factors predictive of poor performance in the form of refusals, run-outs, and falls. It is worth noting that although both napping and spooking are characterised as conflict behaviours, there was a clear difference between their perceived impact on the type of jumping fault. Further definition and explanation of what motivates napping and spooking would help to develop understanding of these behaviours. The results presented here highlight that riders perceive some behaviours to be more likely to lead to jumping faults than others, so further investigation is required to determine whether those associations are correct.

CHAPTER 5:
WHAT ARE YOU LOOKING AT?
RIDER AND NON-RIDER GAZE BEHAVIOUR WHILE WATCHING CROSS COUNTRY EVENTING VIDEO FOOTAGE.

5.1. INTRODUCTION

What a person focusses on while they watch videos can be indicative of what parts of the scene they deem most important, and it is possible to identify the point of visual focus using gaze tracking technology (Holmqvist and Andersson 2017). It is understood that expert and novice respondents in various fields may demonstrate different gaze-behaviours (Mann, *et al.* 2007), but often the stimuli were recorded under standardised conditions for the sole purpose of the research. The study presented here applied gaze tracking methodology to a sample database of commercial equestrian eventing video footage to investigate the visual strategies utilised by riders and non-riders.

What people pay attention to within their environment can be indicative of what they deem to be important (McAuliffe 2004). Gaining experience in specific contexts can develop cognitive expertise and an understanding of which information is unimportant so that focus can be directed to what is most contextually valuable (Mann, *et al.* 2007). Cognitive expertise has applications in day-to-day life such as the ability to drive a car safely (Crundall 2016), but also in professional arenas such as surgery (Tien, *et al.* 2015) or sport (Savelsbergh, *et al.* 2002). One of the most widely broadcast, and financially valuable, physical displays of cognitive expertise is that demonstrated in sport. One method used to assess cognitive processing and attentional focus is oculography, the practice of measuring and recording the position and movements of the eye (Chennamma and Yuan 2013). More commonly referred to as eye-tracking or gaze tracking, monitoring eye movement and activity can, nowadays, be a non-invasive method of identifying what the eye is focussing on (Underwood, et al. 2003a) and hence highlight an individuals' priorities in a given situation.

The study presented here was part of a wider project investigating the value of eventing cross country video footage to equestrian stakeholders. This type of video footage is commercially available to anyone, whether they are the rider featured in the video or not. It is likely that the video footage is perceived differently by viewers depending on their prior experiences. As a result, the aim of this particular chapter was to investigate differences between viewers with respect to their visual behaviour while watching eventing video footage. The results of this study have ramifications for equestrian sport because differences in visual strategy may occur in training and competitive scenarios as well as when watching video footage. Particularly in the case of fence-judges and event officials, who are responsible for allocating penalties and identifying welfare concerns, differences in visual behaviour may be influential.

5.2. LITERATURE REVIEW

5.2.1. Gaze tracking

The scene visible through the human eye is known as the visual field, and only one area of that visual field can be at maximal focus at any one time (Younis, *et al.* 2019). In order to see different objects with equal acuity, observers must move their eyes in order to focus on the desired target (Rayner 2009; Holmqvist, *et al.* 2011). By knowing what information is available within the visual field, and which area of the visual field is being focussed on, it is thought that it is possible to identify where a person's attentional focus lies. However, this concept is debated among gaze tracking researchers and it is possible to be fixating on one thing while attending to another (Murray, *et al.* 2013). In the human eye, and that of many other primates, the fovea centralis is the site of maximal visual acuity which enables sharp central vision (Hendrickson 2009; Stamper, *et al.* 2009). Without this specialised morphological structure, precise activities such as reading and driving would likely have never developed.

Efforts to measure eye movements have been recorded since the 1890's (Huey 1898) and has historically required invasive or uncomfortable equipment requiring contact with either the eyes or skin of the participant (Holmqvist, *et al.* 2011; Oyekoya and Stentiford 2006; Huey 1898). This means that its application has been limited to highly clinical environments. Remote, non-invasive methods have been in use since at least 1974, when Merchant and Porterfield (1974) demonstrated the use of a near infrared beam which reflected off the surface of the eye. The position of the near infrared reflection was measured from the centre of the pupil, meaning that movements of the eye could be tracked (Merchant, *et al.* 1974; Shih, *et al.* 2000). This is the method utilised by most modern-day gaze tracking technology, though until relatively recently it still involved the wearing of cumbersome headwear such as the NAC Eye-Movement Recorder used by Bard *et al.* in (Bard, *et al.* 1980).

As the technology has improved, it has become more affordable and user-friendly so that now eye movements can be tracked using desktop-based technology, or eye-tracking glasses (Burch, *et al.* 2017). Eye movements on their own are largely uninformative, meaning that the equipment must be calibrated to some contextually relevant visual stimulus (Shih, *et al.* 2000). In the case of desktop-based gaze tracking, a digital stimulus can be displayed to the participant.

5.2.2. Gaze tracking metrics

Gaze tracking research often measures eye-movements in degrees of visual angle (°, Holmqvist and Andersson, 2017). Visual angle describes the movement of the eye required to look between two objects, rather than the physical distance between those two objects. The distance between two objects will change depending on how far away they are from the viewer, even though the visual angle between the two may remain the same (figure 5.1).

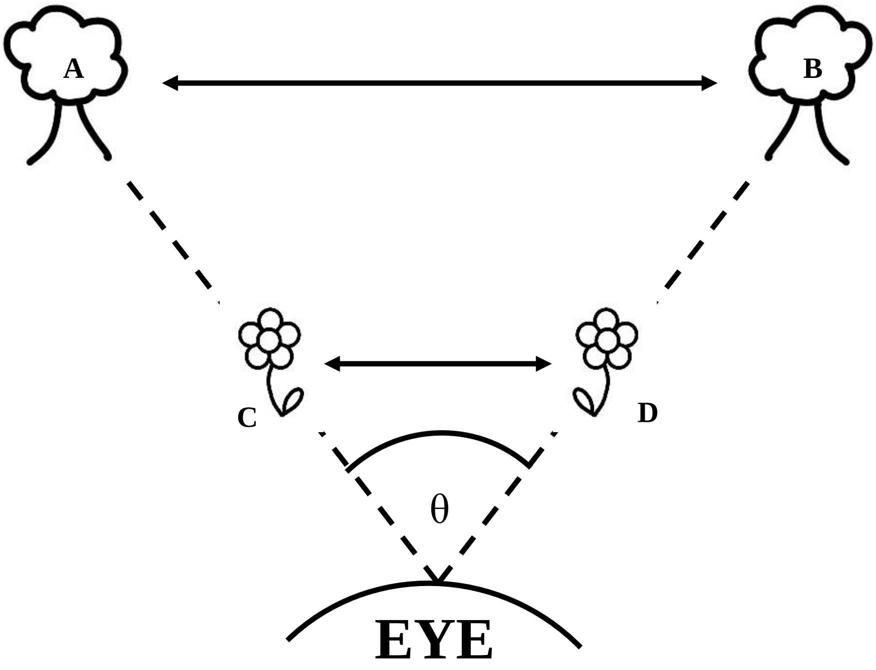


Figure 5.1: Visual angle θ is the same movement required to look from A to B and C to D, even though distances AB and CD are different.

Much of the gaze tracking literature references visual fixations and saccades (Andersson, *et al.* 2010). Fixations are often classified as the period of time that the point of gaze remains within around 1-2°, depending on the study (Piras, *et al.* 2010; Trabulsi, *et al.* 2021). Fixations are thought to be the period during which the brain is able to acquire new information (Rayner 2009; Holmqvist, *et al.* 2011; Duchowski 2017). In order to be classified as a fixation, the point of gaze is usually required to remain relatively still for at least 100ms, but the precise parameters vary from study to study (Trabulsi, *et al.* 2021), and have been known to be as low as 85ms (Rubin, *et al.* 2020). Fixation frequency, duration, and position are common metrics used in gaze tracking literature. It is thought that the longer an object is fixated upon, the more information is able to be extracted (Piras, *et al.* 2010). Saccades are the fast movements between fixations and their amplitude can be measured in degrees of visual angle (°, Feil, Abegg and Abegg, 2018). The length of each fixation and saccade will depend on the context of the task (Tatler, *et al.* 2006). Combining fixation and saccade data can enable the recording of scan paths, sequences of fixations which can give an insight into the pattern of information processing exhibited by a given subject (Underwood, et al. 2003b).

To extract meaningful information from fixation data, it is necessary to categorise areas of the image which are deemed contextually important, commonly referred to as Areas of Interest (AOIs, Hessels *et al.*, 2016). The protocol for assigning AOIs depends on the stimulus being investigated but, generally, assigning AOIs is a method of categorising an object or area of the visual field (Orquin, *et al.* 2016). When the stimulus is relatively predictable, for example in the instance of printed text or standardised still images, it is often possible to use software which can assign AOIs semi-automatically (Orquin, *et al.* 2016; Hessels, *et al.* 2016). AOIs should allow for a margin of 1° to 1.5° around the object to allow for some error in the gaze tracking equipment, though values of up to 2° have been reported (Orquin, *et al.* 2016; Holmqvist, *et al.* 2011). The size of each AOI needs to be large enough to reduce false negatives, but not so large that fixations on other objects in the scene are included mistakenly (Orquin, *et al.* 2016; Holmqvist, *et al.* 2011). Transitions between AOIs can indicate the visual strategy being used by the participant (Goldberg and Helfman 2010).

Data loss is not uncommon in gaze tracking research (Schnipke and Todd 2000), and generally it is necessary to manually check the data. For example, a 2022 study started with a sample of 15 participants but four had to be removed from analysis for various reasons including two participants apparently sleeping during their data collection (Takemoto, *et al.* 2022). Gaze tracking studies need to account for the labour-intensive nature of the methodology, whilst ensuring the data is of high enough quality to produce results. These methodological decisions will be influenced by the research question and goals of each individual project, but often result in small sample sizes.

5.2.3. Gaze tracking study design

The most common paradigm in gaze tracking literature is that which compares the visual behaviour of two or more groups of participants. Such differences in gaze tracking metrics between subjects have been seen repeatedly, often in the context of novice versus expert participants (Tien, *et al.* 2015; Piras, *et al.* 2010), but also with respect to cultural (Lim, *et al.* 2013), and cognitive differences (Sheppard, *et al.* 2017). Attentional indicators, such as gaze fixations, can provide evidence to identify those who are able to recognise the most contextually important information (Carrasco 2011). It is understandable, therefore, that gaze tracking studies have sought to identify participant differences within a given field. Understanding differences in gaze behaviour can provide direction for future research or provide a template against which to assess others. For example, it is possible that using expert surgeon gaze-behaviour could provide an ethically acceptable, low risk assessment tool for trainee surgeons (Tien, *et al.* 2015). It is generally suggested that experts will exhibit fewer, but longer, fixations as a result of a more efficient visual strategy (Underwood, et al. 2003b). Differences in visual behaviour are not valuable on their own, it is necessary to investigate the reason for the variation in the metrics. For example, a study which investigated fear of public speaking reported differences in the number of fixations directed at audience members who were acting interested compared to those who were uninterested in the speaker (Rubin, *et al.* 2020). The likely explanation for these differences in gaze-behaviour was the underlying cognitive processes causing avoidance of social threat (Rubin, *et al.* 2020). Accordingly, gaze tracking research must work in conjunction with specific research goals to have value as a measure of cognitive function.

Not all research studies investigate differences between participants, sometimes the goal of the research is to identify whether gaze-behaviour differs depending on the stimulus being presented. Driving research for example, has aimed to investigate differences in gaze-behaviour when viewing different types of hazards, such as dynamic versus static objects (Underwood, et al. 2003a), or driving along different types of road (Underwood, et al. 2003b). Sometimes the stimulus is consistent, but the task changes, such as when assessing gaze-behaviour associated with tasks of varying degrees of complexity in billiards (Williams, *et al.* 2002). Regardless of the methodology, choosing the most appropriate stimulus is vital for collecting relevant gaze data. It is also necessary to provide the participants with a goal or task to ensure that the data collected is relevant to the research question (Takemoto, *et al.* 2022). Non-goal driven eye movements are thought to generally consist of shorter saccades than when the participant is given a task to achieve (Tatler, *et al.* 2006; Takemoto, *et al.* 2022). To ensure that the data collected is relevant, participants must be given a task related to the research aims. Using cross country video footage as stimuli may enable understanding of how spectators view the sport, and differences in experiential level may reveal cognitive differences between riders of varying levels.

5.2.4. Gaze tracking in equestrian sport

To the author's knowledge, only two published papers have investigated visual behaviour in horse-riders. The first, published in 1989, studies the importance of rider peripheral vision while jumping, and also investigated visual strategies (Laurent, et al. 1989). They found that peripheral vision did not appear to be a vital element for control of the horse's locomotion, and that riders tended to focus their gaze in the middle of the top of the obstacle (Laurent, et al. 1989). Another study, conducted in 2014, used gaze-tracking technology to assess fixation metrics while completing a course of jumps (Hall, et al. 2014b). These studies were both conducted using head-mounted gaze-trackers, which meant that the field of view was determined by the rider's head position (Laurent, et al. 1989; Hall, et al. 2014b). Other equestrian-related gaze tracking studies have utilised video footage recorded from a fixed viewpoint which are then displayed on a screen. The two studies published using this method were designed to investigate viewer ability to detect lameness in horses (Starke and May 2017; Starke and May 2022). Methodological differences between studies have meant that comparisons of results are not straightforward. For example, one study identified the point of gaze in relation to the fence but with only two riders (Laurent, et al. 1989), whereas another identified whether the point of gaze was on the fence, ground, or other using 10 riders (Hall, et al. 2014b). These two rider gaze behaviour studies are especially difficult to compare due to the considerable time gap, and the corresponding improvement in technologies between them. There is potential for gaze-tracking to become a useful tool in equestrian disciplines, particularly where subjective assessments are required, but it is essential that methodologies begin to converge.

5.3. AIM AND OBJECTIVES

The aim of this study was to investigate and compare visual strategies of riders and non-riders while watching video footage of cross country jumping approach behaviour. The specific objectives to achieve this were:

- To determine whether there was a difference in saccadic amplitude between riders and non-riders.
- To develop relevant areas of interest (AOIs) and investigate whether there was an association between viewer rider status and dwell time associated with each AOI.
- To identify transitions between AOIs and explore the frequency of transitions when rider status was considered as a factor.
- Evaluate the suitability of commercially available cross country footage as stimuli for gaze tracking.

Identifying whether riders and non-riders exhibit differing visual behaviour may indicate a corresponding difference in cognitive processes. Understanding how riders allocate their attention when viewing a scene could assist with the development of assessment protocols for fence-judges, coaches, and officials. Competitive cross country video footage filmed from a spectator's point of view is commercially available. It is hoped that this study will demonstrate how this type of video footage, which is largely unstandardised, can be used to produce quantitative data such as viewer gaze behaviour.

5.4. MATERIALS AND METHODS

5.4.1. Ethical approval and consent

Ethical approval was granted for the present study by the ARE Ethical Review Committee and given code ARE896. Participants over the age of 18 were invited to take part in a gaze tracking investigation. Participation in this study included consenting to the collection of anonymous survey and gaze data.

5.4.2. Data collection

Opportunistic sampling recruited individuals who were visiting Brackenhurst campus of Nottingham Trent University during January and February 2020. Twenty videos described in **chapter 2** were assessed for their suitability for use in this gaze tracking study. Videos were excluded if it was not possible to differentiate between fixations on the fence and fixations on the horse/rider unit. Videos were also excluded if there were visual obstructions between the camera and the AOIs such that a fixation could not be accurately coded to an AOI. For example, if the horse and rider passed behind a tree, it was not possible to distinguish whether the participant was fixating on the tree, or the horse and rider. After exclusion criteria were implements, seven videos were identified as appropriate stimuli for a gaze behaviour study. To conclude that differences in gaze behaviour were likely due to participant differences, rather than differences between stimuli, only video clips from the BE100 level in 2018 were used. To further improve the validity of the study, all participants viewed all seven of the videos.

Participants were asked to watch the videos clips of horse and rider combinations approaching a single cross country fence, while their gaze behaviour was monitored. To ensure that the gaze data being collected is relevant to the objectives of the research, participants should be provided with a pertinent task during data collection (Holmqvist, *et al.* 2011; Takemoto, *et al.* 2022). To fulfil this requirement, participants were asked to click the left mouse button if they thought the jumping effort was going to result in anything other than a clear jump i.e., a refusal, run out, or fall. Progress from one video to the next was manually controlled by the researcher to ensure that the participant was prepared for the next video clip before it began. The next clip was started once it had been established that the equipment was still calibrated, and the participant confirmed that they were ready. Two demonstration videos were shown prior to the data collection commencing to allow the participant to become familiar with the process and the equipment. Videos were viewed on an SMI Remote Eyetracking Device (RED) integrated monitor (Figure 5.2) using iView X RED and SMI Experiment Center 3.6 (SensoMotoric Instruments GmbH 2011; SensoMotoric Instruments GmbH 2017b). Subjects were positioned 60-80cm from the screen which was achieved using the automated directions issued by the software to indicate whether the participant needed to move closer, further away, up, or down relative to the screen (SensoMotoric Instruments GmbH 2011). A five-point calibration process was completed by each subject at the beginning of their trial (SensoMotoric Instruments GmbH 2011). The screen measured 474mm by 297mm. Gaze metrics are usually measured in degrees of visual angle, so when the participant's eyes were positioned 70cm from the monitor, the screen subtended 37.41° along the horizontal axis, and 23.95° in the vertical axis (Figure 5.3). The eye-tracking equipment had a reported gaze position accuracy of <0.4° and a sampling rate of 60Hz (SensoMotoric Instruments GmbH 2011).

Figure 5.2: Equipment arrangement for gaze tracking data collection showing the position of the infra-red lights below the stimulus screen. During data collection the left-hand screen faced the researcher while the right-hand screen was observed by the participant.

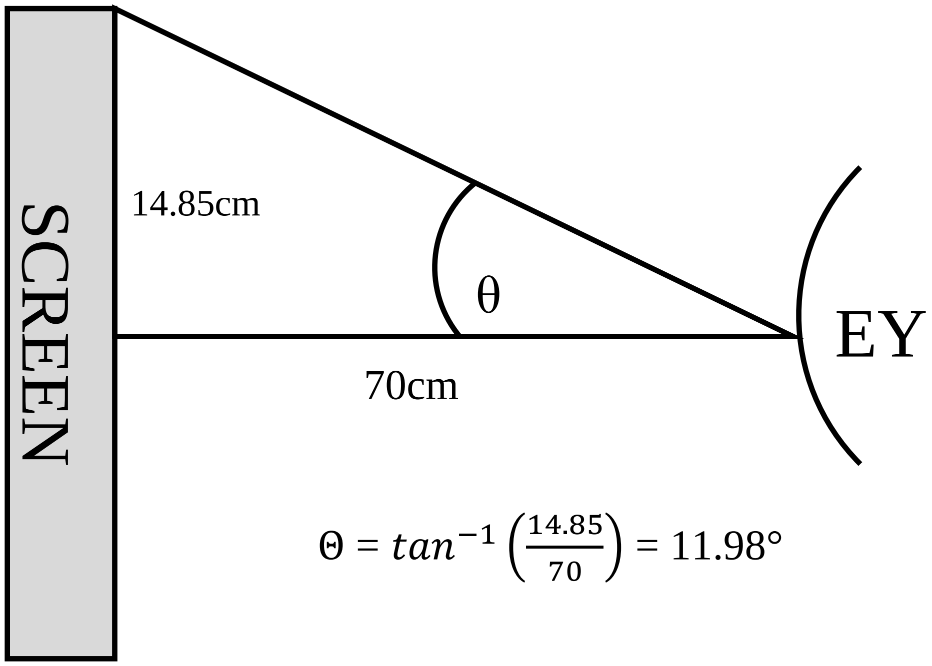


Figure 5.3: Calculation used to determine the vertical dimensions of the screen in degrees of visual angle (°).

Prior to watching the videos, participants were asked to complete a short demographic survey as detailed in **chapter 2** so that demographic and riding experience could be considered during data analysis. After responding to basic demographic questions including age, gender, and geographical location, participants were asked whether they regularly rode a horse, which was defined as riding at least once a month. If the participant did not ride at least once a month, either presently or in the past, they were automatically directed past the riding-related questions. Once the rider participants had answered specific questions about their riding ability, they were asked whether they had ever evented at any level. There are a multitude of ways to be involved in equestrianism, so it was important that the questions reflected skills relevant to the task at hand. Those who had evented were asked further questions about their eventing experience, and those who had not were automatically directed to the end of the survey.

5.4.3. Data analysis

Fixations were allocated to AOIs using the outputs from SMI BeGaze (SensoMotoric Instruments GmbH 2017a) which highlighted each fixation using a circle measuring 1° of visual angle. If any part of the horse and rider fell inside the circle, the fixation was recorded as being on the ‘horse’ AOI (figure 5.4a), any part of the jumpable section of the fence between the flags was recorded as the ‘fence’ (figure 5.4b) AOI. Anything other than ‘horse’ or ‘fence’ was recorded as ‘other’ (figure 5.4c). A fixation was marked as such when the gaze had remained within 100px for at least 100ms. The fixation was allocated an AOI if that AOI passed through the fixation circle at any point throughout the fixation, i.e. the fixation did not need to begin or end on an AOI, only interact with it at some point. Analysis ceased at the point where a fixation circle of diameter 1° would intersect both the ‘horse’ and ‘fence’ AOIs (figure 5.4d), as it was impossible to determine where the definitive point of attention lay.

a)

b)

c)

d)

Figure 5.4: Fixation points on a) 'horse' b) 'fence' and c) 'other'. d) instance at which gaze mapping was ceased as the 'horse' AOI begins to overlap the 'fence' AOI as indicated by the white dashed circle. Green solid circle around fixation point represents 1° of visual angle. The number inside the circle indicates the fixation number.

Videos were manually gaze mapped according to areas of interest, categorised as ‘horse’, ‘fence’, and ‘other’. To reduce the influence of researcher error or bias, gaze mapping was completed twice for each video, by the same researcher, between the 20th May and the 22nd July 2022. No video was coded twice in one day, and the previous coding for each video was hidden from the researcher. Cohen’s kappa was calculated to assess the intra-rated reliability of the AOI coding due to its application for assessing agreement between categorical data whilst accounting for chance (Sun 2011). Over a total number of 1306 AOI categorisations into the three categories of ‘horse’, including the rider, ‘fence’, and ‘other’, a Cohen’s κ of 0.96 was calculated. Using the benchmarks set out by Landis and Koch (1977), this value of kappa can be considered “almost perfect” (Sim and Wright 2005). Intra-subject reliability was not assessed due to the likelihood of prior viewing of the video influencing subsequent gaze behaviour (Lum 2020).

One participant contacted the researcher to request that their data be removed from the study, the process and deadline for which was detailed in the original survey. One further participant was removed from the study on account of inconsistent tracking which was discovered on initial assessment of the data. Saccades which had starting coordinates outside the bounds of the screen, and saccadic amplitudes which were longer than the maximum length of the hypotenuse of the screen were defined as invalid data. As a result, all saccadic amplitudes measuring more than 44.42° were removed from analyses. Only saccades greater than 0.1° were included (Tatler, *et al.* 2006). Any screen shown prior to the beginning of the study stimulus may have an influence on the location of the initial fixations (Holmqvist and Andersson 2017). As a result, fixations and saccades beginning within the first 100ms of each stimulus were removed for they were considered erroneous data which may have misled the results of the study.

After data cleaning, 18 participants were included in the final analyses, eight of which were riders and the remaining 10 were non-riders. A total of seven video clips were included for analysis, all of which had been viewed by every participant. Dwell time was defined, for the purposes of this study, as the sum of all fixations on a given AOI. Dwell times and fixation durations were determined to be almost exclusively non-normally distributed using Shapiro-Wilk tests which were run on each level of the AOI variable, similar to the method used by (García-González, *et al.* 2013). Medians were used due to the data being non-normally distributed, and inter-quartile ranges (IQRs) were calculated exclusive of median. A Kruskal-Wallis rank sum test was conducted to determine whether there was a statistically significant difference between the three AOI levels when considering the corresponding dwell times and median fixation durations (Ostertagová, *et al.* 2014). Post-hoc Wilcoxon rank sum tests with continuity correction were conducted to identify any specific differences between the AOI levels as previously described by Decroix *et al.* (2017). Wilcoxon rank sum testing was also used to compare the dwell time and median fixation durations between riders and non-riders for all fixations, and within AOI levels. Differences between rider and non-rider saccadic amplitudes were tested using the same method.

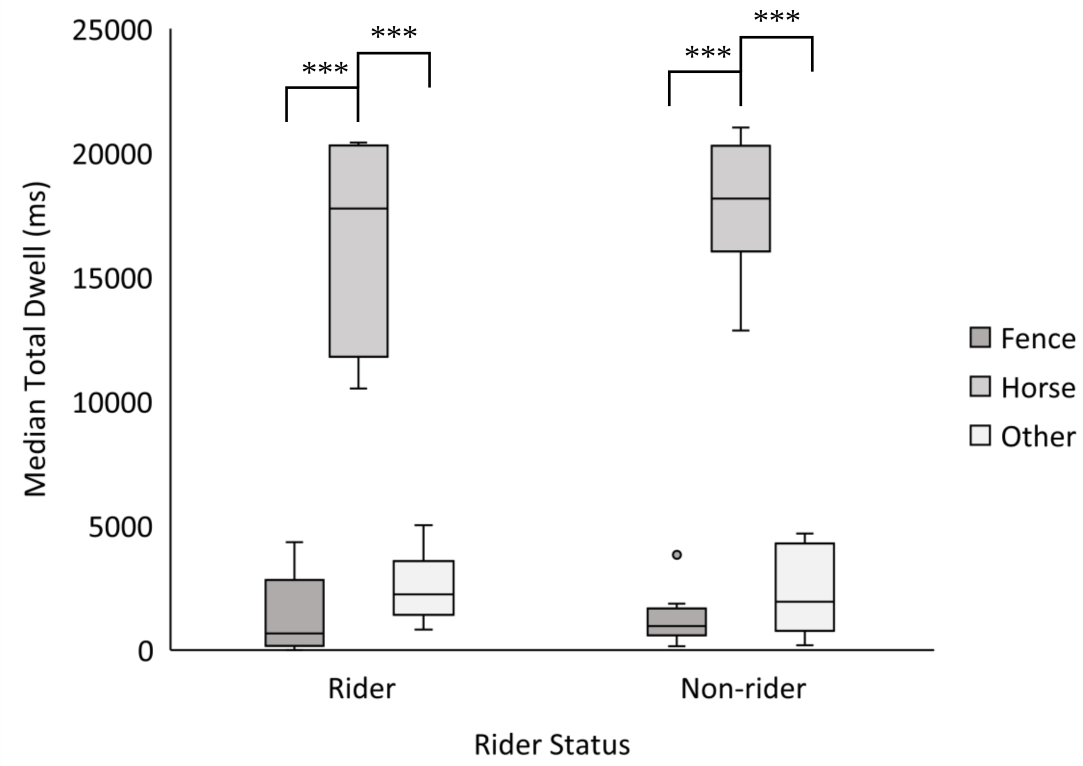
Transitions between AOIs were included for analyses only when they were direct transitions with a single saccade between two fixations, i.e. if the tracking failed between two fixations, this was not counted as a transition. In instances where two concurrent fixations fell into the same AOI, such as when the point of gaze was tracking the horse and then had to move to remain focussed on the horse, these were referred to as homogenous transitions (HH, OO, FF). A contingency table was created to test whether there was a difference between the odds of riders and non-riders performing each type of transition. Fisher's exact test was used due to its suitability to small frequencies.

5.5. RESULTS

5.5.1. Dwell time

When the AOI was considered as a factor, a significant difference was detected (H(2)=37.67, $p<0.001$). Further pairwise Wilcoxon rank sum tests revealed that the ‘horse’ AOI (median 18081.22ms) was fixated upon for significantly longer than either the ‘other’ (median=2166.33ms, Z=-6.28, $p<0.001$) and ‘fence’ (median=858.33ms, Z=-6.28, $p<0.001$). The ‘fence’ AOI was fixated upon for the least amount of time, and this was found to be statistically significant (Z=-2.28, $p<0.05$).

When rider and non-riders were considered separately, the order of dwell time from longest to shortest remained unchanged; ‘horse’, followed by ‘other’, followed by ‘fence’. For riders, the difference between ‘horse’ (median=17757.58ms) and ‘other’ (median=2233.21ms, Z=-3.68), and ‘horse’ and ‘fence’ (median=666.47ms, Z=-3.68), remained statistically significant at the $p<0.001$ level (Figure 5.5). A similar pattern was apparent for non-riders, who looked at the ‘horse’ (median=18155.78ms) for significantly longer than either the ‘other’ AOI (median=1941.41ms, Z=-4.31, $p<0.001$) and the ‘fence’ (median=958.38ms, Z=-4.31, $p<0.001$). The difference between the ‘fence’ and ‘other’ AOI, however, did not reach statistical significance for either riders ($p>0.05$) or non-riders ($p>0.05$).



<u>Figure 5.5:</u> Total dwell time calculated by summing fixations across seven cross country jumping video clips. Riders (N=8), non-riders (N=10). Asterisks *** indicate significance of $p<0.001$.

5.5.2. Fixation duration

There was a significant difference between the three AOIs when considering median fixation duration, (H(2)=145.88, $p<0.001$. Pairwise comparisons found significantly longer fixations on the 'horse' (median=316.68ms), than on both the 'fence' (median=199.5ms, Z=-7.19, $p<0.001$), and the 'other' AOI (median=199.95ms, Z=-10.47, $p<0.001$, figure 5.6). No significant difference was found between the median fixation durations on the 'fence' and 'other' AOI, Z=-0.79, $p>0.05$.

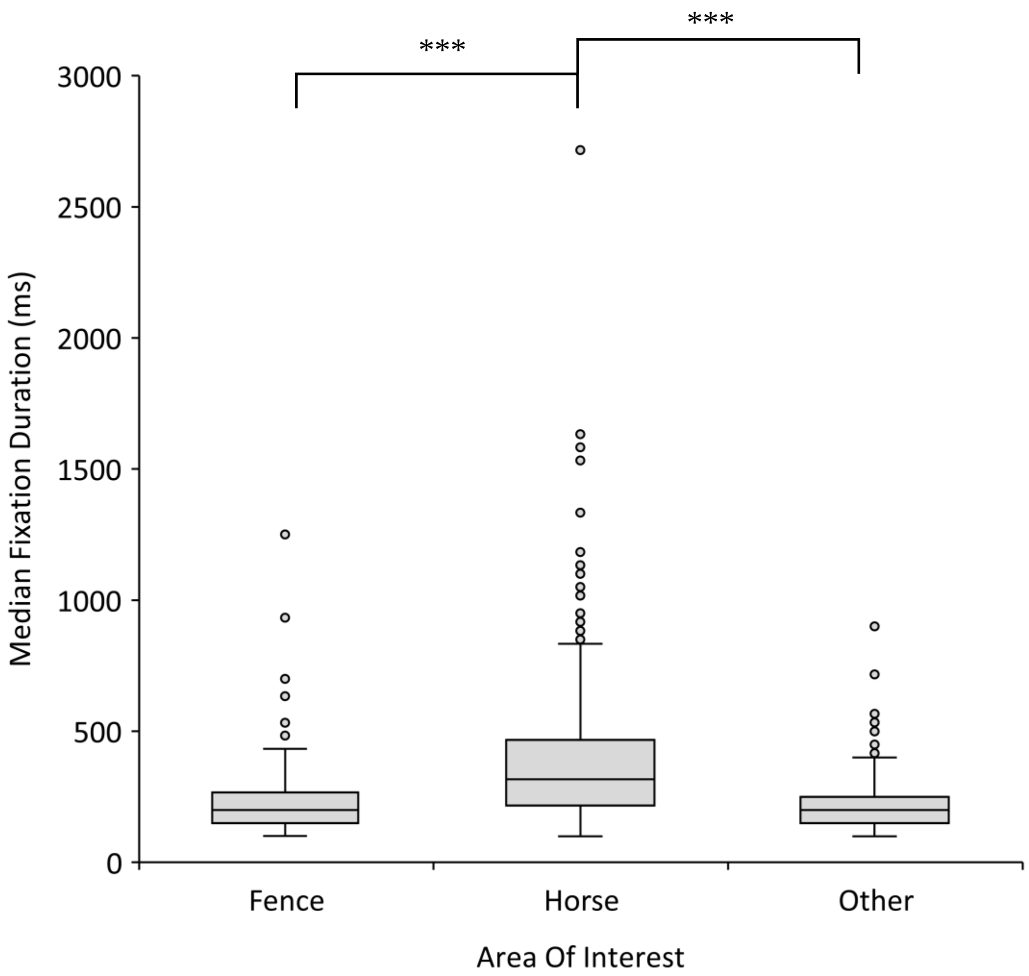
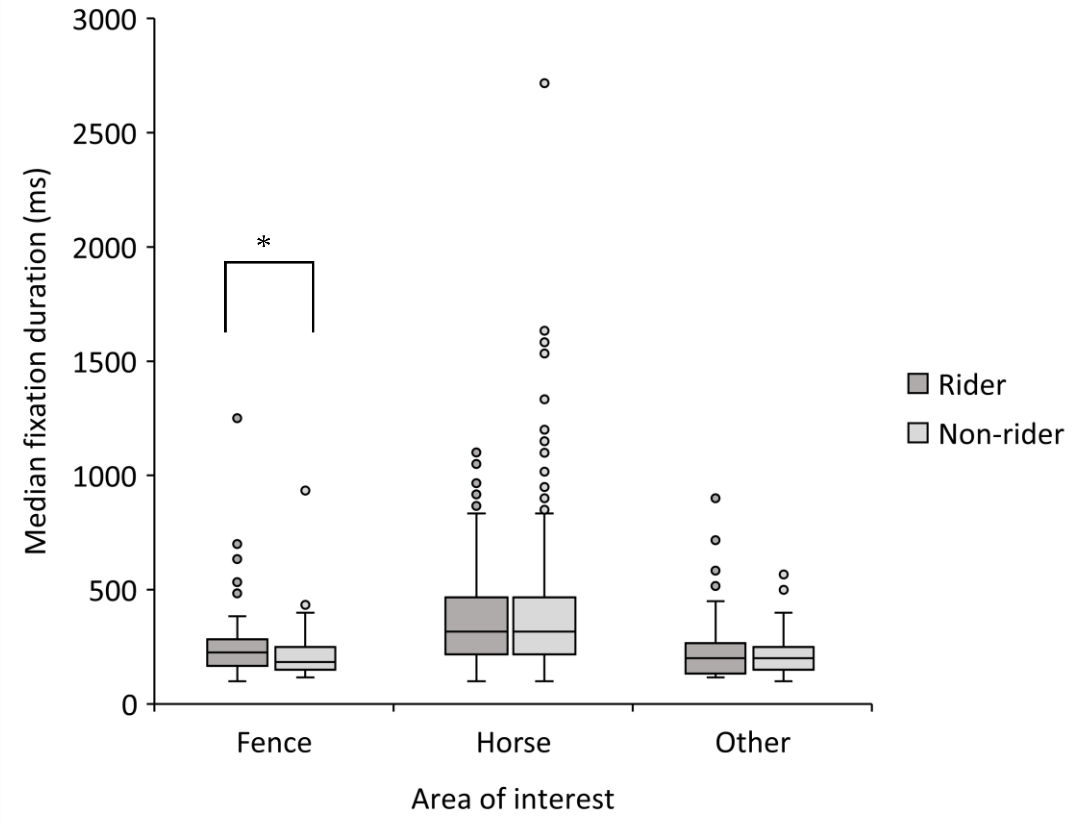


Figure 5.6: Median fixation duration (ms) of fixations on the 'horse', 'fence', and 'other' areas of interest while watching eventing video footage (N=18). Error bars show interquartile range. *** = $p<0.001$.

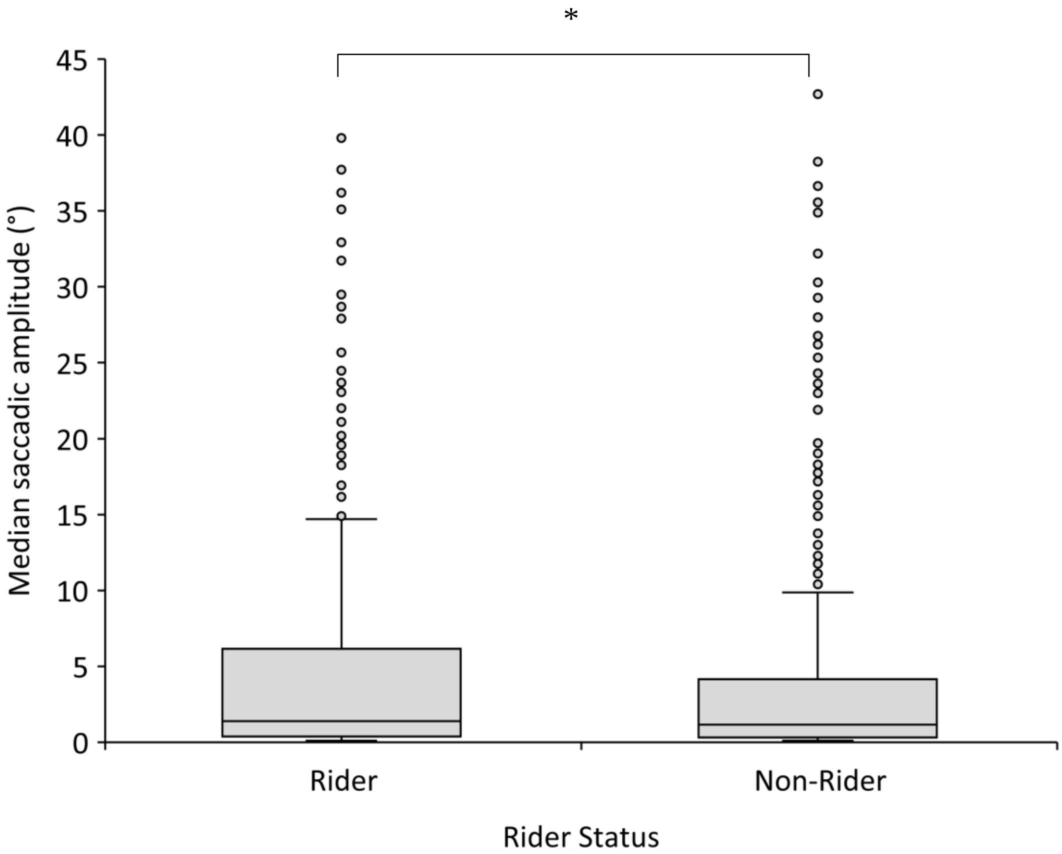
When rider status was considered, no significant difference was found between the median fixation durations exhibited by riders (median=266.7ms) and non-riders (median=266.8ms) when all AOIs were considered together, Z=-0.04, $p>0.05$. When the AOIs were considered separately, riders fixated on the 'fence' AOI (median=225.15ms) for significantly longer than non-riders (median=183.30ms, Z=-2.07, $p<0.05$, figure 5.7). No significant difference was found between riders and non-riders for fixation duration on 'horse' (medians=316.62ms and 316.73, $p>0.05$) or 'other' (medians=199.90ms and 199.95ms, $p>0.05$).



<u>Figure 5.7:</u> Median fixation duration (ms) of fixations on the 'horse', 'fence', and 'other' areas of interest while watching cross country video footage, split by rider status. Error bars show interquartile range. * = $p<0.05$.

5.5.3. Saccadic amplitude

Riders exhibited a significantly longer median saccadic amplitude (median=1.40°) than non-riders (median=1.15°, Z=-2.28, $p<0.05$, see figure 5.8).



<u>Figure 5.8:</u> Median saccadic amplitudes (°) of riders (N=8) and non-riders (N=10) while watching equestrian eventing video footage. Error bars show interquartile range. * = $p<0.05$. Rider (N=8) non-rider (N=10).

5.5.4. Transitions

The most common transitions made for both rider (mean=32.13, 62%) and non-rider (mean=34.70, 64%) were from within the 'horse' AOI to another area within the 'horse' AOI (Table 5.1.). Once these homogenous transitions were removed from analysis, transitions from 'horse' to 'other' were most common for both riders (mean=5.63) and non-riders (mean=5.40, figure 5.9). The results of the Fisher's exact test indicated that there was no significant association between rider status and the type of transitions made ($p>0.05$).

Table 5.1: Frequency and percentage of transitions made by riders (N=8) and non-riders (N=10) between areas of interest while watching cross country eventing video footage.

Transition		Rider			Non-rider		
From	**To**	**Frequency**	**Mean**	**%**	**Frequency**	**Mean**	**%**
Fence	Fence	6	0.75	1.44	11	1.10	2.03
	Horse	12	1.50	2.88	23	2.30	4.25
	Other	7	0.88	1.68	10	1.00	1.85
Horse	Fence	20	2.50	4.80	33	3.30	6.10
	Horse	257	32.13	61.63	347	34.70	64.14
	Other	45	5.63	10.80	54	5.40	9.98
Other	Fence	6	0.75	1.44	10	1.00	1.85
	Horse	37	4.63	8.87	34	3.40	6.28
	Other	27	3.38	6.47	19	1.90	3.51

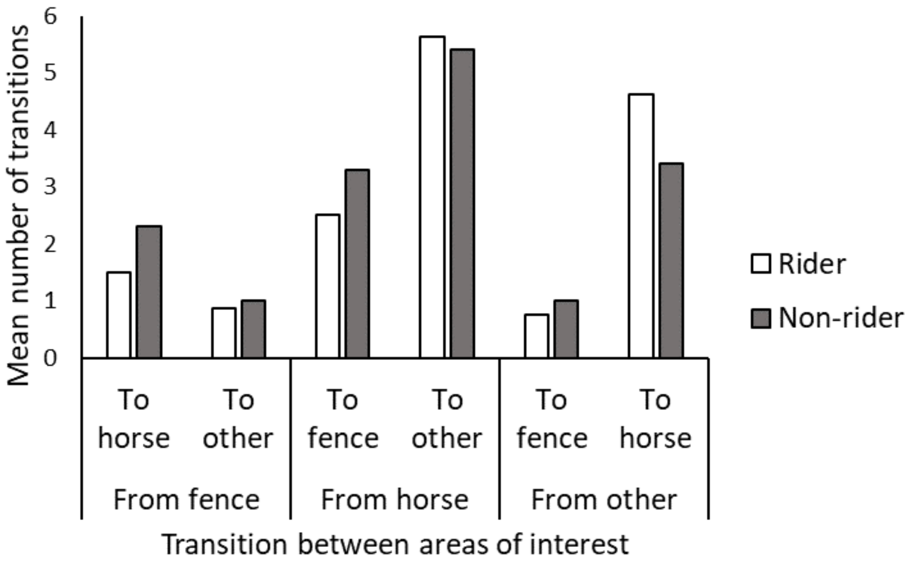


Figure 5.9: Mean number of visual transitions made by riders and non-riders between areas of interest ‘fence’, ‘horse’, and ‘other’ while watching cross country video footage. No significant difference between rider and non-rider for any transition.

5.6. DISCUSSION

Participants appeared to consider the horse the most important AOI present in the scene in terms of both longer dwell times and longer individual fixations (Holmqvist, *et al.* 2011). This was potentially because it was the only dynamic AOI so drew more attention than the static 'fence' AOI. The 'fence' AOI attracted the least amount of attention in terms of dwell time, but riders did exhibit longer individual fixations on the fence than non-riders. Certain types of cross country fences may be associated with greater risk than others (Bennet, *et al.* 2021; Singer, *et al.* 2003), which may be because different styles of fence might require different styles of approach. Knowing that some fences may be more or less difficult than others may have led rider participants to consider the fence type, location, and orientation more than the non-riders. It has been postulated that experts in a field may utilise fewer fixations of a longer duration than novices (Tien, *et al.* 2015). It is often thought that more frequent short fixations indicate a more active visual strategy, perhaps caused by an unfamiliarity with the scene, or a lack of confidence in knowing where to focus one's attention.

Riders demonstrated a slightly longer median saccadic amplitude than non-riders, further supporting the suggestion that they were moving their point of gaze around more deliberately than non-riders (Williams, *et al.* 1994). The difference in saccadic amplitude, while significant, was only very small. This was expected by virtue of all participants viewing the same videos which all followed the same predictable pattern, so the distance travelled by the point of gaze was never likely to vary enormously between individuals (Lum 2020; Takemoto, *et al.* 2022). Similarly, riders and non-riders were not found to make significantly different numbers of transitions between AOIs. With the small sample size, and limited number of distinct AOIs, it is unsurprising that a difference was not seen between transitions. Familiarity with a situation may influence searching strategies, but so too can the task at hand (Lancry-Dayan, *et al.* 2021). It is not possible to assume that the non-riders had never seen a horse being jumped before, so they were probably not totally naïve to the situation but did provide a control group against which to compare the rider participants. Hall *et al.* (2014b) suggested that there were tendencies towards those with a greater self-reported show-jumping skill demonstrating more pre-emptive visual behaviour, though this was non-significant. The use of gaze tracking goggles while mounted as opposed to desktop based eye-tracking limits the comparability of the results to this thesis.

Although riding experience factors were collected, the small sample size as a result of the onset of COVID-19 restrictions meant that analysis was limited to a binary metric of rider versus non-rider. It is reasonable to suggest that variations within the rider category, such as riding frequency, or highest competitive level, may influence visual behaviour. Additionally, it is possible that having experience in risk assessment or situational awareness in non-equestrian situations may have had an impact. As a result, while the small sample size recruited here limited analysis of differences to riders and non-riders, future use of gaze tracking methodology could investigate other relevant experience metrics. Understanding the typical visual strategies utilised by successful event riders at the top level has the potential to be used for assessment and training of those still developing their skills. There are particular applications within the realm of qualifications for teaching and coaching equestrian disciplines, practitioners of which will regularly watch riders from similar perspectives as utilised as stimuli here. For example, it has been demonstrated that lifeguards are faster and more accurate at identifying drowning individuals than those who had no lifeguarding experience (Laxton and Crundall 2017; Laxton, *et al.* 2021). It has also been proposed that video-based methodology could be a valuable tool for assessment of professionals (Laxton and Crundall 2017; Tien, *et al.* 2015). Identifying risk factors in riding practices is an important part of equestrian coaching and is a skill that could be assessed using gaze tracking techniques in the future.

Both riders and non-riders made most of their transitions from one area of the 'horse' AOI to another area of the same AOI. This is likely a result of the dynamic AOI, such that to track the moving part of the scene the eyes had to focus on the horse and then move and re-focus on the horse as it travelled across the screen. This may be a similar result to that seen in a judo study, though clearly it is difficult to compare results of gaze tracking studies between remote, such as eye-goggles, and mobile, such as desktop, methodologies (Piras, *et al.* 2014). There was no significant difference between riders and non-riders in terms of the frequency of any possible transition they could have made. So, although riders appeared to fixate for longer on the fence than non-riders, it does not appear that they moved their fixation point to the fence any more often than non-riders. It is possible that the stimuli used in this study enable collection of peripheral information, meaning that transitions were largely unnecessary. Future methodologies could incorporate spatial occlusions to reduce the amount of visual information available.

5.6.1. Applicability of results:

Many studies have utilised first-person gaze tracking, whereby the gaze of the person partaking in the sport or activity is what was being assessed (Piras, et al. 2010; Hall, et al. 2014b). In those instances, the research questions were designed to investigate the gaze behaviour of the athlete or practitioner. In the case of the study presented here, however, the goal was to investigate the gaze-behaviour of the person viewing the video footage, regardless of who the subject of the video was. In this way, the study demonstrated a viable method for assessing how people watch eventing video footage, and identified a significant difference between riders and non-riders.

The stimuli used here were video clips of horses and riders approaching cross country fence, as filmed from a spectator or fence-judge's viewpoint. The third person perspective used in this study enabled observation of horse, rider, and environment; aspects that are given limited visibility when using first person footage such as that recorded by hat-mounted cameras. The clips were only shown once, with no opportunity to re-watch, but participants were able to prepare for each video clip because progress from one to the next was manually controlled by the researcher. In this regard, they were representative of the experience of a fence-judge at a competition. In practice, however, fence-judges would generally attend to the same one fence for an extended period of time rather than the array of different fences presented to the participants here. They would also be able to assess the ground and weather conditions and, depending on their own eventing experience, may consider how they would approach the fence themselves. It is possible, though, that some of these cognitive processes were undertaken by the participants of the study presented here, an opportunity provided by the comprehensive camera angle. There is potential for the methodology to be applied to video footage of other sports which have existing banks of video footage which could be utilised. The video clips used here were filmed from an angle deemed to provide an overview of the horse and rider behaviour on approach to the fence. The sport of eventing relies heavily on the unmounted stakeholders who act as the referees of equestrian sport, so understanding what they see, and how they see it, is a valuable addition to equestrian science. The results presented here demonstrated some differences in visual strategy between riders and non-riders, so it is possible that differences also exist between levels of eventing expertise. Of particular note, is that inexperienced fence judges may miss certain indicators of risk or even faulty jumps, due to an inappropriate visual search strategy. Consideration should be made as to whether there is an optimum search strategy, or point of focus, when judging certain fences. Future research could use gaze-tracking combined with a training protocol and a simulated scenario where participants must choose whether or not to award penalties. In this way, greater consistency could be developed between fence-judges, and the opportunity to notice problematic behaviours could be increased. Using desktop-based technology and pre-recorded video footage permits a low-risk method of data collection which makes it a promising tool for the future of a notoriously high-risk sport (Paix 1999). As mentioned by Gidlöf *et al.* (2013), eye-tracking results created in a purely laboratory setting will have stimulated different attentional processing than eye-tracking in real-world scenarios. The methodology presented here provided a viewing experience to the participants which was representative of how someone might view eventing video on a computer at home.

There are opportunities, moving forward, to investigate whether different camera angles provide different information, and whether they influence the way in which people watch the video. The data presented here introduced the method of applying mobile gaze tracking techniques to commercially available, third-person eventing video footage. It is hoped that the techniques can be developed such that ease of use, accuracy, reliability, and labour requirements can be improved enough for it to become a beneficial tool for the training and refinement of visual skill.

5.7. CONCLUSION:

Until now, gaze tracking in equestrian sport had only considered the view of the mounted rider. The study presented here utilised footage recorded from the point of view of a spectator, or fence-judge. Video footage from this perspective enables observation of what both the horse and rider are doing, as well as providing information about the environmental conditions and characteristics of the fence being jumped. This study endeavoured to introduce the method of gaze tracking to commercially available eventing video footage, such that distinctions could be drawn between the visual behaviour of riders and non-riders. Research has often compared the visual behaviour of experts and non-experts to identify different cognitive processes when viewing a scene. In this instance, the visual behaviour of riders was compared to non-riders while watching cross country video footage. Differences in dwell time were detected between AOIs, with the horse appearing to be considered the most important aspect of the video footage. The only differences between riders and non-riders were found between dwell time on the fence, and saccadic amplitude. These results suggest that riders may have placed greater importance on the characteristics of the fence, and may have moved their gaze around the scene more deliberately, than non-riders. There was, however, no difference found between riders and non-riders in terms of the transitions they made between AOIs. This may suggest that riders and non-riders demonstrated a similar visual search strategy.

The results of this study warrant further investigation into the value of gaze tracking methods in equestrian sport. Establishing a baseline for how experienced coaches perceive a scene could enable the development of assessment protocols for coach certification, and fence judge training. These methods could be applied to disciplines such as dressage, which relies on the judge’s experience to make observations and score appropriately. Desktop-based gaze tracking has value as a portable, low-risk data collection method for cognitive processes of equestrians.

CHAPTER 6:
WHAT HAPPENS NEXT?
PREDICTIVE ABILITY OF RIDERS AND NON-RIDERS WHEN VIEWING EVENTING VIDEO FOOTAGE.

6.1. INTRODUCTION

To correctly predict any eventuality, an individual must be able to perceive, interpret, and apply information derived from the environment. Human predictive ability has been studied across a number of fields including driving safety (Ventsislavova, *et al.* 2016); learning and education (Seaman, *et al.* 2013); and sport (Smeeton and Huys 2011). There is some understanding that equine behaviour can indicate how the horse may respond in a given situation (Luke, *et al.* 2022). What is not known, however, is whether video recordings of ridden horse behaviour provide sufficient information for successful predictions to be made.

This study was part of a wider project which aimed to describe the value of ridden video footage in equestrian sport, with a particular focus on cross country eventing footage. Pre-recorded video footage enables the implementation of a methodology which does not pose a direct risk to either horse or rider, which therefore enables the inclusion of non-riders as well as novice and experienced riders. Additionally, this methodology provides an opportunity to use video footage recorded in competitive settings. Footage recorded in competitive settings, where the environment is likely to be less controlled than in experimental settings, is arguably more applicable to stakeholders. The study presented in this chapter aimed to investigate the predictive ability of participants using a “what happens next?” protocol. The video footage had been recorded in a competitive environment, and the camera angle was representative of that of a spectator or fence-judge. Being able to predict what happens next may indicate a greater ability to identify and interpret observable indicators, a skill which has implications for both performance and safety. By assessing predictive ability in cross country scenario, the study aimed to shed light on the factors influencing accurate predictions in equestrian sports. The results of this may demonstrate the importance of experiential or demographic factors on predictive ability, which could inform where efforts should be focussed in training.

6.2. LITERATURE REVIEW

Predictive skill is a foundational attribute which underpins any activity, but is particularly influential in competitive performance situations, or in situations where there are significant hazards. When discussed in the context of driving competency, predictive skill is often assessed through hazard perception testing (Crundall 2016; Ventsislavova, *et al.* 2016). Hazard perception in the driving context has been defined as the ability to predict dangerous situations on the road (Crundall 2016), though the word 'road' could theoretically be replaced by any other context in which dangerous situations may arise. Outcome prediction and hazard perception are largely dependent on another concept known as 'situational awareness'. Situational awareness, originally defined for use in pilot assessment (Endsley 1988), describes the cognitive process of using perceptual evidence to generate expectations of the surroundings, especially in a dynamic environment (Caserta and Singer 2007). It is important to note that these concepts of hazard perception, outcome prediction, and situational awareness do not necessarily have to involve danger in the sense of risk of bodily harm. In any scenario where there is motive to thrive, effective evaluative strategies can result in marginal gains and lead to greater success (Pentecost, *et al.* 2018). An example of this is in sport, where being better able to perceive behavioural cues from either teammates or opponents can result in competitive improvement (Morris-Binelli, *et al.* 2018). Experience of training in similar situations is believed to influence situational awareness, which enables the development of mental models; cognitive tools used to map out one's relevant surroundings and make predictions (Salmon, *et al.* 2020). This is particularly relevant in sports where spatial awareness is key. For example, within the equestrian discipline there is a concept known as 'seeing a stride' which involves identifying, and preparing for, the optimum point of take-off for any given obstacle (Hall, et al. 2014b; Laurent, et al. 1989). There will be an optimum take-off point for a horse to jump a fence most efficiently and safely, and the ability to distinguish that on approach to the fence requires the development, and understanding of, a mental map. Experience of equestrian jumping scenarios may contribute to an observer's ability to detect, interpret, and predict behaviours of horses and riders.

The jumping elements of equestrian eventing are scored primarily on whether the horse and rider jump the fence successfully (clear) or have a fault (not-clear). A jumping fault can consist of a refusal, run-out, rider-fall or horse-fall (British Eventing

2020). The ability to predict whether or not the horse and rider are going to fault requires behavioural and situational observational skills, similar to those required for successful hazard-perception while driving (Ventsislavova, *et al.* 2016).

6.3. AIM AND OBJECTIVES

The aim of this study was to evaluate the predictive ability of respondents using video footage of cross country jump approaches, by identifying influential demographic and experiential factors. This was achieved through the following objectives:

- Investigate the relationship between the predictive success of a respondent and their age or gender.
- Describe measures of riding and eventing experience and compare these to predictive success.

Demonstrating that cross country jumping outcomes can be predicted from cross country video footage would highlight that behavioural indicators are detected and interpreted by viewers. Furthermore, identifying those most successful at predicting the outcome could lead to a deeper understanding of expertise in equestrian sport. The results of this study may lead to the development of assessment protocols for riders, coaches, and officials. Using video footage for this purpose could provide a financially viable, accessible, and low-risk addition to equitation education.

6.4. MATERIALS AND METHODS

6.4.1. Ethical approval and consent

Ethical approval was granted for the present study by the ARE Ethical Review Committee and given code ARE896R. Participants over the age of 18 were invited to take part in an online "What happens next?" survey. Six statements identified the rationale of the study and plans for future usage of the data, agreement with which constituted consent for the collection of anonymous survey data. Participation was entirely voluntary, and participants were able to request their data be withdrawn from the study at any point before the 1st March 2020 by providing the unique code they entered at the end of the survey.

6.4.2. Survey design

An online survey (**Appendix 4**) hosted by Qualtrics (Qualtrics 2023) was distributed via the Facebook (https://www.facebook.com/) pages of the researcher and that of the funding collaborators. Social media is a common method of equestrian survey distribution (Bornmann, *et al.* 2021; Evans and Williams 2022). Data were collected from 23rd January to 28th February 2020. The demographic and equestrian experience section of the survey was as described in **chapter 2**. Participants were presented with 20 videos consisting of 10 successful and 10 unsuccessful jumping efforts; seven of which were refusals, two were horse falls, and one was a run-out. Participants were shown two demo videos to demonstrate the survey mechanism.

To ensure that predictive success was a result of participant differences, the video stimuli needed to provide enough information such that some, but not all, participants would be able to successful (Caserta and Singer 2007). To achieve this, the video clips were edited to occlude the outcome of the jumping effort. To determine when this occlusion point would be for each video, it was necessary to utilise data from a parallel study (**chapter 5**). Eight participants of a previous study (Signpost to gaze tracking) watched all 20 videos and were asked to click the left mouse button if they thought the jumping effort was going to result in anything other than a clear jump. The mean time point of the mouse click was calculated for the first eight participants, and this was the point at which the videos were cut to occlude the outcome. At the point of occlusion, the videos transitioned to a blank screen, as opposed to a still image of the last frame, to prevent any additional information being collected by the participant. This method was implemented to more closely resemble the time-limited experience of watching a horse and rider jumping a fence in real-time.

Participants chose which outcome they anticipated from a list of five options. The options given to the participants reflected the categorisation provided by British Eventing (BE) and the Fédération Equestre Internationale (Fédération Equestre Internationale 2018; British Eventing 2020). Descriptions of each outcome are presented in Table 6.1. Once the participants had made their choice, they were informed of the correct answer and were able to view the video it its entirety before moving on to the next one.

Table 6.1: Description of the five possible outcomes of a cross country jumping effort (adapted from FEI *et al.*, 2018).

Outcome	Description
Clear jump	The horse and rider jump the obstacle successfully.
Refusal	The horse stops before the obstacle.
Run out	The horse avoids the obstacle without stopping.
Rider fall	The rider is separated from the horse but the horse remains upright.
Horse fall	The horse falls such that its body touches the floor.

6.4.3. Data analysis

Incomplete responses, and responses from very small groups, were removed during the data cleaning process, leaving a final sample size of 2584 survey respondents. Due to the survey routing, not every participant answered every question. The data were therefore split into three sub-sections:

1. All participants, including non-riders (N=2584)
2. Riders, who may or may not have evented (N=2490)
3. Participants who rode and had competed in eventing at some level (N=1836)

The goal of the study was to investigate factors that influenced participant's ability to predict a clear or non-clear cross country jumping effort. Participants factors that were considered included age and gender, measures of equestrian experience, and involvement in other riding disciplines. A binomial outcome variable was implemented for each video clip viewed meaning that if the participant correctly predicted the outcome of the video, they scored a 1, and if they were incorrect, they scored a 0. Though there were initially five options provided to the participants, their answers were further grouped into “clear” and “not-clear” outcomes. This was because there was not an even distribution of possible outcomes across the included videos. Consequently, if a participant correctly predicted that the jumping effort would be unsuccessful but did not correctly choose between the four possible “not-clear” options, they were still awarded a point. Binomial generalised linear mixed models (GLMMs) were developed for each sub-section of the data to identify relevant factors which may have influenced the success of a participant.

The results provided odds ratios, with corresponding confidence intervals, to describe how the odds of success were influenced by each level of every variable included in the model. An odds ratio of more than 1 is indicative of an increase in the likelihood of success, and less than 1 suggests a decrease in the likelihood of success. The order in which participants viewed the videos was randomised by the survey software to prevent the results from being unduly influenced by the viewing sequence. Order was therefore controlled as a random effect in the model to eliminate any influence this may have had on the success of the participant. All statistical analyses were carried out in R (R Core Team 2022).

6.5. RESULTS

Using the method demonstrated by Vivian *et al.* (2022), a sample of 2490 rider respondents represents a margin of error of ±2% at the 95% confidence interval (SurveyMonkey Inc. 2023). This calculation assumes a population of approximately 1.8 million regular riders (BETA 2019a).

6.5.1. Effect of age and gender

After removal of incomplete data, the sample size of all participants was 2584. The number of those who rode or had ridden in the past was 2490 (96%); the group which will hereafter be referred to as ‘riders’. Of the riders, 1836 (74%) had also taken part in the sport of eventing at some level, this group will be referred to as ‘eventers’ (Table 6.2).

Table 6.2: Names and definitions of each sub-sample of respondents to an online survey investigating rider and non-rider ability to predict the outcome of a cross country jumping effort.

Sub-sample name	Definition	N (%)
All participants	All participants, regardless of whether they had ever ridden a horse or taken part in the sport of eventing.	2584 (100)
Riders	Only participants who reported that they rode a horse more regularly than once a month, or had done in the past, regardless of whether they had ever taken part in the sport of eventing.	2490 (96)
Eventers	Only participants who reported that they had taken part in the sport of eventing at any level.	1836 (71)

There was an even spread of age groups across the three sub-samples, with every age group representing between 20% and 30% of the sample in every instance (Table 6.3). There was, however, a skew towards female versus male participation (95% female, 5% male) which remained the case across all sub-samples (96% female, 4% male).

Table 6.3: Age and gender distribution of all respondents (N=2584), those who rode or had ridden (N=2490), and those who event or had evented (N=1836), as recorded by an online survey investigating ability to predict cross country jumping outcomes.

Variable	**Levels**	**N**			**%**		
		All	Riders	Eventers	All	Riders	Eventers
	Total	2584	2490	1836			
Age	18-25	610	587	428	24	24	23
	26-35	756	737	555	29	30	30
	36-45	519	509	396	20	20	22
	46 or over	699	657	457	27	26	25
Gender	Female	2455	2393	1766	95	96	96
	Male	129	97	70	5	4	4

When all participants were included in the model, age was found to be a factor but only for the oldest group (46 years or over). Being categorised as aged 46 years or over (N=699) indicated significantly lower odds of successfully predicting the outcome of the video footage when compared to those in the 18-25 year old age group (N=610, OR:0.95, CI:0.90-1.00, $p<0.05$). It should be highlighted, however, that this significant effect of age category was not evident once the non-riders had been removed from the analysis, i.e. age could not be considered a factor in the rider or eventer sub-samples. Gender was not found to be a significant factor for any of the sub-samples ($p>0.05$).

6.5.2. Measures of equestrian experience

Of the total 2584 participants, 646 (25%) were employed within the equestrian industry. A similar proportion of equestrian employment was demonstrated even when non-riders, and subsequently non-eventers, were removed (N=644, 26% and N=518, 28% respectively). The most frequently reported jobs included variations of trainer, instructor, or coach; rider; groom or stable hand; and owner or manager of an equestrian facility. Less frequently reported jobs included breeding horses, working in the veterinary profession, and working in equestrian related sales.

A majority of the respondents (N=2104, 81%) rode a horse regularly at the time of completing the survey. For the purposes of this study, riding a horse regularly was defined as at least once a month. A smaller proportion of participants (N=386, 15%) reported that they had ridden regularly, but in the past. When asked how long ago they had ridden, the reported time spans ranged between a few months to over 40 years ago.

Employment in equestrianism was not found to be a significant factor for any of the three groups, whether non-riders and non-eventers were included or not ($p>0.05$). Neither current riders nor past riders were significantly more or less successful at predicting the outcome of eventing video footage than non-riders ($p>0.05$), suggesting that non-riders did not perform any better or worse than people who rode regularly.

Once non-riders were removed from analysis, participant riding experience could be examined in more detail. When asked "how many times per month do you ride a horse?", the modal category was 21-30 times per month (N=752, 30%). Riding more than 30 times per month (N=526) appeared to be significantly associated with greater success in the video outcome prediction task than those who only rode 10 times or fewer per month (N=534, OR:1.09, CI: 1.03-1.16, $p<0.05$). Having taken part in the sport of eventing did not appear to relate to significantly more or less successful video outcome prediction ($p>0.05$). Those who had never competed in the sport of eventing (N=654) were subsequently removed from analysis, leaving only eventers (N=1836), in the model (Table 6.4). Once non-eventers were removed from analysis, the effect of ride frequency remained such that when compared to those who rode a horse 10 times or fewer per month (N=534), riding 21-30 (N=752, OR: 1.08, CI: 1.01-1.15, $p<0.05$) or more than 30 times per month (N=526, OR: 1.12, CI: 1.04-1.21, $p<0.05$) appeared to be related to a significantly higher success rate.

Having competed to the highest level of eventing (120cm or more, N=101) had a borderline significantly positive impact on participant's outcome prediction success when compared to those competing at the 100cm level (N=421, OR: 1.11, CI: 1.00-1.23, p=0.05). Another method of assessing participation within the sport of eventing was to enquire about the affiliation status of the events primarily attended by each participant. Competing primarily at unaffiliated events (N=566) appeared to have a significantly negative relationship with participant predictive success compared to those who primarily competed at affiliated events (N=1270, OR:0.05, CI: 0.91-1.00, $p<0.05$).

Table 6.4: Success rate of eventing video outcome prediction for eventers (N=1836) using measures of riding and eventing experience as fixed variables. Model utilised a binary outcome where 1=successful and 0=unsuccessful prediction for each video. Statistical significance is indicated by *=$p<0.05$ and the arrows indicate the direction of the effect.

Predictors	Levels	N	Odds Ratio	CI	p	Direction of effect
Ride frequency per month	1-10	252	ref			
	11-20	483	1.07	1.00-1.14	0.07	
	21-30	625	1.08	1.01-1.15	0.03*	↑
	More than 30	476	1.12	1.04-1.21	0.003**	↑
Highest level of eventing	100cm	421	ref			
	80cm or less	342	1.00	0.93-1.07	0.98	
	90cm	274	1.04	0.97-1.12	0.25	
	110cm	508	0.99	0.93-1.05	0.70	
	115cm	190	1.08	1.00-1.17	0.06	
	120cm or more	274	1.11	1.00-1.23	0.05	
Primarily affiliated	Affiliated	1270	ref			
	Unaffiliated	566	0.95	0.91-1.00	0.04*	↓

6.5.3. Other riding disciplines

To investigate any relationship between eventing video outcome prediction ability and other equestrian activities, participants were asked what other equestrian disciplines they took part in (Table 6.5). Taking part in leisure riding (N=1088) and dressage (N=1405) were not significant factors in determining predictive success in the video test but partaking in the sport of show-jumping (N=1279) was. Taking part in show-jumping appeared to significantly increase participant chances of correctly predicting the outcome of the eventing video footage (OR:1.05, CI:1.01-1.09, $p<0.05$). Participation in "other" disciplines appeared to have a significantly negative impact on predictive success when watching the eventing video footage (N=730, OR: 0.96, CI: 0.92-1.00, $p<0.05$). The disciplines categorised as "other" in this instance included racing, endurance and showing.

Table 6.5: Success rate of eventing video outcome prediction for riders (N=2490), including non-eventers (N=654) and eventers (N=1836), using riding discipline as fixed variables. Model utilised a binary outcome where 1=successful and 0=unsuccessful prediction for each video. Statistical significance is indicated by *=$p<0.05$ and the arrows indicate the direction of the effect. CI= 95% confidence interval.

Predictors	Levels	N	Odds Ratio	CI	p	Direction of effect
Leisure rider	No	1402	ref			
	Yes	1088	0.99	0.95-1.03	0.614	
Dressage rider	No	1085	ref			
	Yes	1405	1.01	0.97-1.05	0.571	
Show-jump rider	No	1211	ref			
	Yes	1279	1.05	1.01-1.09	0.018*	↑
Other discipline	No	1760	ref			
	Yes	730	0.96	0.92-1.00	0.031*	↓

6.6. DISCUSSION

The results of this study indicate variation in predictive success of viewers (N=2584) watching cross country video footage. The factors which appeared to relate to greater predictive success were riding more frequently per month and participating in show jumping. Factors related to poorer success were being in the oldest age category, but only when non-riders were included, primarily competing at unaffiliated events, and participating in disciplines other than leisure riding, dressage, and show jumping. While these factors could be considered statistically significant, the effect sizes were only very small. The largest effect was that of riding more than 30 times per month when only event riders were considered (OR:1.12, CI: 1.04-1.21, $p<0.003$). The results indicated that riding more than 30 times per month provided a 12% increase in the odds of successfully predicting the outcome of a cross country jumping effort. Future research into whether predictive ability can be influenced by a pre-test training treatment would provide more information as to whether a 12% improvement to predictive ability can be increased further. Being able to correctly predict the outcome of cross country efforts indicates that there must be some observable indication that some viewers are better able to detect. This has implications for welfare of competing horses and riders, and therefore the public perception of the sport of eventing. If those who are skilled at identifying and interpreting potential risk factors are engaged in roles such as fence-judging, their insight may enable officials to intervene before a potentially catastrophic incident occurs. The results of this study demonstrate that some people are better able to interpret the information, and this provides a baseline against which to test other people. At present, fence judges are provided very limited training, and no assessment at all. Video-based tools such as these could provide an accessible method of conducting some level of assessment for fence judges. The people who are most able to notice potentially problematic behaviour in cross country are the fence judges, but they are not necessary the most experienced. It is therefore recommended that further research targets volunteer fence judges, because of their vital communicative role in the sport of eventing.

Horse-riding is one of the sports which allows people of all genders and ages to compete on a level playing field (BETA 2019b). In the present study, when all participants were considered together, the oldest group of participants (46 and over) appeared to be less successful at predicting the outcome of the eventing video footage. This difference between age groups was only significant when non-riders were included, suggesting that the older non-riders influenced this result. Older riders may be more agreeable, conscientious, and less neurotic than younger riders (Wolframm, *et al.* 2015). Once non-riders were removed from analysis, age was no longer a significant factor for predictive success. The inclusivity of equestrian sport means that all riders are having to undergo the same cognitive processes during training and competition, regardless of age. The results of this study suggest that age does not appear to impact on rider ability to detect and interpret behavioural predictors of jumping faults. Participant gender was not a statistically significant factor in successful eventing video outcome prediction at any level, for any sample. It should be highlighted, however, that there was only a small percentage of male participants (5% of all participants). A study reporting on cross country starts demonstrated an approximately 60/40 gender split between females and males, though this did not account for multiple entries per rider (Bennet, *et al.* 2021). A similar, earlier study reported a split of approximately 75% female to 25% male competitors (Singer, *et al.* 2003). A female-heavy gender skew could, therefore, be considered somewhat representative of the sport. It has been found that survey method can influence the representativeness of a sample (Harrison, *et al.* 2023; Cornesse and Bosnjak 2018), so it is also likely that the social-media distribution method of an online survey may have further influenced the demographic. A study investigating senior equine management, for example, reported a similar skew of 91% female respondents (Bushell and Murray 2016), and another looking into spur use reported a 95% female response rate (Lemon, *et al.* 2020). Social-media distribution was, however, chosen for its strength as an efficient, wide-ranging, and cost-effective method for distributing a media-based survey. In the case presented here, it is difficult to determine whether the gender bias was a result of the voluntary aspect of the survey, the equestrian-related theme of the survey, the inherent gender bias present in equestrianism, or a combination of these factors.

The discipline portrayed in the survey was the cross country element of the sport of eventing. It was not however, necessary to have competed in the sport of eventing, or to have ever ridden a horse, to take part in the survey. As a result, participants will have had varying perceptions and experience of eventing, or equestrianism in general. Despite the survey requiring participants to predict the outcome of cross country video footage, there was no significant difference in success rate between riders and non-riders ($p>0.05$). Non-riders appeared to be as capable at interpreting cross country video footage as riders, though there were only 94 (4%) non-rider respondents. Measuring rider experience using only a binary metric of rider vs non-riders may not be sufficient to detect differences in cross country video outcome prediction. It might have been expected that non-riders would perform worse than riders at an equestrian based prediction task, but the results presented here do not support that. In fact, having taken part in the sport of eventing was also not a significant factor, though this may be because there are some aspects of cross country riding that apply across other disciplines. This is further supported by the fact that taking part in show jumping appeared to relate to greater predictive success, even when non-eventers were included. Participating in leisure riding or dressage riding had no statistically significant effect on a participant's success rate, but show-jump riders appeared to be more successful than those who did not show jump. In both show-jumping and cross country jumping, the horse is presented to the fence by the mounted rider (Fercher 2017). It is likely that the behaviours exhibited by show-jumping horses and riders are similar to those of cross country jumping horses and riders, resulting in transferrable perception skills.

Within the sport of eventing there is considerable variation in height of fence, length of course, and technicality of combinations (British Eventing 2022). When participant's highest level of eventing was considered, there was no statistically significant impact on their ability to successfully predict the outcome of eventing video footage. There was, however, a trend towards greater predictive success at the higher levels of eventing. It could be suggested, based on these results, that eventers competing at the highest levels of competition possessed greater knowledge of behavioural risk factors. It should be considered though that just because a participant reportedly competed to a high level, this does not mean that they did so recently, or that they were reporting accurately; a common limitation of self-reporting survey data (Choi and Pak 2005).The riding experience factor that did appear to be influential was ride frequency, or the number of times the respondent rode per month. When only the eventing participants were considered, the influence of riding frequency was even more pronounced. This supports the suggestion that riding more frequently may improve an individual's ability to correctly predict the outcome of cross country jumping video footage. It is likely that those who rode more than 30 times per month probably rode more than one horse. Experience of multiple horses leads to increased ability to detect and interpret behaviours.

The sport of eventing in the UK can either be affiliated with the governing organisation of British Eventing or run unaffiliated. Participants who competed predominantly unaffiliated, had significantly less success than those who predominantly competed affiliated. Unaffiliated events are generally cheaper to enter but will not have to meet the strict requirements on safety and first-aid provision that affiliated events do, and often do not provide competition at high levels. There has, historically, been a perception that participants competing at unaffiliated events are involved primarily for recreation rather than competition (Bye and Chadwick 2018). The results presented here suggest that affiliation may be a useful indicator of equestrian experience and warrants further investigation. Taking part in the "other" disciplines such as showing and racing also appeared to result in poorer performance in the outcome prediction task. There are some cross-overs between eventing and horse-racing such as the risk of falling and the influence of the ground conditions (Williams, *et al.* 2014). It is understandable though that the disciplines may be sufficiently different from one another such that they elicit the development of different cognitive and perception skills. This is concurrent with the findings of Müller *et al.* (2015) who suggested that anticipatory perceptual skill is not easily transferred between dissimilar sports.

This study has identified some factors that may influence the ability of a person watching cross country video footage to correctly predict a jumping fault. The use of cross country video footage recorded from a spectator point of view provided a view representative of that of fence-judges, coaches, and event officials. It can be inferred from these results that those successful respondents were able to detect and correctly interpret some visual indicators present in the footage. Future studies should endeavour to investigate the specific behaviours being perceived by the viewers, and whether those behaviours might be predictive of cross country faults. Predictive ability using video footage has potential as an assessment tool, and the results presented here provide a baseline to begin comparisons. Demonstrating some level of assessment within fence-judge and officials could help to improve eventing's social licence to operate by increasing transparency (Furtado, et al. 2021). Future research would benefit from incorporating a training treatment to ascertain whether the ability to correctly predict the outcome of a cross country jumping effort can be improved through learning.

6.7. CONCLUSION

The results of this study indicate that some participants were able to correctly predict the outcome of eventing video footage, and that there were some significant experiential factors. The umbrella term of "horse-riding" encompasses an enormous range of skills and disciplines, and whether or not a participant classes themselves as a rider is rarely sufficient to make an accurate assessment of their abilities. Incorporating different measures of equestrian knowledge and riding experience provided valuable information into the multi-faceted field of sporting expertise. It is suggested that riding more frequently and participating in parallel disciplines, such as show-jumping, potentially provided useful skills when set a cross country prediction task. It is advised that participation in disciplines other than the one being investigated may influence task performance, and this data should therefore be collected where possible. This study also highlighted that preference for entering affiliated or unaffiliated events may be a useful indicator of equestrian experience.

Correctly predicting the outcome of eventing video footage suggests the ability to identify and interpret relevant visual indicators, most likely horse and rider behaviour. Future research should endeavour to isolate, categorise, and define behaviours which may predict a cross country jumping hazard.

CHAPTER 7:
GENERAL DISCUSSION

7.1. Overall discussion of thesis

This thesis aimed to introduce the perceived value of ridden video footage as a performance analysis tool. Using online surveys for exploratory analysis of existing attitudes, gaze tracking methodology, and assessment of predictive ability, this project has contributed to the understanding of how different people may utilise video in different ways. The results of this project have application to riders, trainers, and officials to better understand how they perceive horse and rider behavioural indicators that may be predictive of cross country faults. Additionally, awareness of how riders use ridden video footage may be beneficial to both trainers and commercial video providers so that the footage recorded can provide optimum value.

Video footage of ridden performance, either in training or competition, provides records of horse and rider behaviour which can be used for performance analysis. Though it was believed that video review was used in equestrian training practices (Winfield 2015), there was little understanding of how it was perceived by the general riding population. The results of this project demonstrate that jumping fault outcomes were able to be predicted, to some degree, from commercially available cross country video footage. Further investigation is warranted into which horse and rider behaviours may be predictive of jumping faults, while appreciating that the complex relationship between horse and rider means that those behaviours cannot be considered as standalone causative factors. Elucidating what riders perceive to be behavioural risk factors deepens our understanding of which aspects of cross country video people may be paying attention to. Additionally, this project offers evidence for differing viewing strategies between riders and non-riders, providing grounds for more in-depth investigation of gaze behaviour while watching cross country.

The nature of equestrian sport often includes lone training, which limits the opportunity for extrinsic feedback. The current study introduces the extent to which horse riders currently use video footage for their own purposes. It should be noted that, while this survey-based study posed questions regarding self-subject ridden video footage, expert-modelling has also been suggested to have performance benefits in other sports such as climbing (Blagus, *et al.* 2023). As such, this thesis addressed rider attitudes towards video footage of their own riding, but later chapters also addressed whether behavioural indicators could be identified by watching video footage of another rider.

The results of this project suggest that individuals who perceive self-subject ridden video footage as useful, appreciate the ability to share it, and multiple motives for watching the footage are more likely to engage with such video footage. Many respondents recognised the social value of ridden video footage, but there were multiple motivations for recording video footage, which is a similar finding to that reported by Lux and Huber (2012). It was also identified that most of the horse behaviours provided were thought to be predictive of jumping faults of some description, but when asked what riders would look for when watching their own riding video very few of them reported that they would assess the horse's behaviour and position. This observation may imply that there is a disparity between riders' perceived focus of attention and their actual visual attention during the task. Future gaze-tracking studies could utilise video footage of sufficient quality and resolution to enable differentiation between fixations on the horse and rider. The footage used in the present study was not of sufficient quality to enable this, so it is suggested that future gaze-tracking studies utilise a panning video where the horse and rider can be maintained as the largest subject in the frame. Participants who rode more frequently and rode to the highest level of eventing did appear to be the most successful at predicting the outcome of eventing footage, but further research is needed to identify the indicators they were able to interpret. The gaze tracking data supported the theory that riders and non-riders (experts and non-experts) viewed the scene differently, but in this case it was not possible to distinguish between whether the observer was focussing on the horse or the rider.

Ridden horse behaviour has been identified as an important potential indicator of pain and stress (Dyson 2021; Cook and Kibler 2019; Dyson and Van Dijk 2020; Visser, et al. 2009), but primarily in disciplines performed on the flat, such as dressage. Research into risk in cross country has relied on fall and fault statistics, or horse and rider demographics (Murray, et al. 2005; Fédération Equestre Internationale and Barnett

2016; Singer, et al. 2003; Bennet, et al. 2021; Hennessy 2017). As video footage of competitive cross country riding has become more available, it is now possible to apply some of the findings regarding behavioural indicators of pain or stress in dressage horses to the cross country discipline. This project investigated rider perception of how these behaviours might influence performance outcomes in a cross country setting. Understanding how these behaviours are considered by equestrian stakeholders is an important step towards behaviour change. It is therefore recommended that stakeholder perception is considered more often in future research, otherwise there is a risk of widening that divide between equitation science and the traditional practices of equestrianism.

7.2. Discussion of subjects

There are a multitude of ways to record participant information, perception, and intention. This thesis relied on survey-based data collection, though efforts were made to ensure consistency across the comprising studies. Across all four studies, the sample was almost exclusively female, though this is not uncommon in equestrian survey-based research. An eventing based study investigated rider perceptions of their own abilities and the abilities of their horse and found an almost 80/20 split of female to male respondents (Beauchamp and Whinton 2005). Another questionnaire study into the physical fitness perceptions of riders reported a 95% female, 5% male sample (Bye and Chadwick 2018). In both cases, the researchers chose not to investigate gender differences and instead pooled male and female respondents (Beauchamp and Whinton 2005; Bye and Chadwick 2018). Conversely, some significant differences were found between female (70%) and male (30%) riders in pre-competitive levels of arousal and self-confidence (Wolframm and Micklewright 2009). While a female-heavy skew is reasonably common within equestrian based studies, the results are not always consistent, and may be further influenced by the data collection method utilised. Where older online surveys may have suffered from a heavily male response rate due to differing proportion of male and female internet users (Healey, *et al.* 2002), the reverse is often reported in more recent times (Smyth and Dagley 2015). Voluntary online surveys, particularly those with an animal themed research question, tend to attract a largely female demographic (Smyth and Dagley 2015; Clayton and Williams 2021; Kogan, *et al.* 2012). It should be noted, however, that not all surveys see a female-heavy bias. For example, a survey aimed at studying the mobile phone usage of respondents saw a heavily male skewed sample with 78% males compared to 22% females (Rashid, *et al.* 2020). Generalisation of the results of this project is cautioned because of the gender skew, though the focus of the research was on video use and how it may benefit performance. Equestrian sport permits males and females to compete equally, and it should therefore be questioned as to whether investigating gender differences is an appropriate allocation of research resources. It could be argued that emphasis should be placed on performance and safety of horses and riders more generally, rather than their sex at birth or gender identity. It is possible that the value of video feedback applies to all, irrespective of gender, though the results of this project are not able to provide evidence for this. Further investigation into whether the application of video feedback differs between male and female athletes may demonstrate whether gender is a relevant factor or not.

Increasing popularity and availability of livestreamed cross country means that the sport is becoming available to an ever-wider audience. With increasing concern for animal welfare from the public placing pressure on the equestrian industry (Davies, et al. 2022b), it is proposed that non-rider observations may provide insight into how equestrian sport is being perceived. Understandably, non-riders are not used in ridden experiments requiring live horses due to the risk of compromising horse welfare. Video footage provides the opportunity to study non-rider perspectives without risk to either horse or human. The results of **chapter 6** reported no difference in the predictive ability between riders and non-riders, though differences were seen between different levels of riding experience. It is possible that these findings were a result of the sample being heavily skewed towards riders. Across the equestrian industry, an awareness of horse behaviour is an important tool for risk management (Warren-Smith and McGreevy 2008). As a result, non-riders may still have had some knowledge of equine behaviour, or potentially experience of animal behaviour in a different setting, thereby possessing some transferrable skills.

Although video footage is largely recorded and broadcast for the benefit of equestrian stakeholders, it is available to the wider public as well. Equestrianism persists due to a social licence to operate which relies on society perceiving the activity as legitimate and appropriate (Furtado, et al. 2021). With the social licence of equestrianism being under threat, it is important to understand how non-equestrians consume media coverage of sports, especially those that are known to be dangerous to both horse and rider. It is therefore recommended that more research includes non-riders, or non-equestrians, to enable a greater understanding of the criteria of the social licence to operate held by equestrian sport. It is possible that the non-riders included here may have had experience of other animals, or animal sports, but this data was not collected. Incorporating animal experience factors rather than only equine experience may provide some understanding as to whether the skills are transferable between species or between disciplines.

7.3. Application of results

Though visual behaviour of the rider has been investigated to some extent (Hall, et al. 2014b; Laurent, et al. 1989), the gaze tracking study presented here was the first to apply this methodology to cross country video footage filmed from a spectators perspective. As is common in gaze tracking research, there was considerable data loss as a result of poor tracking, but the remaining data was sufficient to detect some differences in visual strategy between riders and non-riders. The project as a whole aimed to demonstrate the ways in which commercially available cross country video footage could be utilised. To maintain distinction between the 'horse' and 'fence' areas of interest (AOIs), this meant that much of the video data was not able to be analysed because the angle of the camera was such that the AOIs often overlapped. It is, therefore, suggested that if researchers wish to identify differences in fixations between the 'horse' and 'fence', side-on footage may be more appropriate. Side-on footage would, however, necessitate the use of wide angle lenses in order to maintain visibility of the horse and rider throughout their approach, which then introduces distortion (Vieira, *et al.* 2017).

In the case of self-subject video footage the subject (the rider) will possess prior knowledge of the horse, the task, and their own abilities (Caserta and Singer 2007). The presence of a self-view, such as that displayed during an online video call, has been noted to influence visual behaviour, (De Vasconcelos Filho, *et al.* 2009). The videos used as stimuli were of riders not familiar to the participants, so it can be assumed there was no influence of self-perception. It is cautioned, however, that the results of the gaze tracking study may not be applicable to video footage where the viewer is also the subject. Implementing a stimulus subject factor by comparing visual behaviour while watching self-subject ridden video footage compared to other-subject ridden video footage may illuminate differences between self-modelling and peer- or expert-modelling.

Further investigation into visual strategies may have applications to the training and assessment of coaches and fence-judges. For example, if the viewing strategy of expert instructors could be determined using gaze-tracking technology, this could provide a basis against which to compare less experienced instructors. Fence-judges are a particularly important aspect of the cross country phase of eventing, because they hold responsibility for allocating penalties and reporting and concerns they may have regarding the horse and rider. Currently, there is no known research investigating mental fatigue in fence-judges throughout a competition day, nor is there any testing of fence-judge ability. The results of this project suggest that there may be variation in observers' ability to detect potential behavioural risk factors. It is therefore recommended that some level of testing is applied to fence judges, to ensure that they are able to detect, interpret, and report any behaviours that may increase the likelihood of a jumping fault. In this sense, pre-recorded video footage has potential value as a training tool to improve live observations by observers. Other video providers, particularly those that broadcast the footage, offer live, panning video footage. The project presented here utilised pre-recorded video footage from static cameras, but future investigation into the role that live video footage may have in a competition environment would be beneficial. Currently, video footage is largely used reactively, but its use in proactive training programs may have benefits to eventing stakeholders, as well as producers of video footage.

While it is now possible for equestrian stakeholders to easily record and review their own video footage, this project has elucidated variations in the way in which the footage is utilised. Cross country is unique within equestrian sports by virtue of its use of varying terrain and long distances, making it difficult for an individual to capture more than a section of a competitive round. It should be noted, however, that footage of entire competitive cross country rounds is also widely available. Competitive environments are likely to alter rider levels of anxiety (Wolframm and Micklewright 2009) and mental fatigue (Russell, et al. 2023), thereby impacting behaviour. It is therefore suggested that video footage of competitive performance may elucidate changes in behaviour that are not present in a training environment. Performance analysis seeks to make associations between behaviours or actions and sport-specific outcomes (McGarry 2009), but competitive performance analysis necessitates records of behaviour in competitive scenarios. Appropriate utilisation of competitive video footage alongside video footage of training scenarios may enable the identification of influential behaviours. Training strategies could then be developed which aim to reduce the deleterious behaviours in order to improve competitive performance.

Though it is often claimed that video footage provides an objective record of a performance (Wilson 2008), it should be noted that there is some subjectivity associated with the way in which the video is recorded. For example, the camera angle will determine which elements of the performance are visible, and which are not. The cross country element of eventing is reliant on volunteer fence-judges. The fence-judge role involves recording every horse and rider over their allocated fence or fences (Fédération Equestre Internationale 2022). The rules of eventing outline that video footage may be used to make judgements, but only in instances where official video footage is available (Fédération Equestre Internationale 2022). There are, at present, no guidelines on where or how the cameras should be placed, nor what constitutes 'official video footage'. The project presented here highlights that not only does the predictive ability of viewers differ between experience levels, but so too does their visual strategy. Although these performance metrics were assessed using pre-recorded video footage, it is likely that they transfer to the real-world scenario too. It should be considered, therefore, whether video footage recorded from the viewpoint of the fence judge is beneficial. On one hand, it provides the opportunity for review in the case that a fence judge is unsure of the correct ruling. On the other hand, if the video footage is not being utilised for every rider, there is a risk that some rulings are based on the perception of the fence-judge, and some are based on the recording. Additionally, a recording of a jumping effort facilitates the use of technological tools such as frame-by-frame analysis, pausing of the action, and detailed analysis. This is far beyond that which is available to the fence-judge in the moment, and therefore it is likely that some jumping efforts are subjected to greater scrutiny than others.

Video footage is used in competitive eventing environments for the purposes of rule enforcement and penalty allocation when the fence judges are not able to accurately recall what happened. Event officials will determine what constitutes ‘official video footage’ (FEI 2024), but there is currently no publicised guidance as to how this video review should be implemented. Anecdotally, the researcher has experienced frame-by-frame review of video footage being conducted for a small percentage of riders, whereas the majority are allocated penalties by the volunteer fence judges as normal. The sport of eventing should consider whether this is a reasonable application of video footage, and whether it is fair to those riders who are subjected to additional review where technology permits. The results of this project highlight varying degree of perception when viewing cross country video footage, and this variation is likely to exist between officials too. Greater consistency and transparency within video review strategies would elevate the value that video footage contributes to the sport of eventing, as well as improving athlete reception to video review. If eventing expects to continue relying on fence-judges, it is recommended that video footage be utilised in a supportive fashion. Having the camera angle be as close as possible to the viewpoint of the fence judge may enable a more appropriate review of jumping efforts which is complementary to fence-judges, rather than contradictory.

CHAPTER 8.

GENERAL CONCLUSION

The project has used a variety of methods to evaluate how cross country video footage is currently perceived and how it may be useful to equitation science going forward, with a particular focus on eventing. Interacting with a non-human animal necessitates understanding of other forms of communication such as behaviour. Video footage is an accessible, convenient, and easy to use tool enabling the objective recording of behaviour. The results presented in **chapter 3** outline some factors that may influence rider use of video footage for performance analysis, including employment in the equestrian industry and having previously purchased video of their own ridden performance. An interest in recording footage both in training and competitive environments was also influential, as was an appreciation of the social value of video footage. Coaches wishing to encourage riders to use video feedback for technical improvements may be able to inspire regard for these values, therefore increasing potential uptake. Further research is required to determine the performance benefits of either self-modelling or other-modelling using video footage in order to develop rider appreciation for video as a training tool. The results presented in **chapter 4** give some indication as to the horse and rider behaviours currently perceived by riders to be predictive of jumping faults, including conflict behaviours and rider torso position. These behaviours are identifiable from video footage, meaning that riders can develop their understanding of how the horse and rider interact without needing to ride a horse. Video review can be incorporated into training regimes as a non-ridden component, particularly with the increasing availability of competitive footage. Differences in visual strategies were detected between riders and non-riders in **chapter 5**, warranting further investigation into gaze behaviour of stakeholders. This is of particular importance when considering consistency between officials and fence-judges, and has application beyond eventing to any sport where subjective assessment is incorporated into the scoring. It is hoped that by demonstrating that jumping faults can be predicted from video footage in **chapter 6**, a greater appreciation for horse and rider behaviour will be fostered within the eventing community. Greater understanding of how behaviours can influence performance outputs may enable riders, coaches, fence-judges, and event officials to notice predictive horse and rider behaviours prior to the fault or fall occurring. Fence-judges can report concerns to the event officials, though it's possible that not all are confident enough to do this. Assessing and developing fence-judge ability to identify, interpret, and respond to horse and rider behaviours that may be deleterious could provide event officials with more timely information. When officials have greater confidence in fence-judge assessment of horse and rider behaviour, they may be more able to intervene if the safety and welfare of horse and rider is being placed at unnecessary risk. Ridden video footage is recommended as a valuable tool for improving equestrian performance and safety.

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APPENDIX 1: SURVEY RATIONALE STATEMENT, DEMOGRAPHIC, AND EQUESTRIAN EXPERIENCE QUESTIONS

Q1.1

Introduction: This study is part of a larger PhD project being run in collaboration with An Eventful Life and Nottingham Trent University to investigate the value of video footage within equestrian sport. This survey should take no longer than 25 minutes. Please only take part in this survey if you are 18 or over.

<Specific aim of each chapter>
Data collected may be used for other research activities, including subsequent publication. All individual response information will be stored on a password-protected system and will only be accessible to the research team. No personal information will be shared with third parties and all data will be anonymised within the final report. All data shall not be retained for longer than is necessary for the completion of any research projects.

Your responses are anonymous and will only be used once any identifying features are removed. You may close the browser at any time to stop and withdraw from the study, and you may request that your data be removed from the study at any point up until the <deadline for data removal requests>. After this date, data will be anonymised and prepared for analysis. This study has been ethically reviewed using approved protocols within the School of Animal, Rural and Environmental Sciences and is considered low risk. Any ethical concerns can be raised by contacting AREEthicalReview@ntu.ac.uk. Content quality is the responsibility of the academic supervisor who should be contacted with any concerns using the details below. Jess Johnson (PhD Student): jess.johnson2014@my.ntu.ac.uk Dr Jaime Martin (PhD Supervisor): Jaime.martin@ntu.ac.uk If you do not wish to take part, please close this window now. If you do wish to take part, please click all of the statements below to indicate your consent:

- ☐ I confirm that I am aged 18 or over.
- ☐ I have read the above information and understand the purpose of this study.
- ☐ I understand that I can stop and withdraw from this study by following the process outlined above.
- ☐ I understand that the data I provide will be used for the purposes of research and may be published in writing or via other media (e.g. video).

☐ I give permission for the anonymised data I provide to be stored on a password protected file at Nottingham Trent University so that it may be used for future research purposes.

☐ I agree to take part in this study.

Q1.2 What is your age?

○ 18-25

○ 26-35

○ 36-45

○ 46-55

○ 56-65

○ Over 65

○ Prefer not to say

Q1.3 What is your gender?

○ Male

○ Female

○ Other ____

○ Prefer not to say

Q1.4 In which country do you live?

▼ United Kingdom ... Prefer not to say

Q1.5 Are you employed within the equestrian industry? If yes, please specify.

○ Yes, please specify ____

○ No

Q1.6 Do you participate in equestrian sport in any way? You may select more than one option.

☐ Rider

☐ Owner

☐ Coach

☐ Family or friend of a rider/owner

☐ Official

☐ Volunteer

☐ Sponsor

☐ EHOA member

☐ Other ____

☐ Not at all

Q1.7 Do you regularly ride a horse? (At least once a month)

○ Yes, at least once a month

○ No

○ I have in the past (please indicate how long ago this was) ____

Skip To: End of Block If Do you regularly ride a horse? (At least once a month) = No

Q1.8 On average, how many times per month do/did you ride a horse? (if you ride two horses in one day, this is two times).

- ◯ 1-5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ 21-25
- ◯ 26-30
- ◯ More than 30

Q1.9 Which disciplines do/did you partake in? (please tick all that apply)

- ☐ Leisure riding
- ☐ Dressage
- ☐ Show-jumping
- ☐ Eventing
- ☐ Showing
- ☐ Racing
- ☐ Endurance
- ☐ Other (please specify) ____

Q1.10 Have you ever evented at any level?

- ○ Yes
- ○ No

Skip To: End of Block If Have you ever evented at any level? = No

Q1.11 What is the **highest** level to which you have evented?

- ○ Less than 80cm
- ○ 80cm (BE80)
- ○ 90cm (BE90)
- ○ 100cm (BE100)
- ○ 105cm (BE105)
- ○ 110cm (BENovice)
- ○ 115cm (BEIntermediate)

○ 120cm (BEAdvanced)

○ CCI-S 2*

○ CCI-L 2*

○ CCI-S 3*

○ CCI-L 3*`

○ CCI-S 4*

○ CCI-L 4*

○ CCI-L 5*

Q1.12 When did you compete to **${Q1.11/ChoiceGroup/SelectedChoices}**?

- ○ Within the last month
- ○ Within the last 6 months
- ○ Within the last year
- ○ Within the last 2 years
- ○ Within the last 5 years
- ○ More than 5 years ago

Q1.13 What is the **most recent** level to which you have evented?

- Less than 80cm
- 80cm (BE80)
- 90cm (BE90)
- 100cm (BE100)
- 105cm (BE105)
- 110cm (BENovice)
- 115cm (BEIntermediate)
- 120cm (BEAdvanced)
- CCI-S 2*
- CCI-L 2*
- CCI-S 3*
- CCI-L 3*`
- CCI-S 4*
- CCI-L 4*
- CCI-L 5*

Q1.14 When did you compete to **${Q1.13/ChoiceGroup/SelectedChoices}**?

- ◯ Within the last month
- ◯ Within the last 6 months
- ◯ Within the last year
- ◯ Within the last 2 years
- ◯ Within the last 5 years
- ◯ More than 5 years ago

Q1.15 Do you primarily event affiliated or unaffiliated?

- ◯ Affiliated (please specify which organisation you are affiliated with, e.g. British Eventing, Equestrian Australia etc.) ____
- ◯ Unaffiliated (please explain why you choose not to affiliate) ____

End of Block: Block 1 - Demographics

APPENDIX 2: SURVEY FOR CHAPTER 3 – DID YOU PRESS RECORD?

Start of Block: Block 7 - Continue 2

Q7.1 Are you happy to answer some questions about filming and watching your own riding?

- ○ Yes
- ○ No

End of Block: Block 7 - Continue 2

Start of Block: Block 9 - Filming

Q9.1 Have you ever watched videos of yourself riding?

- ○ Yes
- ○ No

Skip To: End of Block If Have you ever watched videos of yourself riding? = No

Q9.2 Who recorded the video? (please tick all that apply)

- ☐ Friend/Family
- ☐ Groom
- ☐ Coach
- ☐ Static camera (e.g. a stationary camera on a tripod or fence post)
- ☐ Robotic camera (e.g. a camera that tracks your movement like Pixio or Pivo)
- ☐ Professional company
- ☐ Head-cam
- ☐ Drone
- ☐ Other (please specify) ____

Q9.3 In what scenarios have you been filmed riding?

- ☐ Training
- ☐ Competition
- ☐ Other (please specify) ____

Q9.4 Have you ever paid money for video footage of your own riding?

- ○ Yes
- ○ No

Skip To: End of Block If Have you ever paid money for video footage of your own riding? = No

Q9.5 Which companies have you purchased from?

- ☐ An Eventful Life
- ☐ Equireel
- ☐ Meadow Productions
- ☐ Action Replay Photography
- ☐ Total Recall Videos
- ☐ Other (please specify) ____

End of Block: Block 9 – Filming

Start of Block: Block 10 - Video intent

Q10.1 If you were going to purchase a video of your own riding, please use the following statements to explain how much effort you would expect to have to put in.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I expect to be able to locate my video easily	○	○	○	○	○
I expect to be able to pay for my video easily	○	○	○	○	○
I expect to be able to download my video easily	○	○	○	○	○
I expect to be able to preview my video	○	○	○	○	○
I expect I would have to wait for my video to be available	○	○	○	○	○
I expect to be able to view specific sections of my video	○	○	○	○	○
I expect to be able to purchase the entirety of my video	○	○	○	○	○

SCENARIO

Q10.2 If you were to film your own riding, **where** would you do it?

- ☐ Training at home
- ☐ Training away from home
- ☐ Competition
- ☐ Other (please specify)

____

IMMEDIACY:

Q10.3 If you had some video footage of your own riding, **when** would you watch it?

- ☐ Never
- ☐ I would watch the video footage of my riding immediately
- ☐ I would watch the video footage of my riding a day after filming
- ☐ I would watch the video footage of my riding a week after filming
- ☐ I would watch the video footage of my riding a month after filming
- ☐ I would watch the video footage of my riding a year after filming
- ☐ Other (please specify)

____

FUNCTIONALITY

Q10.4 If you had some video footage of your own riding, **how** would you watch it?

- ☐ I would not watch the video footage
- ☐ I would pause my video at specific points
- ☐ I would watch my video in slow-motion
- ☐ I would watch my video frame-by-frame
- ☐ I would edit my video
- ☐ I would zoom in on a section of my video
- ☐ I would play a specific section of my video
- ☐ I would watch my video more than once
- ☐ Other (please specify) ____________________

APPLICATION

Q10.5 If you were going to film your own riding, **what** would you do with the video footage?

- ☐ I would not use the video footage
- ☐ I would show video footage to my coach or trainer
- ☐ I would use video footage for promotional purposes
- ☐ I would use video footage to advertise a horse
- ☐ I would share video footage of my riding on social media
- ☐ I would watch video footage of my riding by myself
- ☐ I would choose who could watch the video footage of my riding
- ☐ Other (please specify)

____

SOCIAL VALUE

Q10.6 If you were to film your own riding, **who** else would like to watch it?

- ☐ No-one
- ☐ Friends
- ☐ Family
- ☐ Coach/Trainer
- ☐ Other (please specify)

____

FOCUS

Q10.7 If you were to film your own riding, **why** would you be doing so?

- ☐ To watch riding errors
- ☐ To watch riding highlights
- ☐ To watch falls
- ☐ To watch jumping faults
- ☐ To watch my behaviour and position
- ☐ To watch the horse's behaviour and position
- ☐ To watch particular achievements or occasions
- ☐ Other (please specify) ____________________

Q10.8 Please tick which of the following you agree with:

- ☐ I intend to film my own riding in the future
- ☐ I intend to ask someone else to film my own riding in the future
- ☐ I intend to purchase a video of my own riding in the future
- ☐ I intend to watch previously recorded video footage of my own riding
- ☐ I intend to analyse my own riding from video footage
- ☐ I intend to ask someone else to analyse my riding from video footage

Q128 Do you have any other comments about the use of video footage in equestrian sport?

____

End of Block: Block 10 - Video intent

APPENDIX 3: SURVEY FOR CHAPTER 4 – GO OR WOAH?

Start of Block: Block 2 - Continue 1

Q2.1 Are you happy to answer some questions regarding horse and rider behaviours which may lead to cross country jumping faults?

○ Yes

○ No

End of Block: Block 2 - Continue 1

Start of Block: Block 3 - Rider behaviours

Q3.1 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.2 Rider head position

- ☐ Rider head in front of torso
- ☐ Rider head behind torso

Q3.3 Any other comments about rider head position

____

Q3.4 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.5 Rider torso position

- ☐ Rider shoulders unlevel
- ☐ Rider leaning forward
- ☐ Rider leaning backward
- ☐ Inconsistent upper body control

Q3.6 Any other comments about rider torso position

____

Q3.7 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.8 Rider hand position

- ☐ Rider hands below the level of the elbow
- ☐ Rider hands in line with the elbow
- ☐ Rider hands above the level of the elbow

Q3.9 Any other comments about rider hand position

____

Q3.10 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.11 Rider leg and foot position

- ☐ Rider feet in line with hip and elbow
- ☐ Rider foot in front of hip
- ☐ Rider foot behind hip
- ☐ Rider thigh in contact with the saddle
- ☐ Rider thigh not in contact with the saddle

Q3.12 Any other comments about rider leg and foot position

____

Q3.13 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.14 Preparing for fence

- ☐ Not preparing the horse for the fence
- ☐ Preparing the horse for the fence too early
- ☐ Preparing the horse for the fence too late

Q3.15 Any other comments about preparing for the fence

____

Q3.16 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.17 Leg aids

- ☐ Nudging or squeezing (the rider's leg does not come away from the horse's side)
- ☐ Kicking (the rider's leg comes away from the horse's side and then back down with force)
- ☐ No leg aids given

Q3.18 Any other comments about leg aids

____

Q3.19 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.20 Rein aids

- ▢ Pulling on reins
- ▢ Pushing reins forward resulting in a looped rein
- ▢ Inconsistent rein contact (sometimes pulling and sometimes offering a loose rein)

Q3.21 Any other comments about rein aids

____

Q3.22 On approach to a fence, which **rider** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q3.23 Use of whip

- ▢ Use of whip once in front of the saddle
- ▢ Use of whip more than once in front of the saddle
- ▢ Use of whip once behind the saddle
- ▢ Use of whip more than once behind the saddle

Q3.24 Any other comments about the use of a whip

____

End of Block: Block 3 - Rider behaviours

Start of Block: Block 4 - Rider behaviour outcomes

Q4.1 Please indicate whether the behaviours you have previously selected most increase the risk of a refusal, run-out, rider-fall or horse-fall.
You may only select one outcome for each behaviour, so please choose the one you feel is most likely.

Display This Question:

If If Rider head position q://QID49/SelectedChoicesCount Is Greater Than 0

Q4.2 Rider head position

Display This Choice:

If Rider head position = Rider head in front of torso

Display This Choice:

If Rider head position = Rider head behind torso

	Refusal	Run-out	Rider-fall	Horse-fall
Display This Choice: If Rider head position = Rider head in front of torso Rider head in front of torso	○	○	○	○
Display This Choice: If Rider head position = Rider head behind torso Rider head behind torso	○	○	○	○

Display This Question:

If If Rider torso position q://QID51/SelectedChoicesCount Is Greater Than 0

Q4.10 Do you have any further comments about rider behaviours on a cross country course?

____

End of Block: Block 4 - Rider behaviour outcomes

Start of Block: Block 5 - Horse behaviours

Q5.1 On approach to a fence, which **horse** behaviours increase the risk of a jumping fault on a cross country course? Please feel free to add an explanation to your answers.

Q5.2 Horse head and neck behaviour

- ☐ Head shaking side-to-side
- ☐ Head shaking up and down
- ☐ Lifting head on approach to fence
- ☐ Lowering head on approach to fence
- ☐ Inconsistent head carriage
- ☐ Turning head to the left or ride on approach to fence

Q5.3 Any other comments about horse head and neck behaviour

____

Q5.5 Horse tongue and mouth behaviour

- ☐ Horse holding mouth open
- ☐ Horse opening and closing mouth repeatedly
- ☐ Horse's tongue sticking out
- ☐ Horse's tongue moving in and out of mouth

Q5.6 Any other comments about horse tongue and mouth behaviour.

____

Q5.8 Horse ear behaviour

- ☐ Ears pointing backwards the majority of the time
- ☐ Ears pointing forwards the majority of the time
- ☐ Ears switching between forwards and backwards
- ☐ One ear pointing forwards and the other ear pointing backwards

Q5.9 Any other comments about horse ear behaviour

____

Q5.11 Horse tail behaviour

- ☐ Tail lifted away from the quarters
- ☐ Tail held close to the quarters
- ☐ Tail held to one side
- ☐ Tail swishing side-to-side
- ☐ Tail swishing up and down

Q5.12 Any other comments about horse tail behaviour

____

Q5.14 Gait

- ☐ Horse dropping out of canter on approach
- ☐ Incorrect canter lead for direction of approach

Q5.15 Any other comments about gait

____

Q5.17 Resistive behaviours

- ☐ Rearing
- ☐ Bucking
- ☐ Reluctance to move forwards
- ☐ Spooking (sudden change of direction)

Q5.18 Any other comments about resistive behaviours

____

Q5.20 Speed

- ☐ Too fast for the fence in question
- ☐ Too slow for the fence in question
- ☐ Speeding up on approach to the fence
- ☐ Slowing down on approach to the fence
- ☐ Inconsistent speed on approach to the fence

Q5.21 Any other comments about speed

____

End of Block: Block 5 - Horse behaviours

Start of Block: Block 6 - Horse behaviour outcomes

Q6.1 Please indicate whether the behaviours you have previously selected most increase the risk of a refusal, run-out, rider-fall or horse-fall.
You may only select one outcome for each behaviour, so please choose the one you feel is most likely.

Q6.3 Horse tongue and mouth behaviour

	Refusal	Run-out	Rider-fall	Horse-fall
Display This Choice: If Horse tongue and mouth behaviour = Horse holding mouth open Horse holding mouth open	○	○	○	○
Display This Choice: If Horse tongue and mouth behaviour = Horse opening and closing mouth repeatedly Horse opening and closing mouth repeatedly	○	○	○	○
Display This Choice: If Horse tongue and mouth behaviour = Horse's tongue sticking out Horse's tongue sticking out	○	○	○	○
Display This Choice: If Horse tongue and mouth behaviour = Horse's tongue moving in and out of mouth Horse's tongue moving in and out of mouth	○	○	○	○

Q6.9 Do you have any further comments about horse behaviours on a cross country course?

____

End of Block: Block 6 - Horse behaviour outcomes

APPENDIX 4: SURVEY FOR CHAPTER 6 – WHAT HAPPENS NEXT?

Start of Block: Intro and consent

Q62 This study is part of a larger PhD project being run in collaboration with NTU and An Eventful Life to investigate the value of video footage within equestrian sport. Please only take part in this survey if you are 18 or over. You will need a reasonable internet connection and the survey should take 20-25 minutes. You will be presented with a random series of videos of riders approaching cross country jumps, with the ending cut off. After watching each cut video, please state what you think the outcome was. You will get a score at the end of the survey. You will also be asked to answer some questions regarding your age, gender, eventing experience and occupation. You may remove your data from the study at any point up until the <deadline for data removal requests>. Any data you do provide will be stored in accordance with GDPR and university regulations. If you have any further questions regarding the study, please feel free to email: Jess Johnson (PhD Student): jess.johnson2014@my.ntu.ac.uk Dr Jaime Martin (PhD Supervisor): Jaime.martin@ntu.ac.uk

Q63 Please click all of the boxes to indicate your consent: If you do NOT wish to take part, please close your browser now.

- ☐ I confirm that I am aged 18 or over
- ☐ I confirm that I have read and understood the information for the above study.
- ☐ I understand that my participation is voluntary and that I am free to withdraw at any time before the 1st March 2020 without giving any reason.
- ☐ I understand that data collected during this study will be processed in accordance with data protection law as explained above.

☐ I understand that to maximise the re-use and societal benefit of this research, anonymous data (which does not identify me) will be publicly shared at the end of the project.

☐ I agree to take part in this study.

Skip To: End of Survey If Condition: Please click all of the box... Is Less Than 6. Skip To: End of Survey.

End of Block: Intro and consent

Start of Block: 1

Q80

Q63 What do you think happens next?

○ Clear jump (the horse and rider jump the obstacle successfully)

○ Refusal (the horse stops before the obstacle)

○ Run out (the horse avoids the obstacle without stopping)

○ Rider fall (the rider is separated from the horse but the horse remains upright)

○ Horse fall (the horse falls such that its body touches the floor)

Display This Question:

If Q63 = Refusal (the horse stops before the obstacle)

Q61 You were right! You can watch the full video below and then click on for the next clip.

Display This Question:

If Q63 != Refusal (the horse stops before the obstacle)

Q79 You were wrong! You can watch the full video below and then click on for the next clip.

Q60

End of Block: 1

Start of Block: Demographics

Q66 What is your age?

- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ Over 65
- ◯ Prefer not to say

Q68 What is your gender?

- ◯ Male
- ◯ Female
- ◯ Other
- ◯ Prefer not to say

Q70 In which country do you live?

▼ United Kingdom ... Prefer not to say

Q72 Are you employed within the equestrian industry? If yes, please specify.

○ Yes, please specify ____

○ No

Q74 Have you ever regularly ridden a horse? (At least once a month)

○ Yes, currently

○ Yes, in the past (please indicate how long ago this was) ____

○ No, never

Skip To: Q92 If Q74 = No, never

Q76 On average, how many times per month do/did you ride a horse? (if you ride two horses in one day, this is two times).

- ○ 1-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ 21-25
- ○ 26-30
- ○ More than 30

Q78 Which disciplines do/did you partake in? (please tick all that apply)

- ☐ Leisure riding
- ☐ Dressage
- ☐ Show-jumping
- ☐ Eventing
- ☐ Showing
- ☐ Racing
- ☐ Endurance
- ☐ Other (please specify) ____

Q80 Have you ever evented at any level?

- ○ Yes
- ○ No

Skip To: Q92 If Q80 = No

Q82 What is the **highest** level to which you have evented?

- ◯ Less than 80cm
- ◯ 80cm (BE80)
- ◯ 90cm (BE90)
- ◯ 100cm (BE100)
- ◯ 105cm (BE105)
- ◯ 110cm (BENovice)
- ◯ 115cm (BEIntermediate)
- ◯ 120cm (BEAdvanced)
- ◯ CCI-S 2*
- ◯ CCI-L 2*
- ◯ CCI-S 3*
- ◯ CCI-L 3*`
- ◯ CCI-S 4*
- ◯ CCI-L 4*
- ◯ CCI-L 5*

Q84 When did you compete to ${Q82/ChoiceGroup/SelectedChoices}?

- ○ Within the last month
- ○ Within the last 6 months
- ○ Within the last year
- ○ Within the last 2 years
- ○ Within the last 5 years
- ○ More than 5 years ago

Q86 What is the **most recent** level to which you have evented?

- Less than 80cm
- 80cm (BE80)
- 90cm (BE90)
- 100cm (BE100)
- 105cm (BE105)
- 110cm (BENovice)
- 115cm (BEIntermediate)
- 120cm (BEAdvanced)
- CCI-S 2*
- CCI-L 2*
- CCI-S 3*
- CCI-L 3*`
- CCI-S 4*
- CCI-L 4*
- CCI-L 5*

Q88 When did you compete to ${Q86/ChoiceGroup/SelectedChoices}?

- Within the last month
- Within the last 6 months
- Within the last year
- Within the last 2 years
- Within the last 5 years
- More than 5 years ago

Q90 Do/did you primarily event affiliated or unaffiliated?

- ○ Affiliated (please specify which organisation you are/were affiliated with, e.g. British Eventing, Equestrian Australia etc.) ____
- ○ Unaffiliated (please explain why you choose/chose not to affiliate) ____

Q92

Please enter a unique code consisting of:

The last three numbers of your phone number

AND

The first three letters of your mother's maiden name

i.e. 951PIK

If you wish to remove your data from this study at any point before the 1st March 2020, you will need to quote this code.

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Q125 Have you taken part in another horse or eventing related survey hosted by Nottingham Trent University in the last two months?

○ Yes

○ No

Q121 If you would like to make any comments on this survey or the use of video feedback in equestrian sport, please use this box.

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