Agriculture

## Teachers resource

### Overview

Resource materials for the HSC on demand Agriculture video on analysing a research paper. Included in this resource are comprehensive questions that guide students through the breakdown of the structure and content of a scientific research paper. These questions can be used in conjunction with the video resource or using another research paper of choice. A selection of questions covering further aspects of experimental design and data analysis are also provided. This resource also includes example examination questions and a glossary of terms.

A copy of the original and annotated research papers can be downloaded from <http://agri-techeducation.com/hsc/>

## Content and activities

Answer the following questions in the space provided.

**Background information**

1. Define the term sheep predation?

| Sheep predation is an attack causing wounds, lacerations, or death to sheep, caused by domestic dogs, wild dogs, or dingoes. |
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1. Outline why sheep predation is a problem for the Australian sheep sector? Consider both economic and welfare concerns.

| Sheep predation costs the Australian sheep sector $65 million annually. Wounds, lacerations, mutilation, and death are of particular welfare concerns for the sheep involved in these attacks. |
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1. Name and describe the technology that is focused on in the research paper. Include a brief description or diagram of how the technology works using simple terms.

| GPS technology. The technology within the research paper is concerned with the GPS technology attached to livestock, in particular sheep, on collars, with future investigations into the use of GPS technology added to ear tags. GPS is an acronym for Global Positioning System which is a system of sending and receiving signals from satellites orbiting the Earth to the location of the individual device attached to the animal. The movement of the animal is tracked, and speed determined as a result. |
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**Analysing a research paper**

1. List the key parts of a research article.

| Title and authors, abstract, introduction, materials and method, results, discussion, conclusion, references. |
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1. Recall the name of the research article and what journal it was published in.

| A pilot study into the use of global navigation satellite system technology to quantify the behavioural responses of sheep during simulated dog predation events.  Published in Animal Production Science, 2014. |
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1. Identify the authors of the research paper and the agencies they are affiliated with.

| The faculty of Veterinary Science, The University of Sydney: Jaime K. Manning, Eloise S. Fogarty, Peter C. Thomson, Russell D. Bush, and Greg M. Cronin.  Precision Agriculture Research Group and CRC for Spatial Information, University of New England: Mark G. Trotter, Derek A. Schneider. |
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1. Outline the purpose of an abstract in a research paper. This question refers to the structure of a research paper.

| An abstract is a short summary of the research paper, including the importance of the research and assists readers to determine if the paper is relevant for them to continue reading. It is usually around 200 words in length and contains the following parts.   * Introduction outlining background research and the importance of the research. * Details of the method used in the research. * Short discussion of the findings from the results of the research. * Brief outline of the discussion and conclusion highlighting the main outcomes and future implications from the research. |
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1. Summarise the information from the abstract of the research study being analysed. Include information such as:
   1. What is the importance of the research?
   2. How was the research conducted?
   3. What were the key results obtained?
   4. What was determined by the research at the conclusion?

The use of dot points or sub-headings for a summary is preferred.

| **Importance**  Sheep predation causes serious welfare issues to inflicted sheep, production losses for producers and economic losses to the Australian economy.  **Method**  GPS/GNSS devices in collars were attached to two flocks of 15 Merino ewes during simulated predation events. Video recordings were also made for further data collection. Each flock or treatment group was subjected to three simulated predation events. Behavioural data collated from video recordings were compared to GPS data collected from the collars to determine spatial distribution and speed for analysis.  **Results**  Velocity or speed of sheep movement was higher during a simulated predation events when compared to velocity before and after the event. Behavioural changes also occurred during simulated predation events, including centripetal rotation.  **Conclusion**  Further research and mathematical modelling of predation events is required as this was a pilot study to determine if there could be any detectable responses. The application of remote sensing technology has the potential to improve future livestock monitoring. |
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1. Outline the purpose of an introduction in a research paper.

This question refers to the structure of a research paper.

| The purpose of the introduction is to look at what is already known using research from other journal articles or reputable sources. The introduction also investigates what is unknown about the topic being research and how and why should the gap of knowledge be filled through further research. |
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1. For the research paper being analysed, describe some of the key pieces of information included in the introduction. This may include the species of plant or animal studied and why the research is needed.

**Describe**: present characteristics and features.

| **What is known about the topic?**  The Australian sheep industry experiences one of the highest production and economic losses from predation and these events are most evident in rangeland Australia. The main canine predators in Australia are dingoes, wild dogs, and domestic dogs.  **What is unknown about the topic?**  There is an inability to supply adequate monitoring to extensive systems, this could be due to the large area grazed by livestock in extensive systems and the declining availability of rural labour.  **Importance of the research.**  There is a serious welfare concern to the sheep as injured individuals that survive an attack may remain undetected for an extended period due to the lack of monitoring in extensive operations. |
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1. Define the aim or objective of this research.

| The objective of the study was to identify if the spatio-temporal data derived from GPS technology can identify a simulated dog predation event. Or in more simplified terms, this research was investigating if data from GPS technology could identify simulated sheep predation events. |
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1. Define the hypothesis given by the researchers. What did they expect the outcome to be based on, prior research or other evidence collected?

| The researchers hypothesised that during a simulated dog predation event, sheep will flock together and increase their speed of movement. |
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1. Outline the purpose of the method section in a research paper.

This question refers to the structure of a research paper.

| A method is like a recipe or set of instructions for carrying out the research task. The paper should provide detailed information on materials used within the research and the steps conducted so that another person or research facility can carry out the same trial and get the same results at the end. |
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1. Describe in detail, the materials used to conduct this research. Include specifics such as:
   1. Amount of test samples or organisms used
   2. Number of treatment groups
   3. Other materials required or included.

| * 30 merino ewes aged between 2-8 years. * 2 treatment groups with 15 ewes randomly allocated into each treatment through drafting from a race, one to one. * 30 GPS collars attached to each individual ewe collecting data every 5 seconds. * 30 coloured and individually numbered identification bibs attached to each ewe. * Location data for where the research was conducted in NSW. * 3 sheep dogs that were trained in specific behaviours to simulate the predation event. The dogs were trained to complete tasks such as rounding up the flock, run around the periphery of the flock, stand still, or walk towards the flock. |
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1. Explain the difference between a control and a treatment group. Identify the control and treatment groups within the research study.

**Explain**: provide why and/or how.

| A treatment group is the experimental group that receives the ‘treatment’ and are used to compare any similarities or differences that occur. For example, in an animal nutritional trial, this will be the group that is allocated the higher protein diets or dietary supplements. The control group however, is the group that does not receive any of the ‘treatment’ and this group is used to determine the baseline data or if there is any difference that is obtained by giving the ‘treatment’ to the other group. For example, in the nutritional trial, these are the animals given the regular diet without the extra protein or added supplements.  In this research study, there were no treatment groups as it was a pilot trial and all animals, or both groups, were subject to the predation events. The data collected prior to and after the predation event was used as baseline behaviour data for comparison. |
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1. Define randomisation and replication. Examine the method presented in the research paper to determine how randomisation and replication (two of the basic principles of good experimental design) were incorporated.

| Randomisation is where animals or individuals are ‘randomly’ assigned to either a control group or treatment group without bias. It ensures any individuals with particular characteristics are equally, and randomly, distributed between groups. In this research study, animals were selected based on the order they came through the race and placed into one of two mobs.  Replication is the repetition of the research trial using different animals or having more than one group subjected to the treatment. In this research trial there are two replications as there are two groups or mobs and there are 15 ewes in each mob. |
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1. Use the information collated from the comparisons in the previous question, to distinguish the:
   1. independent variable
   2. dependent variable
   3. standardised conditions.

| **Standardised conditions**  Something that does not change throughout the trial. In the case of this research trial, the standardised conditions included, the number of sheep in each mob, breed, sex and mix of ages of the sheep, paddock size, dogs used, duration of events, GPS collars used.  **Independent variable**  Simulated dog predation event.  **Dependent variable**  Sheep behaviour and speed when under attack. |
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1. Outline the purpose of the results section in a research paper.

This question refers to the structure of a research paper.

| A results section is used to help summarise all the findings and the key research data points from the research study. It will highlight the key findings. There will most likely be a combination of tables, graphs, or figures to help summarise the important results found during the trial, it is very unlikely that raw data, or large amounts of data are displayed. The reader should be able to look over the results section and determine what important information was found from the trial without having to read the whole research paper. |
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1. Identify the key findings by summarising the results that were recorded from the research, include units of measurement where possible.

| Finding 1: the speed of movement of sheep during a simulated predation event increased in comparison to the speed of movement prior to the simulated predation event. Flock 1 displayed an average of less than 0.3m/s in speed prior to the simulated event, while during the events in trials 1 – 3, they displayed speeds between 0.8 – 1.8m/s. Flock 2 displayed speeds of almost 0m/s prior to the simulated predation events and an increase to between 0.4 – 1.8m/s during the three trials. All of this is displayed within ‘Figure 1’ in the results section of the research paper.  Finding 2: behavioural responses of sheep during simulated predation events, including the ‘flee’ response which occurred 55 times, ‘stands still’ response which occurred 26 times and ‘centripetal rotation by flock’ which occurred 16 times during the trials. These were collected through the video data collected during the trials and supported by the spatio-temporal data collected from the GPS collars. |
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1. Describe what results are presented within the results section and how the author has chosen to present the results, either graphically or in table format. Consider the most effective way of presenting the data and give reasons to justify your answer. Evaluate the authors choice of presentation.

**Evaluate**: make and overall judgement of the process or idea based on identified criteria.

| The key findings from the results have been displayed within the results section using a table and two figures to represent the information.  The table shows 14 different behaviours displayed by the two flocks of sheep with a brief description to explain the term to the reader, the typical behaviour displayed by the dog to get this reaction from the sheep and a frequency tally of how many times it was observed to have happened. This is a summary table showing the overall results, as opposed to the raw data which may have included the individual sheep displaying the behaviour and in what trial. The raw data would be confusing and individual sheep responses are not important, the frequency tally at the end and the fact that they are listed in order from most common to least, makes the information easier to read. The reader can quickly determine the top three behaviours exhibited by sheep during a simulated predation event and use this in further research.  Figure one shows a box and whiskers plot graph highlighting the average speed of movement during simulated predation events across the three trials for each flock and prior to the events for baseline data. By using the box and whiskers plot and including the average from all trials, from both groups onto the one figure, easy comparisons can be made by the reader between the baseline data and the trials, as well as between groups. If the raw data collected for each individual animal, in each trial was included, the reader would need to read pages of information and perform their own calculations to determine the averages and find any trends.  Figure 2 shows the spatiotemporal data collected from three individual sheep separately and includes a basic paddock map overlaid onto the data and directional arrows. This type of data visually depicts the movement of a sheep during centripetal motion. If the raw data was displayed here, it would include a series of numbers for coordinate points that make little sense to the reader.  The use of these three data representations for the key results found, as opposed to the raw data collected, allows the reader to easily decipher the key results, make simple judgements on trends within the data collected and saves a lot of time and space within the research paper. |
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1. Outline the purpose of a discussion in a research paper.

This question refers to the structure of a research paper.

| The discussion section of a research paper is used to summarise the information displayed within the results and put it into context for the reader. It will draw upon previous research or knowledge about the topic and use it to support the findings and justify the statements made by the researchers about why these results are valid. The discussion section will also address limitations of the research trials and future research that is needed in this field. |
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1. Clarify the key points determined by the research paper in the discussion section.

Dot points would be beneficial in presenting this information.

| Centripetal rotation by the flock occurs during a simulated predation event as animals on the periphery of the group are performing a centre-seeking behaviour as they are more vulnerable on the periphery. The research trial determined this behaviour occurs 80% of the time during the simulated predation events and is considered a potential indicator to detect the occurrence of a predation event.  Limitations determined within this trial included the fact that the high speeds recorded by the sheep during the simulated predation event may not be representative in other breeds as they only tested Merino ewes. There were also the occurrences of false positives which causes limitations in using speed alone as an alert for sheep predation events in commercial settings. An algorithm for speed and possibly centripetal rotation should be considered for more accuracy. |
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1. Explain why the hypothesis of the research was or was not supported by the data collected.

Begin with clearly identifying if the hypothesis was or was not supported.

| The hypothesis was that sheep will increase speed during a simulated predation event. This hypothesis was supported, there was an increase in the speed of the sheep during the trials, however, due to false positives detected, the researchers determined that speed alone would not be an effective indicator of a sheep predation event in a commercial setting, parameters such as centripetal rotation could be used in conjunction with the increase in speed to be a more effective alert system for producers. |
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1. Describe the impact the authors expect this research to have on their respective fields for agriculture into the future. Include possible further studies to be conducted or different technologies to be explored that could be linked to this research.

| This is a pilot study that could be used to form the basis of further studies into developing an algorithm that would be the foundation of an alert system that could be attached to ear tags for sheep to alert farmers of possible predation events so that stock could be checked and in turn, improve the welfare of the sheep in extensive grazing systems. For this system to be developed for commercial use, improvements in battery life, durability of ear tags with GPS incorporated and a viable algorithm will need to be studied and tested in both simulated environments and commercial settings.  If this type of technology was developed and commercially available, there is the possibility of reducing the economic impact on sheep production in the Australian rangelands. It could also have the possibility of being applied in other species or other countries to improve animal welfare on a larger scale. |
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1. Explain why there is a need for research in the development of agricultural technologies.

| There is a need for research into the development of agricultural technologies to improve on farm production, increase the welfare of animals in agriculture and reduce economic losses. The use of GPS is not a new technology, but researching how it can be applied in livestock systems is a new application of the technology and has the potential to improve real-time, on-farm monitoring and develop alert systems to save farmers time and reduce costs associated with loss of stock, damaged facilities and stress.  Research into new or existing technologies that could be used in agricultural production have the potential to reduce labour requirements on farms which is important for the aging workforce in this industry. |
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## Examination practice questions

### **2-mark questions**

Answer the following 2-mark questions in the space provided.

1. Recall the name of a research study and outline the aim or objective for undertaking the research.

| A pilot study into the use of global navigation satellite system technology to quantify the behavioural responses of sheep during simulated dog predation events.  The purpose of the study was to identify if spatio-temporal data derived from GNSS technology can identify a (simulated) dog predation event. |
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1. Summarise the conclusion and a recommendation made by the author/s from the research study.

| GNSS technology has enormous potential for improving animal welfare and the frequency of monitoring in extensive grazing systems. This experiment recorded higher speeds of movement by sheep during a simulated dog predation event, supporting the hypothesis. When considered in combination with behavioural changes such as centripetal rotation, remote sensing technologies might be capable of identifying predation events. Further research in commercial settings and development of real-time data collection on a form fitting device is required in future research. |
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1. Outline the type of data collected by the researchers and how it was collected.

| Spatio-temporal data was collected via GPS collars every 5 seconds prior to the simulated predation events and during three simulated predation events for both flocks. This data was presented visually on a map showing direction of the animals’ movements and correlated with a video taken during each trial also to determine what behaviours showed which patterns on the data. The data was also manipulated to determine speed of the individual animals prior to and during the simulated predation events and was recorded in metres per second. The video data collected also allowed for specific behaviours to be observed and a frequency table to be collated on common behaviours in relation to specific dog actions. |
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### 6-mark questions

Answer the following 6-mark questions in the space provided.

1. Explain how the method used in the research study has contributed to the reliability of the conclusion. Use specific examples from the study to support your answer.

**Explain:** identify the underlying relationship between the given subjects and relate the why and how of the way one affects the other.

| Reliability of an experiment is concerned with the consistency of the results which can be achieved through both repetition and minimisation of random errors, usually caused by human error.  Repetition is included within this research trial using two flocks, with each flock having 15 ewes, each collecting individual data. The two flocks were then both subjected to the simulated predation event across three trials, giving the research team six trials worth of data and two baselines, or prior to trials, data to work with. This allowed researchers to see deviations within a flock in each trial as well as compare the deviation of the average data between the two flocks and the total amount of trials. Repetition within a trial does not necessarily mean reliable results, there needs to be consistency across the trials and minimal outliers in data. If the researchers could see multiple outliers within flocks, trials or overall, they could conclude the experiment was not reliable. This was not concluded.  Minimisation of human error was also addressed within the trial using GNSS technology tracking the spatio-temporal data for each animal every five seconds which was downloaded after each simulated predation event. A video recording was also collected of each event so researchers could identify each behaviour displayed by the individual ewes and match these to the same timing on the GNSS data. The ewes had easily identifiable bibs with colours and numbers on them to allow for easy recognition on the video of each individual to reduce further error in matching the visual analysis of the behaviour to the spatio-temporal data. The use of video allows researcher to recheck their work and further reduce human error which is not possible when simply collecting data in real time in the field. |
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1. Discuss the validity of the conclusion from the research study based on its design. Use specific examples from the study to support your answer.

**Discuss:** identify issues or ideas and provide points that support or oppose them.

| Validity within a research trial is a measure of how successfully the method addresses the aim of the trial and how correct the results of the experiment are. Validity relies on having strictly one independent variable and one dependant variable being measured, with all other variables being controlled. Increasing the validity of a research trial means controlling as many variables as possible, improving measurement techniques, increasing randomisation, and adding a control group.  The conclusion of this research trial stated that there was an increase in speed of the sheep during a simulated predation event and that coupled with the centre-seeking behaviour termed as centripetal rotation, could potentially be the basis of a remote-sensing technology to detect dog predation of sheep in extensive grazing systems. To determine the validity of this conclusion, the method of the research trial needs to be examined. There are pros and cons evident within the research, including:   * Pros   + Standardised conditions, same number of ewes in each trial, same breed, same paddock, same trained dogs, same GNSS technology in collars collecting same spatio-temporal data, same location, and time of year.   + One independent variable being introduced, the simulated event on both flocks.   + One dependent variable being collected in terms of quantifiable data, the spatio-temporal data. This was then manipulated to determine a range of information, including speed of travel by the sheep, direction, and location within the paddock and in comparison, to other individuals.   + Randomisation was introduced when allocating sheep into each pilot group through the drafting from a race. * Cons   + There was variation in the duration of time for the simulated predation events, based on the reaction and welfare of the sheep. Welfare considerations always must be considered during research and therefore this was not a variable that could necessarily be controlled consistently.   + No control group, baseline data was collected prior to events for comparison instead.   Limitations described within the research paper also need to be noted when discussing validity, including the fact that only one breed of sheep was used and therefore inconsistencies between breeds could be noted if further research was to be conducted. There were also overlapping speed results between baseline data and trial data in some cases which could reflect false positives if speed was the only determining factor.  Overall, for a pilot study using animals, there was every effort made to improve validity of the results, where possible. The conclusions determined that behavioural analysis used in conjunction with speed could be used in developing an algorithm for real time alerts is a valid conclusion. If a conclusion of the use of speed only was made, then I would say it was not a valid conclusion. |
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1. Summarise the conclusion or findings of the research study analysed in class and explain how this information assists Australian agricultural production or environmental sustainability.

| **Tip:** this question has two parts that need to be addressed.   * 1. Begin with creating a detailed summary of the conclusions found from the research study. This could be done using dot points if they are comprehensive.   2. This question then asks for an explanation of how these findings assist Australian agricultural production, or environmental sustainability. Clearly link the findings from the dot points to uses or benefits in industry using examples.   Conclusions determined from the research study:   * The average speed of movement during a simulated predation event was significantly higher than before or after the predation event * Isolated sheep have faster movements compared with flocks containing 5 – 10 individuals and could contribute to an overall increase in the average speed. * The behavioural response of centripetal rotation occurred 80% of the time during a simulated predation attack and highlights this as a potential indicator to detect the occurrence of a predation event. However, pressure was required on at least two sides by either two or more dogs, or a fence line and a dog.   How does this information assist Australian agricultural production?  The predation of sheep in Australia is a major welfare concern due to the injuries inflicted on the sheep and the time between producers checking on animals in extensive operations. There are also major economic losses to the Australian economy of an estimated $65 million annually through predation events. This research study is a pilot study with potential to influence further research studies into the future on real-time data collection for not only sheep but other livestock which could potentially reduce the welfare concerns, reduce labour that is needed for closer monitoring when dog predation is increased in farming areas and reduce potential economic losses.  While this research study does not give the answers required to determine a working algorithm and alert system for commercial settings, it is the first of its kind in using GNSS technology attached to livestock to determine if behavioural characteristics can be quantified and potentially made into algorithms that would send alerts to mobile or connected devices into the future.  This research found that speed alone was not enough to determine a predation event, with too many false positives potentially being an issue, but it did identify that coupled with centripetal rotation behaviours, there is a potential for an alert system to be made. There were also other factors that were highlighted as being required to be addressed, including the need for real-time data collected, not post event data collection which was used in the research. Also, a need for a form fitting device that was durable and had a lasting battery life. If these further technological improvements were to be accomplished, producers could potentially have an ear tag fitted to livestock, collecting GNSS data in the background, ready to send an alert when the right parameters were reached, informing a producer to check their stock, reducing the amount of time a predation event occurred, and the time injured animals weren’t tended to. Thus, improving animal welfare standards across the industry, reducing economic losses, and reducing labour hours. |
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### **12-mark question**

1. Analyse a research study of the development and/or implementation of ONE agricultural biotechnology/technology/management strategy related to climate variability.

**Analyse:** identify parts and the connection between them; draw out and relate effects.

| **Note:** depending on the elective topic you have studied in class, you will only address the appropriate biotechnology, or technology, or management strategy, not all of them. Please confirm with your classroom teacher if this is unclear.  **Tip:** this is a summary of the whole research study, similar to the questions completed with the video clip.   * 1. Identify the name of the paper and its objective.   2. Provide a summary of the methodology, results, and conclusion.   3. What was the function of the research, for example, what need was it addressing or trying to improve in industry or environmental sustainability? What impact has or could it have on the future production.   Longer answer questions do not always have to be written in essay format, it may be clearer to break it down into sub-headings or use tables to present ideas and information.  **Name:** A pilot study into the use of global navigation satellite system technology to quantify the behavioural responses of sheep during simulated dog predation events.  **Objective:** The purpose of the study was to identify if spatio-temporal data derived from GNSS technology can identify a (simulated) dog predation event.  **Materials:**   * 30 merino ewes aged between 2-8 years. * 2 treatment groups with 15 ewes randomly allocated into each treatment through drafting from a race, one to one. * 30 GPS collars attached to each individual ewe collecting data every 5 seconds. * 30 coloured and individually numbered identification bibs attached to each ewe. * Location data for where the research was conducted in NSW. * 3 sheep dogs that were trained in specific behaviours to simulate the predation event. The dogs were trained to complete tasks such as rounding up the flock, run around the periphery of the flock, stand still, or walk towards the flock.   **Methodology:** The two flocks of 15 ewes were fitted with GNSS collars, collecting data every five seconds. Each ewe was randomly allocated from the race into one of the two groups and fitted with a visually identifiable jacket with colour and number attached. The sheep were then left for 22 hours to become accustomed to the collars, jackets, and new environment. Each group had baseline data collected for a short period of time prior to simulated dog predation events and after. Each group was subjected to three separate simulated predation events conducted by experienced dog handlers, moving through a range of predetermined actions by the dogs, including rounding up the flock, running around the periphery of the flock, walk towards the flock and stand still. |
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| The duration of the trials was determined by the dog handler who closely monitored the sheep and stopped the trials before any sheep showed visual signs of distress. The trials ranged between 5 – 12 minutes in length, with a minimum recovery period of 90 minutes between trials. All trials and baseline data collection periods were monitored via video recordings with 49 minutes of video recordings collected in total. Sheep were left undisturbed for two day before removing the collars and jackets. GNSS data was then downloaded.  **Results:**  Key finding 1: the speed of movement of sheep during a simulated predation event increased in comparison to the speed of movement prior to the simulated predation event. Flock 1 displayed an average of less than 0.3m/s in speed prior to the simulated event, while during the events in trials 1 – 3, they displayed speeds between 0.8 – 1.8m/s. Flock 2 displayed speeds of almost 0m/s prior to the simulated predation events and an increase to between 0.4 – 1.8m/s during the three trials. All of this is displayed within ‘Figure 1’ in the results section of the research paper.  Key finding 2: behavioural responses of sheep during simulated predation events, including the ‘flee’ response which occurred 55 times, ‘stands still’ response which occurred 26 times and ‘centripetal rotation by flock’ which occurred 16 times during the trials. These were collected through the video data collected during the trials and supported by the spatio-temporal data collected from the GPS collars.  **Conclusion:** The hypothesis that sheep will increase speed during a simulated predation event was supported. There was an increase in the average speed of the sheep during the trials, however, due to false positives detected, the researchers determined that speed alone would not be an effective indicator of a sheep predation event in a commercial setting, parameters such as centripetal rotation could be used in conjunction with the increase in speed to be a more effective alert system for producers.  Centripetal rotation by the flock occurs during a simulated predation event as animals on the periphery of the group are performing a centre-seeking behaviour as they are more vulnerable. The research trial determined this behaviour occurs 80% of the time during the simulated predation events and was therefore considered a potential indicator to detect the occurrence of a predation event.  Limitations determined within this trial included the fact that the high speeds recorded by the sheep during the simulated predation event may not be representative in other breeds as they only tested Merino ewes. There were also the occurrences of false positives which causes limitations in using speed alone as an alert for sheep predation events in commercial settings. An algorithm for speed and possibly centripetal rotation should be considered for more accuracy.  **Function of the research:** This was a pilot study that could be used to form the basis of further studies into developing an algorithm that would be the foundation of an alert system that could be attached to ear tags for sheep to alert farmers of possible predation events so that stock could be checked and in turn, improve the welfare of the sheep in extensive grazing systems. For this system to be developed for commercial use, improvements in battery life, durability of ear tags with GPS incorporated and a viable algorithm will need to be studied and tested in both simulated environments and commercial settings.  If this type of technology was developed and commercially available, there is the possibility of reducing the economic impact on sheep production in the Australian rangelands. It could also have the possibility of being applied in other species or other countries to improve animal welfare on a larger scale. |
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## Glossary

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| Term | Definition |
| Aim | Short description of the objective or purpose, it says what can be learned from the experiment. |
| Analyse (HSC verb) | Identify parts and the connection between them; draw out and the relate effects. |
| Clarify (HSC verb) | Make a statement of situation clearer or more understandable. |
| Compare (HSC verb) | Show how things are alike or different |
| Conclusion | A short paragraph that discusses the overall results of an experimental design and states if the hypothesis at the beginning of the experiment was correct or not. |
| Control treatment | The treatment group in an experiment that is not subjected to the varied treatments or represents the current practice in industry. The control is a baseline which allows for comparison. |
| Controlled variable | An experimental element that is kept constant (or changed in constant ways) across all treatment groups. |
| Define (HSC verb) | Give the meaning of a word or phrase and identify important characteristics. |
| Dependant variable | The variable that is being tested or measured and changes in response to the independent variable. |
| Describe (HSC verb) | Present characteristics and features |
| Discuss (HSC verb) | Identify issues or ideas and provide points that support or oppose them. |
| Discussion | An in-depth analysis that interprets and describes the significance of the results. It also gives an evaluation of the experimental design, including its limitations. |
| Distinguish (HSC verb) | Recognise or suggest something as being different from something else or to note differences between two or more things. |
| Examine (HSC verb) | Inspect the nature of something. |
| Experiment | A scientific procedure that results in the collection of data to make a discovery, test a hypothesis, or demonstrate a known fact. |
| Explain (HSC verb) | Identify the underlying relationship between the given subjects and relate the why and how of the way one affects the other. |
| Evaluate (HSC verb) | Make an overall judgement of the process or idea based on identified criteria. |
| Identify (HSC verb) | Recognise and name. |
| Independent variable | The variable that is changed on purpose in an experiment to see what effect it has on the variable you are trying to measure. |
| Hypothesis | A statement of the expected outcome to a scientific question. |
| Justify (HSC verb) | Support and make a case for an argument or theory. |
| Mean (x̅) | The average of the data collected. Calculated by adding together all the numbers collected and then dividing this total by the total number of individual results recorded. |
| Median | The middle value of a sorted list (ordered lowest to highest) of numbers or data collected. |
| Method | A sequence of steps, or processes of the investigation that recall what was carried out by the researcher. |
| Outlier | One or more values of data collected that are far removed in value from the others within the set. |
| Outline (HSC verb) | Present in general terms the main features of. |
| Population | The complete group of individuals of interest. Agricultural trials generally use a sample of a population as opposed to the whole group. |
| Qualitative data | Usually non-numerical data collected through methods of observation, for example colours or attitudes of focus groups. Usually includes units such as kilograms. |
| Quantitative data | Measures of values or counts and are expressed as numbers. For example, weights collected for animals. |
| Range | The difference between the largest and the smallest value recorded. |
| Randomisation | The chance of an experimental group receiving a treatment is exactly the same for all groups. The purpose of randomisation is to reduce bias. |
| Recall (HSC verb) | Present remembered ideas, facts, or experiences. |
| Replication | The practice of repeating the same treatment several times. Replication improves the validity of the experiment or trial. |
| Summarise (HSC verb) | Briefly explain the main points. |
| Sample | A group of individuals from a population selected for use in an experiment. |
| Standardisation | All treatments in the experiment are exposed to the same conditions (other than the independent variable). It helps ensure that one treatment group is not advantaged or disadvantaged by outside factors. |
| Title | A brief description of the experiment. |
| Treatment | The application of the independent variable to the experimental units or groups. |
| Validity | A concept used to evaluate the quality of research and measure of how correct the results of the experiment are. It indicates how well a method, technique, or tests measures something. |
| Variables | Any factor, trait or condition that can be changed, maintained, or measured. |