EFFECTS OF INCREASED HANDLING ON BEHAVIOUR AND STRESS IN FARMED DOMESTIC RABBITS

Project Results, Conclusion & Recommendations

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Assignment Cover Sheet

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Abstract

The goal of domestication is to eliminate potentially avoidable fear responses within animals and thus it is essential to prevent negative consequences associated with stress. Rabbits have appeared to adapt significantly well to the farming environment and the associated management systems. In saying this, it is important to look at the factors affecting the welfare of rabbits and how to minimise stress. Here we explore how the handling of farmed domesticated rabbits alters their behavioural patterns and stress levels. Eight rabbits were observed after ongoing handling and observational data was gathered to determine the frequency of stress related behaviours and other behaviours in relation to the rabbits handling. It was determined that the amount of stress related behaviours observed decreased with the corresponding increase in handling. Data suggests that handled rabbits have a reduced fear response of humans in comparison to those rabbits who remained unhandled for the duration of the study.

Introduction

Native to Europe, domestic rabbits (*Oryctolagus*) were first brought to Australia by the First Fleet as a source of food in the late 1700's. However, selective breeding of rabbits first occurred in the Middle Ages when they were domesticated as farm animals and used as sources of food, fur, wool and as household pets.

Rushen *et al.* (1999) identifies the main goal of the process of domestication as being the elimination of avoidable fear responses within animals however even when domesticated, animals have still been found to show an avoidance towards human beings. In comparison to many other animal species domesticated prior, rabbits have been shown to adapt significantly well to the farming environment and the associated management systems (Price 1999). However, domesticated rabbits, as do many other animals, still retain a handful of the original traits associated with their wild background such as maternal and social behaviours even with the occurrence of high stress levels.

Factors affecting the welfare of rabbits are able to be separated into psychological and physical stressors. Psychological stressors may include social stress which can occur from overcrowding and competition which may lower the rabbits' welfare and alter their physiology and behaviours shown. Physical stressors on the other hand may include environmental variables such as housing systems and climatic factors. All farmers seek to avoid unnecessary stress for their animals where possible as well as preventing negative consequences associated with stress on production animals. It is essential for a high standard of husbandry and management to be maintained, taking into consideration the "five freedoms" (Rushen *et al.* 1999).

This is an undergraduate study conducted for Kindifarm, researching the effects of increased handling on the behavioural tendencies and stress within farmed domestic rabbits by utilizing observational techniques and the process of habituation. Kindifarm is a mobile animal farm first established in 1992. It provides a hands on experience, to learn about animals as well as educating people of all age groups.

Literature Review

Petting zoos allow for opportunities for members of the public to directly interact with animals. Generally, the goal for the majority of petting zoos is to allow visitors to form positive attitudes towards animals as a result of one-on-one interactions with an animal (Kidd & Kidd 1997; Kidd *et al.* 1995). Unfortunately, not all animals tolerate the contact formed and may run away from, bump into or charge at visitors (Anderson *et al.* 2002). Farrand *et al.* (2014) and Anderson *et al.* (2002) examine the impacts which petting zoos have on captive animals. Farrand *et al.* (2014) found that increased levels of non-aggressive interactions were associated with high visitor density thus indicating that the high density of people did not negatively affect the animals' wellbeing and behaviours.

In contrast, Anderson *et al.* (2002) studied the relationship between undesirable behaviour exhibited by domesticated petting zoo animals in the presence of humans and the spatial design of the environment. Three conditions were tested in this study; no retreat space, semi-retreat space and a full retreat space. Retreat space is the space provided to an animal where it can choose to remove itself from an interaction. It allows the animal individual control over interactions with humans. The subjects of this study were African pygmy goats (*Capra hircus*) and Romanov sheep (*Ovis aries*). Anderson *et al.* (2002) found that when a full-retreat environment was used, both the sheep and goat displayed the lowest amount of undesirable behaviours. This allows insight into how exhibit designs and management techniques can both positively and negatively impact on an animals' health and wellbeing as the animals were significantly less distressed when they were able to retreat from forced human interactions.

Verga *et al.* (2007) researched the effects of husbandry and management systems on the physiology and behaviour of farmed rabbits. Data obtained demonstrates that the quantity and quality of available space can largely impact upon the welfare of farmed rabbits not dissimilar to the findings of Anderson *et al.* (2002).

Fearfulness can be influenced by rearing conditions. For example; research on cattle has shown that with a lack of positive human contact at a young age, adult animals display much higher levels of fear and aggression towards humans (Le Neindre *et al.* 1996). McBride (1984) suggests that when animals have some degree of control over their environment either through choice or manipulation, they gain the ability to avoid aversive situations. Whereas with a lack of control, animals tend to respond with negative behaviours such as fight or an attempt to flight. Bloomsmith *et al.* (2000); Markowitz (1979); Novak and Drewson (1989); Snowdon and Savage (1989) view animals having some form of control over their environment as an essential factor in promoting psychological well-being of captive animals.

Verga *et al.* (2007) identified that handling of rabbit kits within the first number of days after birth may help in lowering the general fear of humans through a gradual process of habituation. Habituation can be defined as a simple type of learning, where after a period of exposure, an animal ceases to respond to the stimulus. Csatadi *et al.* (2005) found that the fear response of young rabbits towards humans significantly reduces when the rabbit kits were handled in the days shortly following their birth. It was concluded that even minimal human contact is effective in reducing the fear response associated with humans, thus handling has the potential to be an extremely effective tool in reducing stress and improving wellbeing under all farming conditions. Pongra'cz and Altbacker (1999) similarly found that rabbits handled shortly after nursing were significantly tamer than the controls as adults, irrespective of the length of handling. The reduced fear is long lasting and specific to the handler species (humans in this case).

Alongside identifying the causes of stress in rabbits, it is also essential to identify methods to be used in determining behavioural stressors. In order to evaluate stress reactions, scientific indicators must be measured and monitored, ensuring to consider the species' coping mechanisms to stressors (Verga *et al.* 2007). Measurable stress indicators for rabbits have been identified to be their behaviour, physiology, health and reproduction. Limited research has been undertaken for stress indicators present in farmed rabbits but physiological and behavioural indicators identified for other farm animals are able to be applied to this situation (Morisse and Maurice 1994).

Verga *et al.* (2007) identified behavioural indicators of stress as a result of handling to be; altered feeding behaviours, or altered social and maternal behaviours within rabbits. Observation of these behavioural indicators may indicate distress or impaired wellbeing of the animal. Stereotypies (unchanging repetitive behavioural patterns that have no goal or function) have been noted in farmed rabbits, for example; gnawing at the bars of the cage (Jordan *et al.* 2006). Other symptoms of stress within domesticated farmed rabbits may include; a display of aggression when handled, lethargy and lack of interest in both surroundings and food, excessively jumpy and wary, nervous appearance (freezing, hunched with ears flattened), hiding or flight reaction, heavy breathing, over grooming, altered feeding and toileting habits, constant chewing and teeth grinding, increased drinking (polydipsia), hypervigilant, as well as excessive chewing (destroying things more than the normal paper/substrate/straw).

Methods

Animals and the study site

The subjects of this study were adult domesticated rabbits used in petting zoo excursions by Kindifarm. Eight rabbits were observed over the study period and varied in age.

Observational data collection

The study carried out was entirely observational. The observational data was collected over a four-week period, with two days of observations conducted per week. For this study, eight adult rabbits were used from the research site (Kindifarm). The rabbits at Kindifarm, Dural were housed in multiple long enclosures within a barn with approximately six rabbits in each enclosure. Of these eight rabbits, two were determined as controls (unhandled unless necessary for the duration of the project). Identification of the rabbits was based on their unique colourings and markings which is recorded in a data spreadsheet alongside accompanying photos which allowed for an ease in animal identification during the observational period.

Each rabbit was observed for twenty minutes per day of observations (two observational days per week) (including the control rabbits) for the four-week study period. The rabbits were observed at Kindifarm following their return from daily excursions. Each rabbit was handled multiple times daily for up to 7 days each week in exception for the control rabbits who were kept separated from the other six rabbits in the study. An ethogram (table 1.) was used allowing a short hand notation to be recorded on the data sheet for particular behaviours as well as the use of the J Watcher program during each of the twenty minute observational periods. At the start of each observation day, a new data spreadsheet was created to ensure the data was separated and for the correct date and at the end of each week the data was analysed collectively and condensed.

Table 1: Constructed ethogram of rabbits' stress indicator behaviours to refer to when recording observational data

Behaviour (stress indicator):	Description:
Struggle	Struggle against gentle restraint during handling
Vocalisation	Producing an audible sound during handling
Excessive grooming	Grooming constantly over a period of time (more than usual)
Out of sight	Not visible due to hiding behind or under objects in pen
Head shake	Shaking of the head
Body shake	Shaking of entire body
Digging	Digging in the pen substrate
Rear	Rearing up with placement of fore limbs with or without support from the wall of the pen or another object
Foot stamp	Stamping of the foot either whilst being held or in the pen
Other	Behaviour not listed in ethogram

Table 2: Constructed ethogram of rabbits' other behaviours to refer to when recording observational data

Behaviour (other behaviours):	Description:
Out of sight	Not visible due to hiding behind or under objects in pen
Eat/drink	Eating and/or drinking
Stretch	Stretching of the body
Inactive	Time spent completely motionless and inactive
Crouch/sit	Sitting relaxed with hind limbs tucked under the rump and fore limbs underneath
Lie	Lying down either with legs tucked under body
Movement	Movement around the pen by hopping or small movements
Object interaction	Interaction with objects on floor of pen
Grooming head/face	Grooming head/face using front or hind feet
Grooming body & limbs	Licking or scratching any other part of the body
Groom overall	A combination of the above two behaviours
Other	Behaviour not listed in ethogram

Data analysis

At the end of the four-week observational period, the data was analysed by looking at all the displayed behaviours. By identifying the present stress indicators, it was able to be determined if stress had altered or even decreased with the implementation of daily handling. Stress is a biological response produced when an individual organism perceives to be threatened. The threat is known as the 'stressor' (Moberg and Mench 2000). Rabbits respond to stress in a variety of ways. A behaviour indicating stress differs from the normal behaviours seen on a day to day basis. They have been identified as; vocalisation, excessive grooming, remaining out of sight, head shake, body shake, digging and foot stamping.

Due to the nature of Kindifarm, the rabbits (except for the rabbits determined as controls, unless necessary) have been handled daily. The type of handling which occurred includes; being held for periods of time by staff and members of the public, carried and moved from their regular home (rabbit runs/enclosures at Kindifarm). All eight rabbits (in exception to the controls) were not purely being used for the study and thus were taken out on petting zoo excursions outside of the observational times during the four weeks.

Results

Figure 1. shows the mean observed occurrences of stress indicating behaviours (struggle against handling, remaining out of sight, digging and foot stamping) that occurred within the study rabbits for each observation day (eight observations in total). The highest mean occurrence of these four behaviours was on the first day of observations and was calculated to be the 'remaining out of sight' behaviour occurring at 1.5 times per rabbit in the observational period. In comparison, the lowest mean occurrence of these behaviours in the first day of observations was recorded to be the behaviour of foot stamping at a mean occurrence of 0.8 times per rabbit in the period. As can be seen in figure 1. the mean occurrence for all behaviours decreased by the end of the eighth day of observations. The most significant decrease was found to be the behaviour 'remaining out of sight' which decreased from a mean occurrence of 1.5 per rabbit to 0.7 occurrences per rabbit. The smallest decrease was noted as the 'struggle' behaviour, which went from 0.8 mean occurrences per rabbit to 0.7 mean occurrences per rabbit at the end of the study.

Figure 1: Mean number of times stress indicating behaviours occurred within study rabbits for each observation day over the 4-week study period.

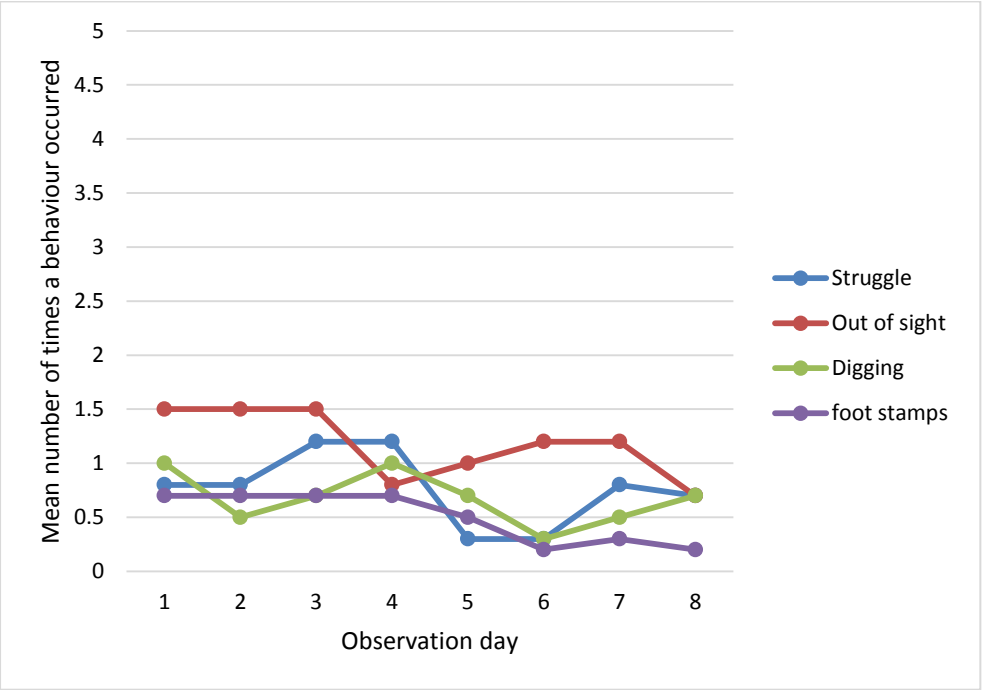

Figure 2. shows the mean observed occurrences of stress indicating behaviours (struggle against handling, remaining out of sight, digging and foot stamping) that occurred within the control rabbits for each observation day (eight observations in total). The highest mean occurrence of these four behaviours was on the first day of observations and was found to be the 'remaining out of sight' behaviour and was calculated to occur at a mean of 2 times per rabbit in the observational period. In comparison, the lowest mean occurrence of these behaviours with the exception of the 'struggling' behaviour which did not occur at all as the control rabbits were not handled, was found to be the 'digging' behaviour which occurred in the first day of observation. This behaviour did not occur at all within the two control rabbits on the first observational day. Figure 2. shows that the overall highest mean occurring behaviour was 'remaining out of sight' whilst the lowest mean occurring behaviour 'digging'.

Figure 2: Mean number of times stress indicating behaviours occurred within control rabbits for each observation day over the 4-week study period.

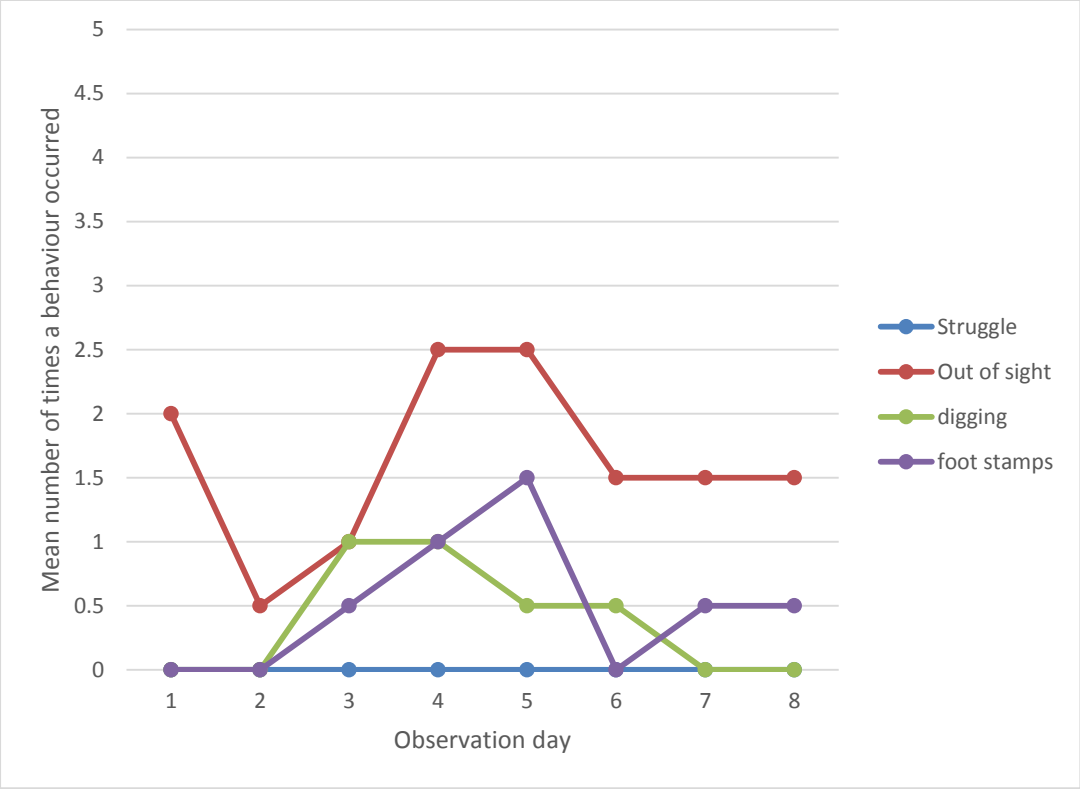

Table 3. displays regression analysis' of all four stress indicating behaviours, thus allowing us to determine the correlation between the length of the study and the mean occurrence of these behaviours and whether the two are linked to each other.

Table 3: Regression analysis determining the relationship between the length of time and the stress indicating behaviours.

Struggle:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7116836
R Square	0.5064935
Adjusted R Square	0.4242424
Standard Error	0.2425068
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.3621429	0.3621429	6.1578947	0.0477076
Residual	6	0.3528571	0.0588095		
Total	7	0.715			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.5928571	0.1889597	8.4296113	0.000152	1.1304893	2.055225	1.1304893	2.055225
Weeks	-0.0928571	0.0374196	-2.4815106	0.0477076	-0.1844196	-0.0012947	-0.1844196	-0.0012947

Out of sight:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7116836
R Square	0.5064935
Adjusted R	0.4242424

Square	
Standard Error	0.2425068
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.3621429	0.3621429	6.1578947	0.0477076
Residual	6	0.3528571	0.0588095		
Total	7	0.715			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.5928571	0.1889597	8.4296113	0.000152	1.1304893	2.055225	1.1304893	2.055225
Weeks	-0.0928571	0.0374196	-2.4815106	0.0477076	-0.1844196	-0.0012947	-0.1844196	-0.0012947

Digging:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.165985
R Square	0.027551
Adjusted R Square	-0.1345238
Standard Error	0.3368269
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.0192857	0.0192857	0.1699895	0.6944472
Residual	6	0.6807143	0.1134524		
Total	7	0.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.6964286	0.2624534	2.653532	0.0378496	0.0542282	1.338629	0.0542282	1.338629
Weeks	-0.0214286	0.0519735	-0.4122978	0.6944472	-0.1486032	0.1057461	-0.1486032	0.1057461

Foot stamp:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9011271
R Square	0.8120301
Adjusted R Square	0.7807018
Standard Error	0.1091089
Observations	8

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.3085714	0.3085714	25.92	0.0022408
Residual	6	0.0714286	0.0119048		
Total	7	0.38			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.8857143	0.085017	10.418084	4.583E-05	0.6776852	1.0937434	0.6776852	1.0937434
Weeks	-0.0857143	0.0168359	-5.0911688	0.0022408	-0.1269102	-0.0445184	-0.1269102	-0.0445184

Discussion

Whilst these results show that handling may have a positive long term effect on rabbits' stress levels, it is important handling occurs in scenarios with minimal stressors. This study looked to investigate the effects of increased handling on the behaviour and stress in farmed domestic rabbits with the hypothesis that handling would positively influence rabbit's welfare and stress levels and reduce their natural fear of humans. Results show (figure 1. And figure 2.) that in the first week of the observational study (week ending June 26th) that the occurrence of stress related behaviours was at its highest in comparison to the three following weeks.

A comparison was also done between the mean occurrences of potential stress indicating behaviours for both the six study rabbits and the two control rabbits. The results indicate that the control rabbits had a lower occurrence of these behaviours however the control rabbits were not being handled unless necessary. Over the duration of the study, the occurrence of these behaviours in both the study and the control rabbits levelled out and decreased from the commencement of the project. During the study it was found that the majority of the behaviours observed and occurring over the course of the four weeks would be considered to be 'normal' or every day behaviours commonly occurring in domesticated rabbits.

Four main behaviours were observed and identified to be indicators of stress including; struggling, hiding or remaining out of sight, digging in substrate or when being held and foot stamping. In exception to 'struggling' the other three behaviours still occurred within the control rabbits but at much lower occurrences in comparison to the study rabbits at the beginning of the study. Over the four weeks, the highest observed behaviour out of the four listed was found to be 'remaining out of sight' at an average of 1.5 occurrences per rabbit on the first day of observations followed by 'digging' which was observed at an average of 1 occurrence per rabbit on the first day of observations. The rabbits used in the study also struggled a lot during handling within the first part of the study. This has been determined as them exhibiting natural fear / flight responses. The number of times all four behaviours were observed each observational day gradually declined over the study period (table 5.). This is in agreement with Pongra'cz and Altbacker (1999), who showed that the behaviour and

welfare of caged or domesticated rabbits can be positively influenced when handled frequently and helps to reduce their natural fear of humans over time.

A comparison of data from figure 1. and figure 2. gives an impression that the rabbits handled in the study show a lower number of observed behaviours indicating stress in comparison to the controls, as did Jezierski and Konecka (1996). Ratner (1967) and Hansen *et al.* (1993) found in their studies that non-handled rabbits were seen to have a larger fear response to human being in comparison to handled rabbits. Csatadi *et al.* (2005) also found that rabbits handled were tamer than controls who were not. This reduced fear is long lasting and specific to the handler species (humans).

A regression analysis (table 3.) was made with the stress indicating behaviours (as the dependent variable) and the length of the study (independent variable) to determine the relationship between the two and to see if the regression analysis reflected the results. The closer 'R square' is to 1 the better the regression line fits the data. This is due to 'R square' being the percentage of variation. For the 'foot stamp' the R square was found to be 0.8, thus the regression line would better fit the data, whilst 'remaining out of sight' and 'struggling against gentle restraint' were slightly lower both measuring as 0.5. Both 'Sig F' and 'P – values' indicate how reliable the data is, these should both record at less than 0.05. For the 'foot stamp' the Sig F and P – values were found to be 0.002 and 0.002 / 4.6 respectively. Both 'remaining out of sight' and 'struggling' had Sig F and P – values of 0.05 and 0.0002/0.05 respectively.

Conducting handling of farmed domestic rabbits allows an interaction between humans that might otherwise not occur, thus reducing their fear responses. This finding is in agreement with Pederson (1994) who found that both juvenile and adult silver fox vixens when both forcibly and gently handled by humans, showed a significant reduction in fear responses in comparison to the control animals. Hemsworth and Barnett (1992) examined the influence of handling of pigs on the behavioural responses of pigs to humans. It was found that handling positively impacted on the responses shown, however it was found that these responses may change over time, due to the pigs' recent contact with humans. This can also apply to rabbits, as their behaviour may alter if the positive human interactions cease or change in frequency.

Negative impacts from handling may also arise if not conducted correctly or if additional potential stressors are present at the time of handling. Induction of fear by both humans and management procedures should be avoided wherever possible. A study found that only a quarter of owners in The Netherlands picked up their rabbits in the appropriate manner; by the scruff of the neck, placing one hand beneath the rabbit to provide adequate support while ensuring a good grip preventing it from falling if it struggles (Schepers *et al.* 2009). Over 57% of owners in the same study, reported their rabbit(s) struggled when picked up. Rabbits are fragile animals and if not handled correctly, serious injuries may occur to them. All precautions must be undertaken to ensure that the rabbits are in a stress-free environment, however this may not prevent negative impacts from handling. It could be concluded that a short period of high stress scenarios, benefits the rabbits in the long term.

There are possible limitations of study in regards to the ages and breeds of the rabbits. The rabbits were all of varying ages and breeds as well as being housed on the farm for varying lengths of time, this might affect the results obtained during this study. If it was to be conducted again, it would be ensured that there were minimal variables within the rabbits to ensure for accuracy. Another limitation of study is the shortness of the project, if the study was to be conducted again to obtain more data, the study would go over a significantly longer period of time to allow for more data to be collected and see if the results altered as a result of the length of the project. The amount of times each rabbit was handled during the study could be considered to be a limitation of study as there were no set amount of times each rabbit had to be handled daily and it varied depending on how many excursions were occurring on a daily basis throughout the study, if it was to occur again, it would be ensured that all rabbits were handled approximately the same amount to ensure accuracy.

Recommendations and conclusions

This study utilised observational data to explore the behaviours and stress indicators of rabbits kept in captivity and used in petting zoo experiences as a result of increased handling. By observing different behaviours of the rabbits after handling, it was possible to determine how the handling influences the rabbit's behaviour and stress levels/ fear of humans.

Several conclusions were drawn from this study. It was determined that the observed stress influenced behaviours decreased as handling continued over the course of the study. If handling ceased or lessened, it could have a negative impact on the rabbits' wellbeing and positive behaviours achieved. It is recommended that the rabbits' handling frequency is maintained to ensure no rabbits' wellbeing is impacted.

Whilst this study identified extensive handling over a period of time to have a beneficial effect on rabbits' behaviours and stress levels, it was also identified that in human handling instances a negative impact may occur to the rabbit. However, no lasting negative effect would be sustained in the long run. This study demonstrates that further research is required on the behavioural impact of handling on rabbits at the 'adult' stage of life as most similar research has been conducted on rabbit kits or juveniles. This information would be important to gain a better understanding of rabbit behaviours and could be utilised for improved rabbit management.

References

Anderson, Benne, Bloomsmith, Maple 2002, 'Retreat space and human visitor density moderate undesirable behaviour in petting zoo animals', *Journal of Applied Animal Welfare Science,* Vol. 5, no. 2, pp. 125-137.

Bloomsmith, Baker, Lambeth, Ross, Schapiro 2000, 'Is giving chimpanzees control over environmental enrichment a good idea?', *In the apes: Challenges for the 21st century, conference proceedings,* pp. 88-89.

Csatadi, Kustos, Eiben, Bilko, Altbacker 2005, 'Even minimal human contact linked to nursing reduces fear responses toward humans in rabbits', *Applied Animal Behaviour Science,* Vol. 95, pp. 123 – 128.

Farrand, Hosey, Buchanan-Smith 2014, 'The visitor effect in petting zoo-housed animals: Aversive or enriching?', *Applied Animal Behaviour Science,* Vol. 151, pp. 117 – 127.

Hansen, Braastad, Storbraten, Tofastrud, 1993, 'Differences in fearfulness indicated by tonic immobility between laying hens in aviaries and in cages', *Animal Welfare*, vol. 2, pp/ 105 – 112.

Hemsworth, Barnett, 1992, 'The effects of early contact with humans on the subsequent level of fear of humans in pigs', *Applied Animal Behaviour Science,* Vol. 35, pp. 83 – 90.

Jezierski, Konecka, 1996, 'Handling and rearing results in young rabbits', *Applied Animal Behaviour Science*, Vol. 46, pp. 243 – 250.

Jordan, Luzi, Verga, Stuhec 2006, 'Environmental enrichment in growing rabbits', *Recent advances in Rabbit Sciences,* pp. 113 – 119.

Kersten, Meijsser, Metz 1989, 'Effect of early handling on later open-field behaviour of rabbits', *Applied Animal Behaviour Science,* Vol. 24, pp. 157 – 167.

Kidd, A, Kidd, R, Zaslof, R 1995, 'Developmental factors and positive attitudes towards zoo animals', *Psychological Reports,* Vol. 76, pp. 71 – 81.

Kidd, A, Kidd, R 1997, 'Characteristics and motives of adolescent volunteers in wildlife education', *Psychological Reports,* Vol. 80, pp. 747 – 753.

Le Neindre, Boivin, Boissy 1996, 'Handling of extensively kept animals', *Applied Animal Behaviour Science,* Vol. 49, pp. 73 – 81.

Markowitz 1979, 'Environmental enrichment and behavioural engineering for captive primates', *Captivity and behaviour: Primates in breeding colonies, laboratories and zoos,* pp. 217 – 238.

McBride 1984, 'Feral animal studies in animal science: The uses and limitations of feral animal studies to contemporary animal science', *Journal of Animal Science,* Vol. 58, pp. 474 – 481.

Morisse, Maurice 1994, 'Welfare and the intensive production of rabbits', *Revue scientifique et technique,* Vol. 13, pp. 143 – 152.

Mugnai, Dal Bosco, Castellini 2009, 'Effect of different rearing systems and pre-kindling handling on behaviour and performance of rabbit does', *Applied Animal Behaviour Science,* Vol. 118, no. 1-2, pp. 91 – 100.

Novak, Drewson 1989, 'Enriching the lives of captive primates: Issues and problems', *Housing, care and psychological well-being of captive and laboratory primates,* pp. 161 – 182.

Pederson, 1994, 'Long-term effects of different handling procedures on behavioural, physiological and production-related parameters in silver foxes', *Applied Animal Behaviour Science,* Vol. 40, no. 3 – 4, pp. 285 – 296.

Pongra'cz, Altbacker 1999, 'The effect of early handling is dependent upon the state of the rabbit *(Oryctolagus cuniculus)* pups around nursing, *Dev. Psychobiol,* Vol. 35, no. 3, pp. 241 – 251.

Price 1999, 'Behavioural development in animals undergoing domestication', *Applied Animal Behaviour Science,* Vol. 65, no. 3, pp. 245 – 271.

Ratner, 1967, 'Comparative aspects of hypnosis', *Handbook of Clinical and Experimental Hypnosis,* Macmillan, New York, pp. 550 – 587.

Rushen, Taylor, Passille 1999. 'Domestic animals' fear of humans and its effect on their welfare', *Applied Animal Behaviour Science,* Vol. 65, no. 3, pp. 285 – 303.

Schepers, Koene, Beerda 2009, 'Welfare assessment in pet rabbits', *Animal Welfare,* Vol. 18, pp. 477 – 485.

Snowdon, Savage 1989, 'Psychological well-being of captive primates: General considerations and examples from Callitrichids', *Housing, care and psychological well-being of captive and laboratory primates,* pp. 75 – 88.

Verga, Luzi, Carenzi 2007, 'Effects of husbandry and management systems on physiology and behaviour of farmed and laboratory rabbits', *Hormones and Behaviour,* Vol. 52, pp. 122 – 129.

Zucca, Redaelli, Marelli. Bonazza, Heinzl, Verga, Luzi, 2012, 'Effect of handling in pre-weaning rabbits', *World Rabbit Science,* Vol. 20, pp. 97 – 101.

Appendix

*Table 4: First observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 26/06/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	2 times	3 times	1 time	none	none	1 time	n/a	n/a
Grooming head/face	1 time	none	1 time	none	2 times	1 time	none	1 time
Movement	1 time	4 times	3 times	1 time	2 times	3 times	1 time	2 times
Out of sight*	1 time	3 times	2 time	none	2 times	1 time	3 times	1 time
Object interaction	none	none	1 time	1 time	none	none	none	1 time
Digging*	1 time	none	2 times	1 time	none	2 times	none	none
Eat/drink	none	1 time	1 time	none	2 times	none	2 times	1 time
Stretch	none	2 times	1 time	none	1 time	none	1 time	none
Other	2 times	none	none	none	none	none	none	none
Crouch/sit	3 times	1 time	2 times	1 time	1 time	none	1 time	1 time
Rear	none	2 times	1 time	none	none	1 time	none	none
Foot stamp*	2 times	none	1 time	none	none	1 time	none	none

*Table 5: Second observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 26/06/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	none	1 time	2 times	none	none	2 times	n/a	n/a
Grooming head/face	none	1 time	none	none	none	1 time	none	none
Movement	1 time	1 time	1 time	3 times	none	1 time	3 times	1 time
Out of sight*	1 time	1 time	1 time	3 times	1 time	2 times	none	1 time
Object interaction	none	none	none	1 time	1 time	none	none	none
Digging*	none	1 time	none	2 times	none	none	none	none
Eat/drink	2 times	none	none	none	none	1 time	none	none
Stretch	none	1 time	none	none	none	2 times	1 time	none
Other	none	none	none	none	none	none	none	1 time
Crouch/sit	1 time	none	1 time	1 time	1 time	1 time	none	1 time
Rear	none	1 time	none	1 time	none	none	none	none
Foot stamp*	none	1 time	2 times	none	none	1 time	none	none

*Table 6: Third observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 03/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	2 times	3 times	1 time	none	none	1 time	n/a	n/a
Grooming head/face	1 time	2 times	none	2 times	none	1 time	3 times	none

Movement	2 times	1 time	1 time	2 times	1 time	2 times	1 time	3 times
Out of sight*	1 time	2 times	3 times	none	none	2 times	1 time	1 time
Object interaction	none	none	none	2 times	none	none	none	1 time
Digging*	1 time	1 time	none	none	none	2 times	1 time	1 time
Eat/drink	none	1 time	2 times	none	1 time	1 time	2 times	none
Stretch	none	2 times	none	1 time	none	2 times	1 time	none
Other	none	none	1 time	none	none	none	none	none
Crouch/sit	3 times	1 time	2 times	none	2 times	3 times	1 time	2 time
Rear	none	2 times	1 time	none	none	2 times	1 time	none
Foot stamp*	2 times	1 time	1 time	none	none	none	none	1 time

*Table 7: Fourth observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 03/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	1 time	1 time	2 time	1 time	2 times	none	n/a	n/a
Grooming head/face	1 time	none	1 time	1 time	none	none	none	none
Movement	none	3 times	4 times	none	none	2 times	3 times	2 times
Out of sight*	1 time	1 time	1 time	1 time	none	1 time	2 times	3 times
Object interaction	1 time	none	none	none	1 time	none	none	none
Digging*	none	1 time	3 times	none	1 time	1 time	2 times	none
Eat/drink	none	1 time	none	none	none	none	none	2 times
Stretch	none	2 times	none	none	none	1 time	1 time	none
Other	none	none	none	none	none	1 time	none	none
Crouch/sit	1 time	1 time	1 time	1 time	2 times	none	none	1 time
Rear	none	1 time	1 time	none	none	none	none	none
Foot	1 time	1 time	1 time	none	none	1 time	none	2

stamp*								times

*Table 8: Fifth observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 10/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	none	1 time	none	none	none	1 time	n/a	n/a
Grooming head/face	2 times	none	1 time	2 times	none	2 times	2 times	none
Movement	2 times	4 times	2 times	1 time	1 time	3 times	3 times	2 times
Out of sight*	1 time	none	2 times	none	1 time	2 times	2 times	3 times
Object interaction	none	none	1 time	none	none	none	none	none
Digging*	1 time	1 time	none	none	none	2 times	1 time	none
Eat/drink	none	none	none	1 time	none	none	none	2 times
Stretch	none	2 times	none	1 time	none	1 time	1 time	none
Other	none	none	none	none	none	none	none	none
Crouch/sit	2 times	1 time	2 times	2 times	3 times	1 time	1 time	1 time
Rear	none	2 times	none	none	none	1 time	none	1 time
Foot stamp*	none	none	2 times	none	none	1 time	2 times	1 time

*Table 9: Sixth observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending 10/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	none	1 time	1 time	none	none	none	n/a	n/a
Grooming head/face	1 time	1 time	none	1 time	none	none	none	none
Movement	1 time	2 times	1 time	1 time	none	2 times	3 times	3 times
Out of sight*	1 time	1 time	none	3 times	1 time	1 time	2 times	1 time
Object interaction	none	none	none	none	none	none	none	none
Digging*	none	1 time	none	none	none	1 time	none	1 time
Eat/drink	1 time	1 time	none	none	none	none	none	none
Stretch	none	none	none	none	none	1 time	1 time	none
Other	none	none	none	none	none	none	none	none
Crouch/sit	none	none	1 time	none	1 time	1 time	none	1 time
Rear	none	1 time	none	1 time	none	none	1 time	none
Foot stamp*	none	none	1 time	none	none	none	none	none

*Table 10: Seventh observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending17/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran for 20 minutes per rabbit.*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	1 time	1 time	2 time	none	none	1 time	none	none
Grooming	1 time	none	1 time	none	1 time	none	3 times	1 time

head/face								
Movement	5 times	3 times	2 times	1 time	2 times	1 time	1 time	2 times
Out of sight*	4 times	2 times	1 time	none	none	none	2 times	1 time
Object interaction	1 time	none	none	none	2 times	none	1 time	none
Digging*	1 time	none	none	none	1 time	1 time	none	none
Eat/drink	1 time	none	2 times	1 time	none	none	1 time	1 time
Stretch	2 times	1 time	1 time	none	none	1 time	2 times	1 time
Other	none	1 time	none	none	1 time	3 times	none	1 time
Crouch/sit	2 times	1 time	3 times	5 times	2 times	1 time	none	3 times
Rear	none	2 times	1 time	none	none	none	none	none
Foot stamp*	1 time	none	1 time	none	none	none	none	1 time

*Table 11: Eighth observation. Number of times a behaviour was observed for individual rabbits over the course of one day during the week ending17/07/2016. Behaviours which are known to be indicators of stress are identified by a *. Each observational period ran*

Behaviours observed	Rabbits used for the observational study						Controls	
	Grey rabbit (with dwarf ears)	White rabbit with grey ears (lop ear)	White and brown (small rabbit)	Orange/ brown rabbit	White rabbit w/ orange patches (small and lop ear)	Fawn rabbit with dark face (lop ear)		
Struggle*	none	1 time	3 times	none	none	none	n/a	n/a
Grooming head/face	none	1 time	1 time	none	none	none	none	none
Movement	3 times	2 times	2 times	none	1 time	1 time	1 time	1 time
Out of sight*	2 times	1 time	none	1 time	none	none	2 times	1 time
Object interaction	none	none	none	none	none	1 time	1 time	none
Digging*	none	2 times	none	none	none	2 times	none	none
Eat/drink	none	none	1 time	1 time	1 time	1 time	none	none
Stretch	1 time	2 times	none	1 time	none	none	1 time	1 time
Other	none	1 time	none	none	none	1 time	none	none
Crouch/sit	1 time	2 times	2 times	3 times	2 times	none	1 time	3 times
Rear	none	1 time	1 time	1 time	none	none	none	none

Foot stamp*	none	none	1 time	none	none	none	1 time	none