The effects of movable novel objects, novel olfactory stimuli and novel auditory stimuli on the exploratory, play and stereotypical behaviour of captive species: A comparative study.

Kathryn Lampard, B. Sc. Hons (Adelaide)

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Department of Psychology
The University of Adelaide

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Abstract

In recent decades there has been an increasing interest in the area of environmental enrichment for captive animals. The central premise of this thesis was that four species in captivity would be enriched, by increasing levels of exploratory and play behaviour and decreasing stereotypical behaviour, by providing them with access to three different types of novel stimuli. It was expected that each type of novelty would elicit different reactions from each species. Various theoretical constructs have been suggested to explain exploratory and play behaviour, however no theory has satisfactorily explained exploratory or play behaviour in all their forms.

The experimental component, of the current research, involved presenting three different types of novel stimuli, including novel objects, auditory and olfactory stimuli, to four species. The subject species were Barbary sheep, zebra, oriental small-clawed otters, and collared peccaries.

The series of studies employed a modified repeated measures design. In each of the studies the animals were presented with a different type of novelty. The novelty included movable and non-movable objects, food-related olfactory stimuli and predator-associated auditory stimuli. Visual inspection was the main form of data analysis due to low subject numbers and because it allowed individual and group reactions to be reported.

Results indicated each type of novelty stimulated increases in both exploratory and play behaviour and decreased stereotypical behaviour. In addition to these overall increases, some types of novelty were found to affect these behaviours more than others. Overall these results suggested that the different responses were related to the biological significance of the novel stimuli for the individual and the species concerned.

Discussion focussed on factors that can be used to predict how a species will react to novelty, including the ecological niche of the species, feeding patterns and the biological significance of the novel stimuli. In addition to this, other factors, such as the previous experiences of the individual, have to be considered. It was concluded that novelty, including objects, odours and auditory stimuli, is a simple, cheap and effective method of enriching the lives of animals in captivity.

Statement

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Signed

Kathryn Lampard
July 2002

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Chapter 1: Captive populations – A last resort

> *...the public's growing interest in animal welfare demands that zoos carefully consider programs and techniques that will contribute to the "psychological well-being" of the entire collection.* (Tudge, 1991).

The central premise of this thesis was that animals in captivity could be enriched by providing them with access to various types of novelty. This enrichment was expected to occur because of an increase in exploratory and play behaviour stimulated by the presence of novelty. In addition, it was suggested that novelty would reduce the level of stereotypical behaviour exhibited by the animals. Exploratory and play behaviour are important in all animals, but especially animals in captivity, because they do not have to perform the same behaviours as those in the wild. Therefore, exploratory and play behaviour can help to maintain the physiological and psychological health of animals in captivity. Play and exploratory behaviours also resemble behaviours often performed in the wild, but not in captivity, and can be used to conserve these behaviours in captive populations. This will aid in the survival of animals involved in release programs that are aimed at restocking wild populations. The presentation of novelty to the species was also expected to encourage the animals not to overreact to novel stimuli, as can be the case with captive animals. This will aid in their survival if they are ever involved in release programs. Novelty is essential for animals in captivity to stimulate them psychologically and to encourage them to be physically active. To understand why animals need to be kept in a zoo environment at all it is important to first examine a history of zoos.

1.1 Animals and captivity

1.1.1 Zoos as a necessity

Zoological Gardens, or Conservation Centres, have the potential to play an essential role in modern conservation strategy. Durrell (1990) has considered that conservation should be the major aim of all zoos, ahead of research and education. Zoos have often justified their existence through their role in conservation (Tudge, 1991). Not all species are protected in their natural environment due to the pressures that threaten the existence of many animals and their habitats. These pressures include wars, the building of dams and bridges, population, hunting and development of land (Tudge, 1991). As humans move even further into species' habitats, it appears to result in, desertification, erosion, pollution and ozone depletion (Koebner, 1994). If the habitats remain, they are often fragmented by roads or towns and become isolated islands. This can have severe consequences for the remaining population by keeping members of the same species apart. This narrows the genetic pool and can eventually destroy species.

The most significant threat comes from population growth and the consequent reduction in suitable habitats for many species. The human population reached the five billion mark in the 1980s and experts predict that it will peak in the mid twenty-first century somewhere between eight and twelve billion (Tudge, 1991). In addition to this only 3.7 percent of the earth is classified as protected land, yet humans continue to grow and impinge on this land (Koebner, 1994). As a result of this it has been estimated that 27 000 species are becoming extinct each year (Koebner, 1994).

Zoos in the past have tended to list conservation as one of three main aims along with education and entertainment (Tudge, 1991). Until the habitats of species in the wild are secure, zoos must function as the arks of the twenty-first century, and therefore conservation must be their primary function (Tudge, 1991). According to Durrell (1990) the second job of a zoo is to establish breeding colonies in the species' country of origin and train people to breed and release animals to help the wild population and increase genetic diversity. Thirdly, zoos should promote research about species, both in the wild and captivity, to encourage a better understanding of each individual species' requirements. A fourth role of the zoo is to promote conservation education in the country where the species originated (Durrell, 1990). In this way, zoos could be more than just places to display animals and they have been responsible for saving many species that have then influenced countless other species (Koebner, 1994). It is only in recent decades that people have realised that the population of some species is larger in captivity than in the wild (Tudge, 1991). Consequently, there are now some species that are completely extinct in the wild and exist only in zoo populations (Koebner, 1994).

McKenna (1987), however, has painted a bleak picture of zoos in general. She has stated that many zoos are not active in conservation issues and they hide behind zoos that are performing a conservation role (such as Jersey Zoo). She has argued that some zoos use conservation as the excuse for keeping animals in captivity when they are doing nothing to help conserve species and are concerned only with making money. The solution may not be to close all zoos but to improve education and promote awareness about what a zoo's role should be and encourage the public only to visit responsible zoos (Durrell, 1990).

In America, modern menageries and roadside zoos have been illegal for some time and the American Zoo and Aquarium Association and their accredited zoos agree that these roadside zoos are a disgrace to society (Durrell, 1990). Another argument against zoos, put forward by McKenna (1987), is that many of the animals in captivity stereotype badly and do not possess the skills necessary for release to the wild. Not all animals begin their life in accredited zoos, with many having been kept in roadside zoos, as pets or in the circus and they stereotype as a result of previous experience. (Stereotyped behaviour is discussed in more detail in Sections 1.1.1 and 1.1.2). It may be necessary to police zoos to ensure that the animals in their care are well cared for both physiologically and psychologically.

Durrell (1990) has reported that many conservationists believe that by removing animals from the wild and breeding them in zoos they are condemned to a life in captivity (Durrell, 1990). Animals should only be taken and bred in captivity as a safeguard against extinction, while every effort is made to preserve their wild habitats and populations so that the captive animals can be released (Durrell, 1990). Conservation breeding in zoos appears to be a more feasible approach for many species rather than conservation of their whole habitat (Tudge, 1991). Captive populations have become essential to help save species that become extinct and also help increase the genetic diversity of endangered populations (Tudge, 1991). Many zoos have resorted to saving keystone species, such as large mammals that require large habitats and also help to form and keep ecosystems together. These large mammals have become representatives for their habitats and can help to save countless other species (Koebner, 1994). In contrast to the early days of zoos the populations in zoos are growing due to better breeding methods in zoos and not because zoos are 'robbing' the wild (Tudge, 1991).

1.1.2 The evolution of zoos

A stone tablet records the earliest known recorded collection of animals in 2300 BC in the Sumerian City of Ur (Koebner, 1994). Initially, these animals were kept as a display of wealth and power and were often given as gifts by royalty (Koebner, 1994). This early display of animals reached its peak in 27 BC – 476 AD in the Roman era. The Romans used the captive animals in their collections for the entertainment of the people. They put various animals in arenas together with gladiators where they fought each other to the death while the crowd watched (Koebner, 1994). As humans conquered new worlds there were new and exotic animals to bring back to the collections (Koebner, 1994). Little thought was given to the animals needs; instead, they were displayed purely for the benefit of the spectators (Jamieson, 1995). As the nobility lost power and control over the common people, animal collections became more accessible to all people. These captive collections on display came to be called "menageries" and were basically collections of wild animals in cages (Koebner, 1994).

In these menageries, animals were still put on display merely to be looked at as curiosities, but they were not studied. The most common cages were made from cement and bars or a pit in the ground and were not designed with the needs of the animals in mind. Rather, the cages were designed to afford the crowds a better view of the animals and provided no places for the animals to escape from the gaze of people (Jamieson, 1995). The animals were trapped in the wild only to be put in solitary bare cages where they stereotyped badly for the rest of their short lives (Bostock, 1993). Animals kept in English menageries between the 13th and 18th centuries were used for the entertainment of Royal guests, much the same as in Roman times. Royalty in many countries such as Italy, Germany and Austria kept menageries of this kind. Once again in 1790, the royalty were losing power and the common people claimed the right to have access to the menageries of captive animals (Koebner, 1994). In the early 19th century, the smaller menageries were collected into larger more organised structures called Zoological Gardens (Koebner, 1994).

Regent's Park in London was the first Zoological Gardens to open, in 1828. The stated purpose of this zoo was to study captive animals in order to increase understanding of their wild relatives (Koebner, 1994; Mench & Kreger, 1996). More zoos began to establish themselves across the UK, Europe and America during the rest of the 19th and early 20th centuries. These animals were still housed alone in barren cement cages and often displayed, to the delight of the crowds watching them, the behaviours that we now term 'abnormal' (Stevenson, 1983). The most common form of abnormal behaviour is stereotyping (discussed further in Sections 1.1.1 and

1.1.2) (Stevenson, 1983). In these early zoos, animals were caught in the wild and transported in cramped conditions to bare cages where they lived out their short lives and were then replaced with new animals caught from the wild (Koebner, 1994). Competition was fierce between zoos at this time; if one zoo had a giraffe then all the other zoos needed one to stay competitive. The early zoos also did little to educate the average visitor. It was not until the 20th century that people began to doubt that this was the best way of displaying animals. This was partly due to naturalists returning from the wild with news that animals did not behave the same way in the wild (Stevenson, 1983). It was also becoming apparent that, because of reduced populations, some species were increasingly harder to capture in the wild, many of them were endangered and some were already extinct. It was essential that animals in captivity remain healthy and also begin to breed. To achieve these goals it was apparent that animals needed environments more like their wild ones (Koebner, 1994).

In 1907, Carl Hagenbeck opened a Zoo in Hamburg, Germany that utilised his ideas and philosophies and would change the look of zoos worldwide (Cherfas, 1984). It is also interesting to note that he collected people from different countries and displayed them in an environment that resembled their native lands. Not satisfied with the way animals were exhibited, and from his experiences with training animals for his acts, he decided to open his own zoo based on what he knew of animal behaviour (Koebner, 1994). His new type of zoo did not confine animals to narrow spaces with bars but rather they had improved freedom and looked like they were in the wild. He achieved this through the clever use of moats and designed exhibits where predator and prey appeared to be in the same exhibit (Stevenson, 1983). People started to learn something about the relationships between species in their natural habitats and the animals could also lead a more natural life. Many other zoo directors saw the advantages of this approach and began to follow suit. Ever since that time we have been learning more about species in their natural habitat and more about what they need in captivity (Koebner, 1994). The early work of Hediger (1950, 1955) and Meyer-Holzapfel (1968) also did much to alert the zoos further as to the state of animals' behaviour in captive populations (Stevenson, 1983). Since this time there has been an increasing interest in how zoos display animals and what long-term effects this has on captive populations.

In the 1970s, people began to learn more about the welfare of animals and as a consequence became concerned about the lives of zoo animals. Attitudes within the zoos were also changing; zoos were beginning to work together to share animals and information about husbandry techniques rather than competing with each other. Consideration was also being given to conservation, the treatment of animals and the role of zoos in society (Koebner, 1994). The zoos also took on the role of policing themselves and they formed the American Association of Zoological Parks and Aquarium Association (AAZPA) now known as the American Zoological Association (AZA). The AZA now insists that conservation, education and scientific study must be more of a priority than recreation (Koebner, 1994). The world zoo conservation strategy is another first for zoos. It emphasizes three areas where zoos and aquariums can help reach conservation goals (Koebner, 1994): (i) Support conservation of endangered species and ecosystems, (ii) offer professional support and facilities to increase scientific knowledge that will benefit conservation and (iii) promote public awareness of the need for conservation. With their increasing role in conservation issues, zoos have once again changed and are now being thought of as conservation centres (Koebner, 1994). Zoos have moved from their very beginnings as menageries, with animals displayed as little more than curiosities, to where zoos have the potential to play a very significant role in the conservation of many species (Koebner, 1994).

An important way that zoos can move forward to being conservation centres is by ensuring that animals perform as little abnormal behaviour as possible. Before this can be achieved it is important to understand what abnormal behaviours are and why they can be damaging to the animal. A discussion of the types of abnormal behaviours that animals exhibit follows in the next section.

1.2 Captivity and behaviour

1.2.1 Abnormal behaviours

Defining abnormal behaviours is difficult because what might be seen as normal in one situation would be considered abnormal in another. The normality of behaviour depends on the situation in which it is seen (Erwin & Deni, 1979; Sackett, 1968). Erwin and Deni (1979) pointed out that 'abnormal' behaviours are not those that are just infrequent they are also pathological. Meyer-Holzapfel (1968) defined abnormal behaviour as behaviour that is uncommon or completely absent from the behavioural repertoire of the wild animal. These behaviours can be either adaptive or maladaptive to the captive animal. By this definition, if an animal has not been studied sufficiently in the wild then we cannot recognise whether these behaviours are abnormal or not. It is unlikely that any species has been studied sufficiently to say that specific behaviours definitely do not occur in the wild and therefore this definition cannot be applied in any practical sense.

The definition put forth by Erwin and Deni (1979) can be applied more easily and is the one to be used for the purposes of this thesis. They divide abnormal behaviours into two groups and compare the frequencies of the behaviours in both wild and captive groups. Qualitative abnormal behaviours occur in a captive setting but not in the wild whereas quantitative abnormal behaviours occur in the wild but occur much more or much less in captivity. Some examples of qualitatively abnormal behaviours include bizarre postures (floating limbs, self-biting), stereotyped motor acts, (pacing, bouncing in place), appetitive disorders (copraphagia, paint eating), and sexual disorders (inappropriate orientation, sexual dysfunction). Quantitative abnormal behaviours can include activity patterns (apathy or hyperactivity), appetitive disorders (too much or not enough eating or drinking), and agonistic disorders (too much aggression).

There are some behaviours that have been thought to be abnormal and have subsequently been observed in wild populations of animals and are no longer considered abnormal (Stevenson, 1983). Some species, such as the lion, are inactive in the wild and inactivity in a captive situation is merely a reflection of this and not an abnormal level of behaviour (Stevenson, 1983).

All of the abnormal behaviours mentioned above can have different causes and certainly not all of them are detrimental to the animal, whereas others can be life threatening. Many of them can be prevented easily, while others prove difficult to eradicate even when the animal is placed in a more enriched environment with plenty of space (Meyer-Holzapfel, 1968). Abnormal behaviours can be very diverse, depending on the species and the eliciting stimuli (Mason, 1991). The most powerful drive for many species is that of escape which can be a more powerful motivator than hunger. Ungulates when placed in captivity have been known to break their necks because of attempts to escape (Meyer-Holzapfel, 1968). The intensity of this reaction varies with the age and species of the animal concerned.

The most frequent group of abnormal behaviours in a captive situation are stereotyped motor acts (Mason, 1991). Stereotypy is something that is not easy to define (Tudge, 1991). A simple definition of stereotypy is any kind of repetitive behaviour that helps to reduce the anxiety or frustration of a situation (Koebner, 1994). Under this banner digging in meerkats could also be seen as a stereotypical act (MacDonald, 1992). A better definition has been put forth by Odberg (1978) who has stated that there are three components to a stereotyped motor act. Firstly the movements are identical, secondly they are repeated regularly and finally the behaviour has no observable function.

Stereotypy is often labelled as abnormal, but this can mean two very different things. Mason (1991) has reported that abnormal behaviour has been labelled by some researchers as statistically rare or different from a chosen population; whereas other researchers report that abnormal behaviour is where the behaviour is lacking in function or causing harm to the animal. Some suggestions as to why abnormal behaviours occur are over-arousal and under-arousal; it is the animal's way of coping with an adverse environment and regulating the stimulation it is receiving (Tudge, 1991). Animals in their natural environment compensate for minor fluctuations with small changes to their behaviour. Large fluctuations require large changes.

The stereotyped motor reaction that can be observed easily by even the most untrained observer is pacing behaviour. Bears and large cats are often seen to perform this type of behaviour and it is believed that the pacing results from repeated attempts by the animal to escape from its enclosure (Meyer-Holzapfel, 1968). The animal takes several paces in one direction turns and then paces in the other direction repeatedly for many hours a day (Meyer-Holzapfel, 1968). This behaviour is often so ingrained that even putting logs in the pacing pathway does not prevent it; animals just walk right over it or around it. It is necessary to determine the important environmental stimuli that influence the animal's behavioural repertoire in order to improve its environment and behaviour (Stevenson, 1983).

1.2.2 Factors that contribute towards abnormal behaviours

Many factors can contribute towards the quantity of abnormal behaviour that individual animals exhibit in captivity. Many of these factors appear to have evolved from a lack of knowledge about the needs of captive animals and this has resulted in poor husbandry techniques. Animals in captivity do not have to find food, shelter, a mate, or fight off predators, as they would in the wild. As a consequence, animals in captivity suffer from a lack of things to do.

One of the factors contributing to abnormal behaviours appears to be the way in which animals are fed in captivity (Meyer-Holzapfel, 1968). In the wild, foraging and/or hunting and eating consume a considerable amount of an animal's time. In addition to this, animals such as big cats only eat once every two or three days. This is in contrast to the captive situation where animals are presented regularly with food in a manner that usually only takes minutes to consume. Mason (1991) has reported that animals in this situation may feel frustration because a drive to hunt or forage for their food is present but they are not given any opportunities to do so. First, the animal may display displacement behaviours and then, if the situation does not change, this may lead to stereotypy. Presenting food in a manner that requires the animal to work, such as spreading nuts or seeds in the enclosure and allowing the animal to forage for it, can often alleviate this situation. Another factor that may contribute to frustration is a small enclosure that restrains motor activity (Mason, 1991). This can result in pacing behaviour that is very difficult to eradicate. Providing a large enclosure with plenty of activities to keep the animals occupied can reduce the level of pacing behaviour.

Another factor is the unavoidable stress or fear that some animals encounter in a captive situation (Mason, 1991). These stressors include being housed in inappropriate social groupings that lead to high levels of aggression or being placed in a new enclosure or an enclosure that does not provide adequate quarters (Erwin & Deni, 1979; Meyer-Holzapfel, 1968). There may also be levels of stress due to the close presence of a predator, an animal being close to but not able to get to an animal of the same species or the presence of visitors (Mason, 1991). Another factor contributing to abnormal behaviour levels is an environment that is lacking in stimulation for the animal (Mason, 1991). Stereotypies have been seen as a coping mechanism to keep the animal in optimal physiological and psychological limits (Fraser & Broom, 1990). This type of pacing can be reduced by the introduction of a more complex environment (Stevenson, 1983). On many occasions an animal will stop its abnormal behaviour once the cause is resolved. However, on some occasions the behaviour has become so much of a habit that it continues even in a large enclosure or once the releasing stimuli have been removed. Thus, it is evident that it is important to reduce abnormal levels of behaviour and this can also help in conserving natural and species-specific behaviours.

1.2.3 Conserving natural behaviours

As was described previously, zoos in the past have tended to concern themselves solely with animals' physical health as opposed to psychological health. In more recent times, they have begun to recognise the importance of the psychological health of animals. The ultimate and perhaps most important aim of conservation breeding programs is to release animals into the wild. It is essential for the animals in captive populations to retain enough of their species typical behaviours to survive in the wild (Tudge, 1991). Many of these behaviours are not innate and need to be learnt (Box, 1991). It is essential that the animals be provided with an environment that facilitates the learning of these behaviours (Tudge, 1991). One of the first release programs involved the golden lion tamarins, with the first attempt resulting in the deaths of all the 11 released animals (Tudge, 1991). After this disastrous result it was realised that before being released the animals needed basic training. This realisation led to some changes being made in basic husbandry to help animals learn skills for survival. One example of this was that tamarins were very poor at moving in the canopy of the rainforest and preferred to move along the forest floor, thus making them vulnerable to predators. The animals were then given thin branches that were changed around twice a week and this led to a better success rate (Tudge, 1991). Box (1991) reports that animals need to learn skills such as orientation and movement in space. (This is also called cognitive mapping and will be discussed further in Section 3.1.4.1), foraging, how to find places to sleep and hide, interaction with other species and establishing intra-species relationships. To achieve this training environmental challenges are required to stimulate natural patterns of behaviour (Box, 1991). Environmental enrichment is important to ensure that animals have the basic skills for survival in the wild if they are involved in a release program. It is also essential for the general maintenance of behaviours of all species of animal living in captivity.

1.3 Behavioural enrichment

1.3.1 Change in the way animals are perceived

Following J.B. Watson, the founder of the behaviourist movement, many early behaviourists considered that an animal's state of mind could not be quantified whereas behaviour could. What could be quantified was therefore valid as the objective of empirical investigation (Tudge, 1991). Early studies in animal behaviour in this tradition were carried out in laboratories under strict control. Another influential person around the turn of the century was the psychologist, Edward Thorndike. He too concentrated only on events that could be directly observed and quantified (Shepherdson, 1998). In addition, two ethologists, Konrad Lorenz and Niko Tinbergen, developed theories that sought to explain behaviour in terms of 'drives' or 'instincts'. It was believed that animal learning could be explained by innate drives or instincts (Shepherdson, 1998).

B.F. Skinner was one of the strongest influences on the study of behaviour during the last century. Skinner developed the approach now known as the experimental analysis of behaviour. Skinner's approach to learning differed from the others in that he was largely anti-theoretical. He developed the concept of 'operant conditioning' where animals could be taught to respond in certain ways through the reinforcement of certain behaviours (Skinner, 1938). Animals were still thought of as largely mechanistic and any concepts of an animal's psychological needs were ignored (Shepherdson, 1998).

In the 1960s Breland and Breland (1961) performed a series of studies that showed animals do not always behave in accordance with the principles of conditioning. They used operant conditioning techniques to train animals to perform behaviours that were not normally in their repertoire. In one study (Breland & Breland, 1961), pigs were conditioned to carry tokens to a container for food. After a while the animals began tossing the coins on the ground and rooting them around with their snouts, and the longer it was since they had been fed the more intense their rooting was. This was described as 'instructive drift' and is where the animal begins to revert to its natural behaviour pattern. This has since been seen in a number of studies and shows that animals cannot be seen as simply reacting to conditioned stimuli. Animal behaviours could no longer be understood in terms of a string of conditioned reflexes. Instead, animals began to be seen as having unique and varied lives. One of the most significant studies was with chimpanzees. They were not only seen to use tools but manufacture them as well. This capacity had long been used to exemplify the difference between humans and animals (Goodall, 1986). Yet more recently, studies on apes are even revealing that they have a language (Shepherdson, 1998). In addition to this, research with an African grey parrot has revealed that linguistic capacities are not necessarily limited to apes or even mammals, and that birds can be taught to use language in unique and meaningful ways that are not simply imitative (Pepperburg, 1991).

If, as shown above, animals have varied and complex lives that reflect a significant mental component, then the captive environment may affect animals in ways that we do not understand. A series of studies on primates (Gluck et al., 1973; Harlow & Harlow, 1962) and domestic dogs (Pfaffenberger & Scott, 1976; cited by Shepherdson, 1998) revealed the importance of specific environmental and social stimuli for normal animal development. Morris (1964) and Meyer-Holzapfel (1968) studied the psychological needs of captive animals and discovered that, if these needs are not met, then there is an increase in abnormal behaviour. It is from studies such as these that the concept of behavioural needs was developed. This suggests that animals can be motivated to perform behaviours even when it is not necessary for the animal to perform them (Shepherdson, 1998). An example of this was revealed with experiments on rats and pigeons that had been taught to bar press or peck a light for food. They continued to 'work' for their food even if food was freely available (Neuringer, 1969). The importance of allowing animals to perform these appetitive behaviours can be seen by the finding that by allowing or encouraging animals to do so can reduce the amount of time animals spend performing abnormal behaviours (Shepherdson et al, 1993). This shift in attitude from seeing animals as a string of reflexes to understanding that they lead complex lives with certain behavioural needs has led people to understand that environmental enrichment for animals in captivity is not a luxury but rather a necessity. The question must now be asked of zoos whether captive animals can fulfil their biological needs (Jordan, 1987). Zoos dedicated to conserving species are starting to address the issues of ensuring that animals in their care have complex environments with the ability to interact socially and fulfil basic natural instincts. It is through environmental enrichment that these needs can be met.

1.3.2 Aims of Environmental enrichment

Shepherdson (1998) states that environmental enrichment is the process used to enhance the quality of captive animal care, by identifying and providing the environmental stimuli essential for optimal psychological and physical health. On the largest scale, environmental enrichment can involve completely renovating an old sterile concrete cage to a new enclosure that allows an animal to perform most of its natural behavioural repertoire. In contrast, at its simplest level environmental enrichment can involve scattering an animal's daily rations around the enclosure so that the animal has the opportunity to forage for its food (Shepherdson, 1998). Environmental enrichment can also increase the effectiveness of captive breeding programs and thereby help zoos to fulfil their role in conservation aims (Shepherdson, 1998). One of the most important roles of environmental enrichment can be seen in release programs, where animals do better when released into the wild if they have had enriched lives in the zoo environment. Another important area of environmental enrichment is the education of people who visit the zoo. People learn more about species if the enclosure is natural and the animal is behaving normally (Shepherdson, 1998).

The two main aims of environmental enrichment are to maintain the welfare of the animal and to prepare them for release into the wild (Tudge, 1991). One method of measuring a captive animal's welfare is to measure the levels of its stress hormones (Tudge, 1991). The problem then becomes how to determine what this means for the animal and how much stress is too much or not enough. Another way of measuring an animal's welfare is to compare how closely its behaviour in captivity matches that of wild animals of the same species. As mentioned, it is then possible to determine how much of the zoo behaviour is abnormal and whether this is caused by an extra stimulus that is present or a stimulus that is lacking (Tudge, 1991). In this way the welfare of animals in captivity can be monitored and, through environmental enrichment, elements of their environment can be altered accordingly. The ultimate aim of responsible zoos for endangered species is to release animals into the wild so that they form self-sustaining populations. For this to be achieved the animals need to maintain their species-specific behaviours so that they can function in the wild. Tudge (1991) reported a decade ago that there were about 100 release programs operating worldwide. Since then, Beck (1995) has calculated that, at last count, 13 million captive-bred mammals have been released, including 70,000 mammals, birds and reptiles. Each of these species must have the necessary environmental stimuli in their captive enclosures to learn all of the skills that are necessary for their survival in the wild (Tudge, 1991). Once again this can be achieved through environmental enrichment.

1.3.3 Types of environmental enrichment

When a zoological exhibit is designed there are many things to consider, including the temperature, light, drains, taps, noise and odours. In addition, the needs of the animals, keepers and visitors must be taken into account. The best exhibits are those that resemble and retain the key elements of the wild (Koebner, 1994). A good enclosure should also take into account the type of space that animals need, whether they need to climb or swim (Koebner, 1994). Visual tricks can also make the enclosure seem more natural for the visitor and the animal or even make it appear that predator and prey are in the same enclosure. Furthermore, sound effects can help immerse the visitor into the animal's world (Koebner, 1994). In addition to these considerations, enclosures can include some elements of environmental enrichment. Perhaps the most well recognised example of environmental enrichment is the provision of a termite mound for chimpanzees in captivity. Other simple forms of enrichment can include scattering seed so monkeys can forage, or hiding meat so that cats can 'hunt', or even just providing nesting materials (Koebner, 1994; Maple & Perkins, 1996).

Environmental enrichment can occur in three main ways. The first is in the style of Carl Hagenbeck, where researchers consider what the animal responds to in the wild and then try to reproduce this in captivity. The second is largely associated with Hal Markowitz and involves the use of interactive machines (Tudge, 1991). The third type of enrichment involves the use of novelty to stimulate exploratory (Maple & Perkins, 1996) and play behaviour (Thompson, 1996).

1.3.3.1 Carl Hagenbeck

Carl Hagenbeck created zoo environments with a softer touch through the use of moats and clever design practices. Only simple apparatuses were employed, such as a tube with holes drilled in it and stuffed with newspapers and mealworms. As the mealworms moved about one would occasionally fall out, encouraging the animals to forage (Tudge, 1991). This approach also involved changing feeding regimes, with animals fed smaller amounts more often. Another approach was also to leave scent trails of meat around the enclosures, sometimes ending in a piece of meat and sometimes not (Tudge, 1991). One problem with this approach was that sometimes the enclosure would just look good for the zoo visitor, but from the animal's point of view it was no better than the cement and bars. This was because the animals were often not allowed access to the extra plants and other features that were placed in the enclosures. These areas were fenced off so that the animals would not destroy them and they remained looking healthy for the zoo visitors. In addition the murals often painted on the walls of the enclosures may have looked good for the visitors but served no purpose for the animals whatsoever.

1.3.3.2 Hal Markowitz

In 1925, Robert Yerkes said that primates in captivity needed to be provided with ways to work and play to improve their lives in captivity. Thus, Yerkes set about inventing apparatuses that could be installed in the animal's cage. In the 1970s, Hal Markowitz continued this approach with the idea that animals needed to work for their food in a way that was appropriate for their species (Markowitz, 1978). His first trials involved a group of gibbons living in a traditional cement cage and where there were no opportunities to build a new enclosure at the time. Markowitz designed an apparatus where the gibbons could press a lever and swing to the other side of the cage to collect a food reward (Tudge, 1991). All the animals learnt very quickly how to work the apparatus and were willing to work for their food, despite being fed regularly (Tudge, 1991). Interestingly, a juvenile male, "Harvey", was willing to press the lever for his mother to collect the reward but not for his siblings. Another study involved a family of Diana monkeys, taught to pull a chain in response to a light. They would then receive a token that they could trade for food. Once again this training elicited novel responses from the animals. The older monkeys did not learn how to operate the machine but one of them would steal tokens from the younger ones. In response to this one of the younger animals learnt to palm her tokens, leaving the older animal confused (Tudge, 1991).

A problem associated with this type of enrichment is the time and money that it takes to set up and maintain. One of the studies using this technique utilised a locust gun for meerkats. The locusts had to be loaded individually, requiring a large time investment from a keeper. Another problem can be that dominant animals may control the machine and not let the subordinate animals use it. This can lead to an increase in abnormal behaviour for the subordinate animal (Tudge, 1991). A further problem with this approach is that one abnormal behaviour can end up replacing another. When large cats were given the opportunity to hunt artificial prey, some animals started doing it up to 200 times a day (Tudge, 1991). In addition, Mellen, Stevens and Markowitz (1981) attempted to reward otters for sliding behaviour with fish. In response to this conditioning the otters were observed sliding 159.1 times an hour.

1.3.3.3 Novelty

After examining several methods of environmental enrichment, Stevenson (1983) found that the best was to make the enclosure as close as possible to the features used in the wild, while still providing stimulus change and novelty where possible. The methods of enrichment mentioned above also included placing novel items in the enclosures of animals. However, they include the novel items as a way of feeding animals or training them to respond in a certain way. This means that the animals quickly habituate to the apparatuses and the animals therefore no longer consider them novel. (Habituation to novel stimuli is discussed further in Section 2.2.3). This type of enrichment differs in that novelty is used *as the enrichment* and is not a by-product of the enrichment.

Even modern zoos can be barren environments and the best rarely match the wild in complexity and unpredictability (Tudge, 1991). Morris (1964) stated that animals back in the 1960s were getting excellent medical treatment in zoos and the only things they lacked were the variability, novelty and stimuli to maintain a high activity level. Almost 40 years later this is still the case in many zoos around the world. Zoos are now required, because of the public's growing interest in animal welfare, to include programs and techniques that cater for the "psychological well-being" of all the animals in their care (Maple & Perkins, 1996). Carlstead (1996) reported that animals in the wild have to probe constantly and investigate their environment to survive. Once in captivity, animals then have to adapt to cope with the unchanging environment. Captivity can provide too much stimulation and stress the animal or provide too little novel stimulation and leave the animal under-aroused (Stevenson, 1983). Either under-arousing or stressing the animal can lead to maladaptive behaviours that may be detrimental to the animal. All species can benefit from the provision of usable surfaces, objects and "toys" to provide them with sources of novelty, variability and stimulus change (Maple & Perkins, 1996).

This topic of providing novelty for zoo animals and the effects that it has on their behaviour is explored in the next chapter.

1.4 Chapter summary

In summary, it is evident that zoos have the potential to play an important role in the conservation of endangered species. To achieve this it is important that animals in captivity retain species-typical behaviours and do not exhibit abnormal behaviours. One of the methods used to achieve this is environmental enrichment. A number of different approaches to environmental enrichment have been developed. The progenitors of two of these approaches were Carl Hagenbeck and Hal Markowitz. The third approach involves providing animals with novelty to maintain a high activity level. The provision of novelty increases play and exploratory behaviour and decreases stereotypical behaviour, thereby enriching the lives of the animals. Instead of simply maintaining the animals' physical health their psychological health is being addressed as well. It is this approach that is to be investigated further in the current work. The next chapter will investigate the importance and effects of novelty on the behaviour of captive animals.

Chapter 2: Novelty and its effects on exploratory and play behaviour.

> *Zoos, though, can be barren environments, and even at their best they rarely match the wilderness in complexity, and certainly not in unpredictability.* (Tudge, 1991).

2.1 The Importance of Novelty

Despite the progress made in the area of environmental enrichment, zoos can still be barren environments that do not match the wild in complexity and unpredictability (Tudge, 1991). The modern zoo is required not only to keep the animal alive but also keep the animal fit for the wild and meet the needs of its psyche (Tudge, 1991). Although Morris (1966) emphasized that animals in the wild have to constantly probe and investigate their environment to survive, almost 40 years later many zoo environments still lack the variability and novelty necessary to encourage a high activity level. The captive environment can be lacking in novel stimulation and consequently provide little stimulation for exploratory behaviours and lead to inactivity for many animals (Stevenson, 1983). Animals have to adapt to cope with the unchanging captive environment.

One example of this is the increase in play behaviour that is often associated with animals in captivity (Maple & Zucker, 1978). Loizos (1966) reported that this increase might reflect a positive need for engagement in activity. Captivity can provide too much stimulation and stress the animal, or provide too little novel stimulation and leave the animal under-aroused (Stevenson, 1983). As previously stated, too little or too much stimulation can lead to abnormal and maladaptive behaviours that can be detrimental to the animal (Stevenson, 1983; Wood-Gush & Vestergaard, 1991). Determining the right level of stimulation for each species and individual animal is essential, but virtually impossible without trial and error.

The following studies have shown that animals are more active in and spend more time in enriched environments than barren ones. Bradshaw and Polling (1991) found that rats preferred to spend time in cages enriched with plastic pipes, wood platforms, wood chips, and paper towels rather than identical cages without these items. Hubrecht (1993) found that the provision of novel objects to laboratory dogs reduced stereotypic pacing and the animals spent 24% of their time playing with the objects. Westergaard and Fragaszy (1985) found that capuchin monkeys increased their activity level when they were provided with a variety of "toys". Other researchers have also found that novelty increases activity levels and this will be discussed further in Section 2.2.

Animals that have been severely deprived of novel stimulation in their juvenile years show little interest in novelty when it is introduced into their surroundings. An animal's levels of activity and exploration are affected by the amount of novel stimulation that they receive when being reared (Sackett, 1967). Berlyne (1964) further stated that species with higher phylogenetic status benefit more from novelty than lower phylogenetic species, because their nervous systems are more tailored to cope with a moderately high influx of novelty and complexity. However, nowadays this is a concept that is widely debated and most species are thought to benefit from some degree of novelty. Baer (1998) reports that the increased activity associated with exposure to novelty may counter obesity, musculoskeletal deterioration and provide care-giving staff with an opportunity to monitor health status, because any injuries or disease are more obvious in an active animal. Therefore novelty is important for animals in captive environments and can affect animals in a variety of different ways, as will be discussed in the next section.

2.2 The Effects of Novelty

Reactions to novelty depend on the type of stimulus, the species and whether the animal has had prior experience with the stimulus (Joseph & Gallagher, 1980). For the purposes of investigation, novelty can be broken down into three basic types (Russell, 1983). The first type of novelty is where animals are removed from a familiar to an unfamiliar environment. In this scenario it is generally assumed that any locomotor activity is exploratory behaviour. This can be misleading because it is impossible to determine if the behaviour is indeed exploratory or another behaviour such as escape behaviour. Furthermore this method has little validity for real-world situations because this would never happen in the wild (Russell, 1983). A second type of novelty is exposure to a discrete and localized unfamiliar stimulus. In this situation it is easier to determine if the animals are reacting to the novel stimuli because exploratory behaviour is measured by contact with the stimulus and the animals can show preference for or avoidance of the stimulus. A variation on this theme is to allow animal's access to an unfamiliar environment that is connected to a familiar one and the animals can either stay in their familiar environment or explore the novel one. A final type of novelty is teaching animals to respond in order to gain access to an unfamiliar environment or stimulus. This can act as a powerful reinforcer and animals will learn tasks, even if access to novelty is the only reward.

Animals can exhibit a variety of responses to novelty, including freezing (stopping still), attacking, sniffing, or scent marking. A typical series of responses would be for the animal to freeze, then orient itself to the novelty and, with the passage of time, to approach and finally manipulate the object (Joseph & Gallagher, 1980). Orienting to a novel stimulus has been called the investigatory reflex (Pavlov, 1927) and diversive exploration (Berlyne, 1960). The manipulation of a novel object is referred to as direct investigation or specific exploration (Berlyne, 1960) and is the subsequent investigation of objects after orienting has occurred. (These concepts will be discussed in more detail in Section 2.2).

Novelty has been found to stimulate exploratory behaviour in a variety of species including pigs (Wood-Gush & Vestergaard, 1991), tamarins (Glick-Bauer, 1997; Lampard, 1997), the greater bushbaby (Renner et al., 1992), orang-utans (Wilson, 1982), chimpanzees (Paquette & Prescott, 1988), birds (Sandos, 1999) and octopuses (Wood & Wood, 1999). Aldis (1975) reports that moderate levels of novelty can stimulate fear in animals and as a consequence elicit *first* exploratory and *then* play behaviour. This could be due to the fact that one motivational system may arouse another and therefore fear may arouse the desire to play (Berlyne, 1950). Prior to playing, the animal seeks to reduce the fear associated with novelty by exploring the object or environment (Aldis, 1975). Play behaviour has been stimulated by novelty in a number of species including pigs (Wood-Gush & Vestergaard, 1991), ravens (Heinrich & Smolker, 1998), a Nile soft-shelled turtle (Burghardt, Ward & Rosscoe, 1996), cotton-top tamarins (Lampard, 1997) and octopuses (Wood & Wood, 1999). Loizos (1966) found that the play behaviour that occurs following the introduction of a novel object to a group of polecats was not with the object but rather amongst the animals themselves. Novelty encourages both exploration and play, suggesting that they may be motivationally linked and play may have some purpose in exploration (Wood-Gush & Vestergaard, 1991).

A number of studies have demonstrated that the use of novelty is important for increasing activity in animals in captivity. Wilson (1982) showed that the presence of stationary, movable, temporary objects was strongly correlated with activity levels in apes. Paquette and Prescott (1988) found that giving chimpanzees novel objects increased manipulation frequency and decreased inactivity. The novel presentation of food was also found to increase the subjects' use of the exhibit space, and increase activity; and the animals invested more time exploring and obtaining food (Glick-Bauer, 1997). Renner, Bennett, Ford and Pierre (1992) worked with prosimians and found that they displayed sustained investigations of non-food related novel objects. It has also been reported that cats spent considerably less time pacing in enclosures that were more complex (Mellen et al., 1998).

There are also a number of factors such as complexity of the novel object, the social environment, habituation and the past experiences of the animal that can affect how an animal reacts to novel stimuli. These are discussed in the next few sections.

2.2.1 Level of novelty and complexity of the stimuli

According to Sheldon (1969), whether an animal approaches or withdraws from a novel object depends on the novelty of the object. The novelty of a stimulus is difficult to define and has to be defined in terms of the animal's experiences (Birke & Archer, 1983). This indicates that the experimenter must make an informed decision as to what stimuli the animal will find novel. Birke and Archer (1983) have pointed out that this is not difficult for laboratory or captive animals, but provides a greater challenge for wild animals. Furthermore, Birke and Archer (1983) have indicated that distinctions made in terms of "absolute" and "relative" novelty are arbitrary since it is highly unlikely that any adult animal will encounter something that is an entirely new stimulus. Russell (1983, p. 37) defines stimulus complexity as "the number of distinguishable elements and the dissimilarity of those elements". Animals are conditioned to approach stimuli that fall within the range of complexity that they typically encounter in their habitat (Russell, 1983). Complex objects elicit more exploration than simple ones because there is more information for the animal to assimilate.

An object or environment that is not novel enough or too novel will only evoke disinterest or fear respectively and prevent the animal from approaching (Berlyne, 1964; White, 1977). This is because novelty, surprise and uncertainty produce rises in the "level of arousal" or how excited an organism is. Inordinately high levels of arousal are uncomfortable and reduce efficient functioning. As a consequence, it becomes rewarding for the animal to reduce its level of arousal by withdrawing from the novelty. In addition to this, very low levels of arousal are negative for the animal and it becomes rewarding for the animal to seek out novelty to increase its arousal. This may account for why animals sometimes seek out novelty and at other times avoid it.

2.2.2 The social environment

The social environment can also determine the effects that novelty has on social animals. Katzir (1983) studied the response of captive jackdaws (*Corvus monedula*) to a novel environment and found that it is important to study the effects of novelty on social species in a group environment. The socially dominant jackdaws were the first to explore the novel environment, followed by the lower ranking birds. Fragaszy, Visalberghi, and Galloway (1997) found that animals consumed more novel foods but not more familiar foods in the presence of companions. Social facilitation was also evident with novel but not familiar foods in gerbils (Forkman, 1991). It is also important to provide enough novel objects so that lower ranked individuals can gain access to them and their presence does not increase aggression between the animals (Paquette & Prescott, 1988).

2.2.3 Habituation

Animals tend to habituate to novel objects that are presented to them over time (Hutt, 1966). Habituation is the process whereby animals gradually stop orienting to, and exploring, novel stimuli (Xavier, Saito & Stein, 1991). Cardinal and Kent (1997) have suggested that the benefits of novelty may last longer than the actual contact time and rotating the objects between enclosures can be beneficial by increasing habituation time. After the animals have habituated to the novel objects, renewed interest can be obtained by simply moving the objects. This suggests that the animals can detect the spatial changes in the objects. Hall (1998) has reported that animals can take longer to habituate to an object if there is a sensory component to it. Indeed, ravens were found to take longer to habituate to objects that were edible rather than those that were not (Heinrich & Smolker, 1998). This may be because the ravens found the edible objects more biologically significant than the non-edible items. Seligman (1970) reported that animals learn responses quicker if they have some adaptive significance for them and he calls this process "preparedness". This concept explains why animals will orient more towards novel stimuli that have relevance for their particular species. The novel stimuli that have significance for species will fluctuate according to the time of year and the state of the animal. For example, if the animal is nesting then nesting materials are the objects that will have the most adaptive significance for them.

2.2.4 Past experiences

The past experiences of animals also have to be taken into account, because an impoverished environment can lead to an increased reactivity to novelty (Glickman & Sroges, 1966). Joseph and Gallagher (1980) noted that rats reared in a restricted environment were 'overactive' to stimuli when compared to controls reared in an enriched environment. A study by Glickman and Sroges (1966) found that some animals were more reactive to novel stimuli than other animals. They suggested that the animals varied in response according to the taxonomic group to which they belonged. Another explanation could be that the animals varied because of their past experiences and thus some animals were overactive to the novel stimuli. No consideration was given to the past experiences of the animals or to the different amounts of time that it takes different species, individuals and age groups to habituate to novel situations. This will be discussed further in the next section.

2.3 Phylogenetic status and novelty

Glickman and Sroges (1966) carried out the largest comparative study of the reactions of animals to novel objects. The study included 222 mammal subjects and 20 reptile subjects, with representatives from over 100 different species. All of the animals were either housed at the Lincoln Park Zoo in Chicago or the Bronx Zoo in New York. Glickman and Sroges (1966) used a standardised set of novel objects that were scaled to the size of the animals, so the large animals had large objects and the small animals small objects and the ones in between medium objects. Wherever possible the researchers provided each individual animal with its own set of objects, so the animals were reacting purely to the objects and not to odours or other variables. The set of objects included two wooden blocks, two pieces of steel chain, two pieces of wooden dowel, two pieces of rubber tubing and a ball of crumpled paper. The nine objects were always presented to the animals in that order. During the test sessions, the animals were separated and placed in a test cage where the objects were presented in pairs, or singly for the paper ball, and then left for a six-minute test session. The objects were then removed and the next one(s) presented. Thus, each animal had 5 test sessions.

As mentioned, representatives from over 100 species were included in the study. Two groups of animals purposely not sampled were the large hoofed animals, because they were too difficult to separate from the herd, and the great apes because of the damage that they could do to the test cage. Interestingly, the reptile sample was biased, with species being selected by the zoo curators specifically because they were thought most likely to react to the novel stimuli. Animals were not included in the final results if they failed to complete at least four of the five tests and tests were stopped if the animals attempted to eat the paper ball or were at risk of injuring themselves.

Data were collected using data sheets, with records being made every five seconds, with a total of 72 samples per session. The two main categories of exploratory behaviour recorded were visual exploration and contact with the objects, including any deliberate contact made with any part of the body. Differences between the groups of species were found in the amount of exploratory behaviour directed towards the objects. Glickman and Sroges (1966) reported that primates and carnivores exhibited more exploratory behaviour than rodents or a group of "primitive mammals" which included ungulates. In addition, the sample of reptiles, with the exception of one crocodile, showed very little response to the novel objects. These results indicate there could be a link between exploratory behaviour and phylogenetic status, and as a consequence, the development of the nervous system. This was evident only when considering the broad evolutionary gaps, for example from reptiles to mammals. Glickman and Sroges (1966) found discrepancies that did not support the impact of phylogenetic status on exploratory behaviour within the mammalian class. More recently, Maple and Perkins (1996) have reported that there has been some evidence to suggest that species with higher phylogenetic status require more stimulation.

Glickman and Sroges (1966) also considered the evolutionary aspects of exploratory behaviour and what its adaptive significance in natural habitats might be. The general function of behaviour is to allow organisms to adjust effectively to environmental change (Glickman & Sroges, 1966). The ways that different species and animals respond to novelty has a special significance when viewed as part of the life history of a species. Indeed their response to novelty as a species may influence the rest of their behaviours, such as foraging strategy or the habitat they occupy. A species that seeks out novelty would be expected to be an opportunistic species, such as an omnivore, and have a ranging habitat. Feeding behaviour that requires extensive manipulation of the environment would favour the development of investigatory behaviour. An increase in investigatory activity means a reduction in vigilance for avoiding predators. Thus, high levels of investigatory activities are not likely to occur in species with a high danger from predators. Glickman and Sroges (1966) reported that omnivores and opportunists require a higher level of stimulation because in the wild their food sources are less abundant. The animals also have to explore more to find their food sources and require more stimulation. Glickman and Sroges (1966) found that species like herbivores and ungulates were less likely than other animals to spend time exploring objects.

Inherent in the Glickman and Sroges (1966) study, though, were a number of fundamental methodological problems because the researchers were trying to control for variables that may affect the results. As a result they may have classified animals as non-reactive when in fact they may have been quite exploratory when given the correct conditions. During the test sessions each of the animals was first placed in an unfamiliar test cage and then presented with the novel objects. This means that the animals were first exposed to a novel environment, and before having time to habituate to this novelty, they were then presented with novel objects. For many species this situation may just have been too novel and therefore they displayed avoidance reactions or simply did not respond to the objects. Moreover, the animals were removed from their social groupings and, as was discussed in Section 2.1.2.3, the social environment can affect the way that animals react to novelty. In addition, no attempt was made to tailor objects to suit each individual animal or to evaluate what properties of the objects influenced each species. Thus, certain species may not have investigated the objects simply because they were of no value to the animals and not because they are not exploratory by nature. Glickman and Sroges (1966) also did not record what influence the presence of the objects had on overall activity levels. As a consequence of studies such as the one by Glickman and Sroges (1966), most research on the effects of novelty has concentrated primarily on primates and carnivores. Only a few studies are beginning to show the importance of novelty for other animals including Renner, Bennett, Ford and Pierre (1992) with the greater bushbaby, Burghardt et al. (1996) with a Nile soft-shelled turtle and Wood and Wood (1999) with an octopus. There is a need to determine what elements or qualities of novel objects are important for different species and how the animals react to these different types of novelty.

2.4 Qualities of the novel objects

Carlstead (1996) has reported that one must consider how the qualities of the objects relate to each species and the previous experiences of each individual animal. The more complex, varied, unusual, and rare a stimulus is, the more likely an animal will find it novel. On the other hand, the longer a given individual has access to a novel stimulus the less likely the stimulus will be perceived as novel (Baldwin & Baldwin, 1977). Novelty is determined by the individual experience of the animal and the stimulus properties. Fiske and Maddi (1961) defined novel stimuli in terms of three properties, variety, intensity and meaningfulness. The qualities usually taken into consideration by zoo keepers include expense, ease of preparation, cleaning, and maintenance (Sambrook & Buchanan-Smith, 1996). These features are important but it must also be considered what features are important to generate a response from the animal. The qualities of the objects must be analysed from the animal's "point of view", such as in the "theromorphic technique" suggested by Timberlake (1998).

When observing animals, most humans tend to make assumptions about motivations and emotions by concluding that animals have human-like appearance and behaviours (Timberlake, 1998). In this way humans may assume that their pets can look 'sad' when they leave them and 'happy' when they return. However, the sensory and motor capacities of humans are widely accepted as differing vastly from those of all other animals. There is even less known about the desires and emotions of animals than we know about humans (Timberlake, 1998). Where there is such a lack of knowledge it is unscientific to practice an anthropomorphic approach to behaviour and run the risk of misinterpreting behaviour and its determinants (Timberlake, 1998). Rather than rely on the anthromorphic approach, Timberlake (1997) proposed an animal-centered or theromorphic approach.

The theromorphic approach suggests that researchers attempt to put themselves in the place of the animal rather than assigning human thoughts and feelings to the animal. Timberlake (1997) admits that this may cause confusion, as people will tend to ask how they would feel in the animal's position. Theromorphism differs from the anthromorphic approach in that it is based on information from a variety of sources, including behaviour, physiology, and the results of experimental manipulations. Timberlake (1997) has stated that the central premise of the theromorphic approach is to base it on knowledge about the animal. This approach must be coupled with knowledge of the sensory capabilities of the species, the animal's past experiences, the role of social interactions and what types of strategic choices are available to the animal at the time (Timberlake, 1997). Timberlake (1997) has suggested that the following questions should be asked with reference to a hunting lioness:

> *Perceptually, what can a lioness see at eye height on the veldt? What do we know about the sensitivity of the visual system of big cats to movement and its ability to resolve adjacent edges accurately? What sort of configurations produce the greatest attention? Which way is the wind blowing and how sensitive is the olfactory system to relevant types of molecules? Behaviourally, what are a lion's reactions to moving stimuli? What is its top speed relative to that of the prey? What killing techniques have evolved in lions? What is its experience with this prey? with this location? What is its body state? What changes of behavior occur related to the presence of other members of the pride?* (Timberlake, 1997, p. 9).

In the present studies questions must be asked as to what are the sensory capabilities of the animal and how they will perceive certain elements of the novel stimuli. Even though a toy may be given to an otter, the otter may not perceive the object as a toy, as it may have other relevance for the animal. In this way, it is important to consider all elements of novel stimuli, including sensory components, and how the animal will perceive them. Clearly, more information needs to be gathered about the sensory capabilities of each individual species and how they react to input before this can be achieved.

Qualities of novel objects that should be considered include the manipulability, flexibility, predictability of movement, smell, and complexity of the objects (Wilson, 1982). The complexity relates to the number of distinguishable elements and the dissimilarity of those elements (Berlyne, 1960, Walker, 1970). Moderately complex objects elicit more exploration than simple ones because there is more information to assimilate. Stimuli higher in complexity tend to be avoided and this may be because objects require some familiar elements to make them biologically interesting (Russell, 1983). Most studies on novelty in the past have tended to focus on complexity and control. Sambrook and Buchanan-Smith (1996) found that a species of monkey preferred responsive objects but did not show a preference for complex or simple objects. A study with orang-utans found that the number of companions and the presence of objects influenced the activity levels of the orang-utans and those aspects were found to be more important than the actual size of the enclosure (Wilson, 1982). In addition, movable objects were found to influence the activity levels of the animals more than the non-movable objects. Paquette and Prescott (1988) found that chimpanzees manipulated objects more when they were movable, large, bright, configurally heterogeneous, and capable of producing auditory or visual changes. Therefore, a species of monkey and two great apes were found to show a preference for movable objects. Aldis (1975) claimed that all species prefer movable objects to non-movable objects. However, this has not as yet been tested and, although the majority of species investigated so far have shown a preference for movable objects, many of these have been non-human primates and do not represent a good cross-section of species.

The most important features of objects are novelty and that the objects all stimulate multiple senses (Thompson, 1996). The emphasis in the past for environmental enrichment has been on housing design, manipulable objects and foraging, while less attention has been devoted to sensory stimulation. Ostrower and Brent (1997) reported that sense of smell is important for animals to locate food, mates and predators. They studied the effects of scented cloth on the behaviour of chimpanzees and found that the cloth was handled less but sniffed more when it had scent on it. The chimpanzees spent more time with the cloth when it smelt of smoke, moth balls and orange and less time when it smelt of peach, garlic and oyster. Information such as this can provide a basis for future enrichment programs.

Ward, MacDonald and Doncaster (1997) have found that even though animals may have never encountered a certain predator odour they may have an innate ability to recognize it as predator odour. This was shown by hedgehogs avoiding areas tainted with faeces from badgers, known predators of hedgehogs, even though the animals had never encountered badgers previously. Another study found that when novel distress calls were played to a predator species it made some animals attack more aggressively (Conover, 1994). A study with pigs looked at novel visual, olfactory, auditory and tactile stimuli (Hutson, Dickenson, Wilkinson & Luxford, 1993). The pigs did not respond to any of the visual stimuli or the noise of a cap gun, whereas a buzzer caused the pigs to move to the rear of their stall. Hutson et al. (1993) found that the pigs did not react to ammonia, or acetic acid, whereas they did lift their heads and rub them on the sides of their stall in response to eucalyptus oil and perfume. Finally, the pigs did not react to a rub or a prod but did stand when presented with water and a slap. This study therefore demonstrated that certain types of novel stimuli are most effective in obtaining reactions from pigs. In another study with pigs, Wood-Gush and Beilharz (1983) found that the animals used a trough with dirt more than toys. In a study with Barbados green monkeys, Watson (1998) found that they showed a preference for natural novel items over man-made ones and for clear versus opaque novel items. Sandos (1999) has also emphasized the point that birds can benefit greatly from novel objects in their enclosure and were found to manipulate such objects with their beaks. Three species of birds, horned puffins, parakeet auklets and thick-billed murres, shared an exhibit at the North Carolina Zoo and the keepers were concerned because of the high level of aggression between the animals. When the keepers introduced novel objects, such as seashells, medium sized rocks, durable plastic and rubber models of sea creatures (including squid, jellyfish, octopus and sea turtles) the animals performed more exploratory behaviour and the level of aggression declined rapidly. All of these studies have demonstrated that different species will react to different kinds of novel enrichment and it is therefore a matter of finding the most effective form of enrichment to increase exploratory and play behaviour for each species.

2.5 Chapter summary

This chapter has shown that the captive environment can be lacking in novel stimulation and this can lead to animals exhibiting abnormal behaviours. In addition to this, animals have been shown to spend more time in enriched environments than barren ones when given the choice. A number of different factors have also been shown to affect how animals react to novelty. These factors included level and complexity of novelty, the social environment, habituation and the past experiences of the animal. The large comparative study by Glickman and Sroges (1966) was also evaluated. Finally, the qualities of the novel objects were considered and what features would elicit the most exploratory and play behaviour from each species. The theories, definitions and a general examination of exploratory and play behaviour will follow in the next chapter.

Chapter 3: Exploratory and play behaviour

3.1 Exploratory Behaviour

3.1.1 Why animals explore

Exploratory behaviour is highly adaptive, because knowledge of the surrounding environment is important for survival and reproduction (Weisler & McCall, 1976). By exploring the home range systematically, an animal acquires information about where it can shelter from predators, find potential mates and locate food resources (Dewsbury, 1978). If animals did not investigate new stimuli or changes in their environment, they would be at greater risk from predators and not learn of new resources in the environment (Weisler & McCall, 1976). An animal may explore even when it is not in danger, hungry or looking for a mate (Dewsbury, 1978). Exploratory behaviour is most likely to occur when moderate levels of uncertainty confront the animal and can take precedence over basic biological functions such as eating and drinking (Berlyne, 1950). Russell (1973) reported that when an animal encounters a novel stimulus, it explores to obtain information that will reduce the uncertainty and the cause of the anxiety.

Exploratory behaviour is also important in captivity and when it is prevented there is often a higher incidence of abnormal behaviours. Dewsbury (1978) has shown that rats will learn tasks even if the only reinforcer is the opportunity to explore. Aldis (1975) reported that young animals explore more than adults. This is because it is thought that young animals begin life with a generalised fear of everything and start exploring the least novel stimuli and then gradually explore more novel stimuli. Adult animals are also less likely to encounter something new in the environment and therefore are less likely to need to explore (Dollhinow & Bishop, 1972). In addition, Menzel and Menzel (1979) suggested that adults have a more efficient information pickup system and can recognise objects more efficiently and as a consequence do not need to explore as much. Each animal explores enough to ensure its own survival and reproductive success. By keeping close to their parents, young animals learn to avoid the same stimuli as their parents, and gradually lose their fear of stimuli that are harmless. In this way, the process of learning is culturally transmitted (Aldis, 1975). Active exploration is risky and it is better that animals take these risks when alert and when young. Young animals explore more because they have more to learn and encounter more novel stimuli than adult animals. Consequently, animals explore to learn more about their environment, so as to ensure their survival and reproductive success. Exploration is vital for the survival of many species but is also exceedingly difficult to define. The definition of exploratory behaviour will be discussed in the next section.

3.1.2 Defining exploratory behaviour

Researchers have found it difficult to agree on a concise definition of exploratory behaviour. Einon (1983) has argued that all behaviours are hard to define; and Burghardt (1984) considers that "exploration" is particularly hard to define - as is "consciousness", "intelligence" and "instinct". Researchers argue over the definition of exploration because it has not been determined what motivates exploratory behaviour and there are no obvious consummatory aspects attached to it. A widely accepted definition of exploratory behaviour is that it "*consists of a relatively stereotyped perceptual-motor examination of an object, situation or event the function of which is to reduce subjective uncertainty (i.e. acquire information).*" (Weisler & McCall, 1976, p. 493). Other researchers consider that a more practical definition is to be made in terms of the appearance of the animal when it is exploring. Exploratory behaviour is generally characterised by highly stereotyped behaviour that includes a high degree of involvement of sensory modalities, for example, sniffing, tasting, touching (Aldis, 1975; Weisler & McCall, 1976). In addition to this, the exploring animal will appear tense and will proceed slowly and deliberately (Weisler & McCall, 1976).

Many of the methods of categorising exploratory behaviour have been described by Berlyne (1960, 1963). Some of the distinctions made have been between specific and diversive exploration, extrinsic and intrinsic exploration, inquisitive and inspective exploration. In addition, Burghardt (1984) has made a distinction between exploration and curiosity.

First, specific exploration is evoked by novel stimuli whereas diversive exploration is where the animal tries to alter the stimulation that it is receiving. Diversive exploration is likely to be exhibited when an animal is confronted by absolute novelty; that is where the animal may show general changes in behaviour, such as increased locomotion. On the other hand, specific exploration involves direct exploration of the novel stimuli and is likely to be elicited by relative novelty (Birke

& Archer, 1983). Another way of describing this distinction is that specific exploration is directed at obtaining information about a changed object or event and diversive exploration is motivated by a lack of stimulus change and is behaviour directed at obtaining stimulus change and information from any environmental source.

The second distinction referred to above is between extrinsic and intrinsic exploration. Extrinsic exploration is directed at obtaining information about a biologically significant event, such as foraging, whereas intrinsic exploration is directed at stimuli of little apparent biological significance or that cannot be linked so readily to a biological conclusion (Berlyne, 1964). From an adaptive and ecological view, it is doubtful if an animal would ever encounter anything that has no biological importance, since any change, at the very least, has the potential to be important. Consequently, this method of categorization cannot be applied to real-world situations.

The third method of categorizing exploratory behaviour is that of inquisitive and inspective exploration (Berlyne, 1960). Inquisitive exploration brings the animal into contact with unfamiliar stimuli, such as when the animal is searching for food or patrolling the home range. Inspective exploration is where further information is gained from partially familiar situations, such as novel objects. Another way of describing the difference is that inspective exploration is where the animal is responding *to* an environmental change, whereas inquisitive is where the animal is responding *for* an environmental change (Russell, 1983).

A final classification system has been that of exploration and curiosity (Burghardt, 1984). Exploration is when an animal gains information from chemical, auditory, tactile and visual stimuli in a cursory but sometimes repetitive manner. Curiosity involves more active scrutiny of objects, including approach-withdrawal, manipulation and close inspection with nose, paws and mouth.

Although Berlyne's extensive classifications have been seen as theoretically useful, they have been criticized as arbitrary, in terms of applying them to the real world (Halliday, 1966). Birke and Archer (1983) considered that these categories do not necessarily provide us with a useful definition of exploration and, furthermore, the distinctions can become blurred between the various classifications. Similarly, Cowan (1983) raised questions about the operational value of Berlyne's classifications, due to the problem of identifying the motivations of the animals. The appearance of animals while they are exploring appears to have a more practical application to recognising exploratory behaviour in animals. Rather than looking at classifying exploratory behaviour a number of other researchers have attempted to explain exploratory behaviour in terms of theory.

3.1.3 Theories about exploratory behaviour

There were many psychological studies into exploratory behaviour in the 1950s and early 1960s. These early studies, for example by Harlow (1953) and Montgomery (1954), concentrated on "investigatory" or "manipulatory" behaviours. These led to the following theories being suggested to explain exploratory behaviour.

3.1.3.1 Environmental Modeling and Discrepancy Theory

The Environmental Modeling and Discrepancy Theory states that animals respond to environmental changes by comparing what they already know from past experiences with the change with which they are confronted (Russell, 1983). This idea was formed into modeling theory by Sokolov (1960) and applied to exploratory behaviour by Salzen (1962, 1970). Salzen reported that, through experience, an animal builds up an internal model of a familiar event and, when confronted by an environmental change or novel element, there is a discrepancy between the model and the current input. A behavioural system is then activated that serves to reduce the discrepancy. Salzen suggested that small discrepancies produce low levels of activation and result in approach and investigation or specific exploration to establish a new model and eliminate the discrepancy. More drastic discrepancies produce intense activation and are likely to result in withdrawal and a search for something that is not discrepant. In addition, there is decay in the internal model; and patrolling behaviour or diversive exploration is the method used to repair the model (Russell, 1983). Alternatively, an assumption could be that the goal is the achievement of a mild degree of discrepancy rather than a match (Russell, 1983). In this situation, a close match would activate withdrawal, while a discrepancy would mean approach. Problems with this theory include the fact that it cannot be tested because there is no way of assessing the discrepancies of the novel stimuli. Additionally, there are no means of predicting in advance whether a particular change will produce approach or withdrawal.

3.1.3.2 Drive theories

Another group of theories include those concerned with 'curiosity' and 'boredom' and are primarily drive theories. The discrepancy theory mentioned above can be converted into the language of classical drive theory where the activation stemming from a discrepancy equates to curiosity (Russell, 1983). This is unhelpful since the drive is both being inferred from and used to explain, thus making it a circular argument.

Other major psychological drive concepts suffer from the problem of independent specification as well. This includes the boredom drive theory proposed by Myers and Miller (1954). They held that the motivation for exploration is a drive state generated by exposure to monotonous, unchanging stimulation or a state that is reduced by exposure to change. These two drive theories can be used in combination; i.e. the exposure to an unchanging environment may motivate behaviour directed away from familiar sources ('boredom') and towards new sources ('curiosity').

3.1.3.3 Optimal stimulation and arousal theories

The central theme of optimal stimulation and arousal theories is that organisms behave to maintain an optimal level of stimulation, or arousal. Environmental change or novelty is an important determinant of arousal (Berlyne, 1960). There are two variants of arousal theory. The first has been proposed by Fiske and Maddi (1961) and equates an unchanging environment to low arousal and regards exploration as behaviour directed at increasing arousal towards an optimum level. Low arousal equates to boredom. Arousal is reduced through inspective exploration or withdrawal and avoidance. The second variant has been proposed by Berlyne (1960) and argues that arousal is a U-shaped function of stimulation; with high and low levels of stimulus change being highly arousing. There are difficulties in using these theories to make predictions and it has been said that they tend to 'explain everything' but 'predict nothing' since we are talking about the accumulation and discharge of arousal, a concept that is very difficult to define. A further difficulty is to specify what the optimum level of arousal is for a particular species and whether individuals are above or below that level (Russell, 1983). Optimal stimulation and arousal theories were also discussed in Section 2.2.1.

Despite the problems associated with the Optimal Arousal Theory it has retained its popularity with some researchers, such as Baldwin and Baldwin (1977, 1978) who reformulated it.

3.1.3.4 Fear and exploration theories

Fear and exploration theories state that exploration is motivated by the fear generated by environmental changes (Halliday, 1966; Lester, 1967; Mowrer, 1960). High levels of fear elicit withdrawal and lower levels of fear elicit approach and investigation. This type of theory suffers from some conceptual difficulties, including whether it is possible to distinguish a drive state of 'fear' from a drive state of 'curiosity', since there are no distinguishing features and it would be difficult to test. In addition to this, even if there is a correlation between levels of fear and exploratory behaviour, it does not mean that there is causation.

3.1.3.5 Information Primacy Theory

Toates (1983) interprets exploration in terms of the theories of incentive and cognition and places emphasis on the cognitive or spatial maps first suggested by Tolman (1932). This theory is the Information Primacy Theory and states that exploration serves to establish and refine an animal's "cognitive map" (Discussed further in Section 3.1.4.1) in terms of the location of food sources, hiding places and other relevant environmental stimuli (Mench, 1998). The animal, by utilizing the cognitive map, can then carry out goal-directed behaviour by visiting the various sites encoded on the map. The preferred goals are those that are motivated by the internal state of the animal and therefore have the highest incentive value (Mench, 1998). This theory has been criticized because of its reliance on the assumption that animals can form and be aware of mental representations. One argument put forward is that more mechanistic interpretations of exploratory behaviour are adequate as an explanation (Kennedy, 1992). There is however some evidence to support the Information Primacy Theory of exploratory behaviour and this has been outlined by Inglis (1983). The first line of evidence is that animals will search for food even when there is an abundance of food. The second line of evidence is that animals will explore familiar or novel environments even when they contain no resources that can be used by the animal during the exploration. The function of this exploratory behaviour could be to provide future information about food resources, nesting sites and other important environmental stimuli (Mench, 1998).

There has recently been renewed interest in the area of exploratory behaviour and especially how it can improve the welfare of animals in captivity. Examples of this include Poole (1992), Shepherdson, Carlstead, Mellen and Seidensticker (1993), and Wemelsfelder and Birke (1997). Researchers such as Mench (1998) are now starting to examine exploratory behaviour in terms of its function rather than explaining it in terms of theory.

3.1.4 Functions and costs of exploratory behaviour

Cowan (1983) suggested that a general function of exploratory behaviour may be to gain information. Russell (1983) stated that exploratory behaviour plays an important role in the day-to-day lives of most animals and has important implications for their survival. Due to exploratory behaviour being of vital importance for many species, it will have strong selective pressures to ensure its continuation (Wood-Gush, Stolba & Miller, 1983). Associated with the benefits of exploratory behaviour are costs, including energy expenditure, and dangers, such as the risk of predation (Barnett & Cowan, 1976). A study involving mice found that exploratory mice were more likely to be preyed upon by owls, compared with less exploratory mice (Glickman & Morrison, 1969). In addition, Baldwin and Baldwin (1977) reported that young primates risk greater chances of predation, poisoning, falls from trees, separation from the troop and maladaptive learning, as some of the risks that an animal takes when exploring. They reported that stimulus-seeking behaviour lies on a continuum between maladaptive and adaptive behaviour but remains predominantly closer to the adaptive end. For any animal to continue exploring, the benefits must outweigh the risks.

3.1.4.1 Acquisition of information

A general benefit of exploratory behaviour may be the acquisition of information about the animal's environment (Mench, 1998). Russell (1983) reported that 'arousal', 'curiosity' and 'boredom' may have evolved to provide animals with information about their environment. From an adaptive viewpoint, the more an animal knows about the environment that it lives in, the more likely it will survive. For example, a knowledge of where to find cover would be of vital importance to animals and even more so to a prey species. As already described in Section 3.1.3.5, the process by which animals acquire information about their surroundings is called cognitive mapping. Tolman (1932) was the first to describe 'cognitive mapping' as a process involving the formation of internal models or maps of an animal's world. Exploratory behaviour through cognitive mapping can provide a source of knowledge about the animal's environment, a function that is of central importance (Mench, 1998).

3.1.4.2 Familiarity with the home range

Another function of exploratory behaviour is the maintenance of familiarity with the home range. Jewell (1966) reported that many species are attached to some sort of a home range and so it is important that they are familiar with all the changes within their range. Many species explore their home range systematically and regularly presumably to maintain familiarity. The adaptive significance of this is that they have a better survival chance if they know where to find food, water and hiding places (Russell, 1983). Russell (1983) argued that habitats change over time and the maintenance of familiarity requires regular inspections. This involves systematic patrolling and works twofold by refreshing the animal's memory and gives the animal an opportunity to discover what changes have been made.

3.1.4.3 Location of new resources

The location of new resources is another proposed function of exploratory behaviour (Mench, 1998). Birke and Archer (1983) suggested that knowledge of the location of different resources (nest sites, food sites, mates, hiding places and potential hazards) are remembered and then exploited at some time in the future. Resources can be located in the future, without the need for time consuming searches and this is a benefit that resident animals have over animals that have recently migrated to an area (Birke & Archer, 1983).

3.1.4.4 Avoidance of predators

The avoidance of predators is another function of exploratory behaviour that has been suggested (Mench, 1998). Glickman and Morrison (1969) found that, if placed in unfamiliar surroundings, then mice are more vulnerable to predation. They are preyed upon more by owls than when they are unfamiliar with their environment.

Ambrose (1972) speculated that this might be because animals in unfamiliar situations are more active than residents in the same area and residents can explore when there is no threat.

3.1.4.5 Learning new adaptive strategies

A further suggested function of exploratory behaviour is perhaps the most significant and states that exploration facilitates the learning of new adaptive strategies. In this way, an animal can adapt its strategies to be the most effective for a particular situation (Birke & Archer, 1983). Habitats are not static and change over time. Thus, animals need to learn to adapt their behaviour to allow for environmental changes. One way that habitats change is by the fluctuations in the type of food, and its availability as the seasons change. Davies and Houston (1981) found that pied wagtails defend a territory and hunt other wagtails out of their area when food is low, whereas they tolerate other animals when there is an abundance of food.

In summary, exploratory behaviour increases the chance of survival, by reducing the risk of mortality (such as vulnerability to predators) and increasing factors that contribute to survival (such as finding food and places to sleep). Baldwin and Baldwin (1977) reported that exploratory behaviour also functions to involve young animals in activities that exercise skeletal muscles and the cardiovascular system. Exploratory behaviour can improve the physical fitness of animals and encourages healthy growth in young animals. Exploratory behaviour can also lead animals into varied experiences and interrupt the monotony of captive life and this is beneficial for the development of the central nervous system. In addition, exploratory behaviour can include a wide variety of learning experiences, including perceptual skills, tool use, social perception, motor skills and predator defenses. The functions of exploratory behaviour can vary between species and this is discussed in the next section.

3.1.5 Species differences in exploratory behaviour

Exploratory behaviour varies both qualitatively and quantitatively according to the individual species. Studies sampling a wide variety of species have found that habitat and behavioural adaptations are the best predictors of exploratory behaviour (Glickman & Sroges, 1966; Russell & Pearce, 1971). Consequently, exploratory behaviour reflects the skills that an animal utilises for survival. It can be related to the feeding habits of species, with foraging or hunting requiring increased manipulation and this is correlated with a higher level of exploratory behaviour (Glickman & Sroges, 1966). Predatory species are more likely to be exploratory, whereas prey species tend to avoid exploring novel stimuli. This may be a mechanism to protect prey species against predation and allow predatory species to seek out prey. Omnivores are also expected to be very exploratory because they have to search for their food, requiring extensive manipulation of their environment (Glickman & Sroges, 1966). Mench (1998) has suggested that the three groups of species that need exploratory opportunities the most are:

- The generalists or species that have adapted to highly variable environments. An example of this group of species would be omnivores.
- The species that have developed highly complex antipredator behaviours. For example animals that have developed complex escape routes within their habitat.
- The species that have a complex social structure. It has been suggested that social behaviour can increase cognitive ability because of the need to communicate effectively and predict the behaviour of other animals.

Therefore, it has been suggested by Glickman and Sroges (1966), and more recently by Mench (1998) that different groups of species will be more or less exploratory depending on the niche that they occupy in the wild.

As well as encouraging exploratory behaviour, novelty also increases levels of play behaviour. Wood-Gush and Vestergaard (1991) have suggested that this could be because play and exploratory behaviour may be motivationally linked. Therefore, it is important when considering novelty and exploratory behaviour, also to investigate play behaviour. An examination of why it is important to study play behavior follows in the next section.

3.2 Play behaviour

3.2.1 Why play is important and the study of play

Play behaviour is an essential element of most species' behavioural repertoire and must be studied to understand behavioural development and social organization (Maple & Zucker, 1978). Play may have an engineering role in the evolution of complex behaviours (Brown, 1998). Many researchers have found that species have devoted less than 10 percent of their time to play behaviours (Burghardt, 1984; Fagen, 1981). This suggests that play is a relatively unimportant activity. However, many species spend even less time copulating, for example no more than once a year, and yet copulating is a very important activity. Bekoff and Byers (1992) have suggested that a better way of representing the data would be as a percentage of the total active time and that this shows the true importance of play behaviour.

The importance of play only becomes apparent in its absence and animals that are deprived of play in their infancy may suffer impairments as adults (Aldis, 1975; Markus & Croft, 1995). Deprivation of social play has been found to cause impairment of social development, including ineffective mating strategy, poor motor-pattern development and low motivation (Lancaster, 1972). The importance of play is even more apparent in captivity since survival pressures are eliminated. Animals do not have to forage or defend themselves from predators and the only way to learn and preserve these skills is through play behaviour. Most infants initially play with their mother and this provides general stimulation and readies the infant for more vigorous play with its peers. Bekoff (1978) reported that it might also be beneficial for animals to play with their kin because this increases their own fitness. Play behaviour decreases in frequency as the animal matures (Fagen, 1981). Poirier, Bellisari and Haines (1978) suggested that this might be because young animals simply find play more novel and stimulating than adults do. It has also been suggested that adults generally do not play since the risks are high if an animal misinterprets a signal (Dolhinow & Bishop, 1972). Fagen (1976) reported that adult play is only necessary in times of food abundance, to maintain physical fitness. This would explain why adults play more in captivity. In summary, it appears that play is an important activity that can help maintain the behavioural repertoire and physical fitness of animals in captivity. Even though play is important, especially to animals in captivity, it has proven to be a category of behaviour that is exceptionally difficult to define and this will be discussed in the next section.

3.2.2 Defining Play Behaviour

Fagen (1981) argued that play had become somewhat of a catch-all category, with many behaviours being classified in the domain simply because they had no observable function. There is still considerable disagreement over a concise definition or widely accepted function of play (Bekoff & Allen, 1998; Bekoff & Byers, 1981;

Burghardt, 1998; Fagen, 1981; Martin & Caro, 1985). Some of the difficulties are the same as those involved in defining exploratory behaviour and have been discussed previously. Play may have been ignored because it is not an easily outlined category, while emphasis is placed on those aspects that are easily described (Einon, 1983). Play is easily recognized at the extremes but is more difficult to fit into an exclusive category of behaviour (Heinrich & Smolker, 1998). Despite these problems, it has been confirmed many times that even naive observers can agree when animals are playing (Aldis, 1975; Dewsbury, 1978; Fagen, 1981; Symons, 1978), indicating that play is a genuine phenomenon worthy of study. There are two conceptual approaches to defining play behaviour, the functionalist and structuralist approach. The functionalist approach focuses on the adaptive significance of play and functions of play. The structuralist approach focuses on the form and appearance of the motor activities involved in play (Bekoff, 1976).

Hinde (1966) argued that play is a general term for behaviours that appear to make no immediate contribution to the animal's survival. Structuralists have suggested the following five areas that may assist the definition of play (Fagen, 1981):

- The behaviours performed in play are similar to those that occur in *functional* acts;
- Play acts are usually *exaggerated*;
- Play movements tend to be *repeated* more often;
- Play sequences have a more *variable order*; and
- Play movements lack the *biological consequences* that are found in their functional counterparts.

A definition that incorporates both the functionalist and structuralist approaches would be that play behaviour includes a wide variety of exaggerated, repeated, variable sequenced pre-existing behaviours, *appearing* to be devoid of biological consequences that function to develop and/or maintain any combination of physical, cognitive and social skills.

Many researchers have agreed that play behaviour can be broken down into three categories: locomotor, social and object play (Aldis, 1975; Burghardt, 1984; Fagen, 1981). *Locomotor play* is solitary or non-social play where the emphasis is on the individual (Poole & Fish, 1975). Locomotor play includes movements known as locomotor-rotational that involve exaggerated and repetitive elements of locomotion seen in other contexts (Maple & Perkins, 1996; Wilson & Kleiman, 1974). Examples of locomotor play include running activities, leaping and climbing. *Social play* involves sequences of play behaviour involving interactions between two or more individuals (Maple & Perkins, 1996; Poole, 1978). Social play can then be divided further into play-fighting and play-chasing (Chalmers & Locke-Haydon, 1984). Once again, the behaviours seen in play-fighting and play-chasing resemble behaviours seen in serious activities but without the end result that accompanies serious situations. Play-fighting can involve wrestling and biting in primates and sparring in ungulates and includes play signals that ensure that this behaviour does not escalate into a serious fight. Play-chasing is similar to locomotor play but involves two or more individuals and can involve animals chasing each other, with the partners swapping so that one animal is not always the one being chased. *Object play* is often preceded by initial inspection or exploration and involves interactions that are considered inappropriate for the object (Einon, 1983; Fagen, 1981; Thompson, 1996). This type of play has also been called diversive and manipulative play. Object play involves relaxed, unrestrained behavior with an object and can occur in a solitary or social context (Baldwin & Baldwin, 1977). Object play can involve shaking or biting an object by a solitary animal or the incorporation of an object into social play behaviours (Aldis, 1975).

Baldwin and Baldwin (1977) report that play is clearly distinguished from non-playful behaviour by the fact that play produces novel, varied, and jumbled sequences of activity whereas non-playful behaviour is more routine, habitual, predictable, and devoid of novel variations. In addition, the playing animal appears relaxed and is vigorous, rapid and forceful. Play is characterised by a high degree of effector involvement and lack of consistency (Candland, French & Johnson, 1978). Play normally occurs when animals are relaxed, in familiar surroundings and where there is no tension or danger (Dolhinow & Bishop, 1972). Thus, play behaviour is clearly distinguishable from other behaviours such as exploratory behaviour and a number of theories have been postulated to attempt to account for it.

3.2.3 Theories of play

There are a number of theories concerning why play occurs. Four popular theories are the Surplus Energy Theory, Optimal Arousal Theory, Practice Theory (Smith, 1978) and the relatively more recent Surplus Resource Theory (Burghardt, 1988). These theories of play are not necessarily mutually exclusive but each may account for a different type of play or play across time and species. Indeed Bekoff (1976) considered that any single theory about play is bound to be inadequate since play varies so much in form and function.

3.2.3.1 Surplus Energy Theory

The poet Frederich Schiller first suggested that play was the result of an overflow of energy and Herbert Spencer turned this idea into the Surplus Energy theory (Smith, 1978). This theory states that young animals have surplus energy because their parents care for them by providing food and protecting them from predators (Smith, 1978). This surplus of energy then manifests itself in play behaviour (Bekoff, 1976). Support for this comes from the observation that young animals and those that are cared for by others, such as zoo animals, play more. This has been a difficult theory to test and studies have produced conflicting results (Bekoff, 1976). A series of studies by Baldwin and Baldwin (1973; 1974; 1976) showed that a lack of energy due to food shortages can inhibit play behaviour. However Muller-Schwarze (1968) found no significant increase in play behaviour following a period of play deprivation, indicating that an excess of energy does not necessarily mean that animals will play more (Smith, 1978). A further problem with this theory is that it is based on circular reasoning (Beach, 1945). The theory itself centres on the definition of surplus but whether the energy is surplus depends on whether the behaviour is playful or serious. Another problem with this theory is that it is based on the accumulation and discharge of hypothetical forces (Beach, 1945). Consequently, this theory has had some support but also has fundamental definitional problems.

3.2.3.2 Practice Theory

Groos (1898) established another theory based loosely on the concepts associated with natural selection. This theory stated that when young animals play, they are practicing behaviours to be used later in life (Smith, 1978). In this way, young animals fine-tune their imperfect skills that they will need for survival as adults (Poirier & Smith, 1978). This theory is difficult to test because the main method for doing so is to suppress play behaviour; but as a result, all other social behaviours are suppressed as well. A study by Potegal and Einon (1989) tried to control for these effects by utilising three groups. The first was a control group with rats raised in a social setting. A second group of rats was raised in total isolation and a third group was only allowed social contact through play behaviour. Potegal and Einon (1989) found that the isolated rats were incompetent in potentially aggressive encounters, by taking offence where there was none or by failing to act aggressively to a real threat. A daily hour of play experience was enough to prevent or reverse these effects. Results from other studies trying to confirm or disconfirm this theory have produced conflicting results. Research has also shown that many of the behaviours required for adult life are unchanged by early experience (Fox, 1969; Poole, 1966). In addition, this theory does not explain why adults play since they should have perfected their skills and not need to play at all (Loizos, 1966; Millar, 1968).

Despite the problems associated with the practice theory of play, it has retained popularity and has been the basis for many definitions of play behaviour (Burghardt, 1998). More recent supporters of the practice theory include Russell (1990), Westergaard (1992) and Byers and Walker (1995).

3.2.3.3 Optimal Arousal Theory

The Optimal Arousal theory is based on a conceptual framework advanced by Hebb (1955) and Berlyne (1960). In this theory, play is seen as the method by which arousal is maintained at an optimum level. As already discussed above, this theory suffers because arousal is a vague term with no absolute definition. A further problem is that an animal's optimal arousal cannot be determined, nor whether the animal is above or below it. This was discussed previously in Section 2.2.1.

3.2.3.4 Surplus Resource Theory

This theory is relatively more recent than the three previous theories and was put forward by Burghardt (1988). The Surplus Resource theory is a more updated version of the Optimal Arousal and Surplus Energy theories. This theory states that species have evolved metabolic strategies that provide surplus energy to allow animals to play, especially when young (Hall, 1998). The surplus resources of different species are calculated according to size of the animal, basal metabolic rate, and level of parental care. Burghardt (1988) then made 19 predictions about how playful different species and animals will be. These were based on, for example, whether the animals are in nutritional stress, are constantly active near their physiological limits or have an extended period of parental care. This theory can explain play behaviour in both young and adult animals since it does not rely on play behaviour being practice for adulthood. Furthermore, it explains why animals in captivity play more, because they are cared for by others and have the surplus resources to expend energy in play.

These are four popular theories of play behaviour but, as can be seen, none of these fully explains play behaviour in each of its many forms. Rather than trying to develop one theory to explain play, another method for examining it is to look at all the different functions of play behaviour.

3.2.4 Functions and benefits of play behaviour

Play behaviour cannot be seen as a category of behaviour with a single function (Bekoff, 2001; Bekoff, & Byers, 1981; Fagen, 1981) and over 30 functions of play have been suggested (Baldwin, 1986). Bekoff (2001) has reported that there are few data concerning the benefits of social play in terms of survival and reproductive success. The effects of play behaviour are generally thought to vary between species and among different age and sex groups within each species (Bekoff, 2001). This is further supported by the findings of Caro (1995), that different types of cheetah play have different rates of development. An explanation for this might be that different types of play may have different motivational systems and these are activated as the animal matures (Caro, 1981) and that different components may serve different functions (Gommendio, 1988).

Play is generally considered to have immediate, potentially dangerous consequences but also delayed benefits (Aldis, 1975; Fagen, 1981; White, 1977). Thus, animals that are playing are more conspicuous, reduce their vigilance, and are more likely to fall and be injured. Playing is a risky business and, if play has delayed benefits, then it would make more sense for animals to play when they are larger and less likely to be preyed upon or injured (Bekoff & Byers, 1981). Gommendio (1988) stated that each stage of life must be considered in its own right, with the same pressures acting at each stage. Thus, play during early stages reveals that there are either negligible costs or that play is necessary for skills at that age (Gommendio, 1988). Play would have greater selective pressures for it if it had immediate benefits (Caro, 1995). If there was no reason to play when young then play would be selected against and animals would not engage in it. The answer to this is that animals play because when they are young play has immediate benefits such as increased physical strength (Gommendio, 1988).

Power (2000) has maintained that there is little doubt that play has some benefits and that the absence of play can have devastating consequences on social development (see also Bekoff, 2001). All of the suggested functions of play can be formulated into five main groups, including physical development, social development (Aldis, 1975), establishment of a dominance hierarchy, social communication and social integration (Millar, 1968).

3.2.4.1 Motor training

One of the most often reported functions of play behaviour is that of motor training or physical development (Baldwin & Baldwin, 1977; Bekoff, 2001; Chalmers & Lock-Haydon, 1984; Hall, 1998; Hinde, 1983; Markus & Croft, 1995; Watson, 1998). Millers and Byers (1998) found that sparring in an ungulate helped to improve some of the motor skills involved in serious fighting. Byers (1977) predicted that, if play behaviour was training, then it could be expected that a species living predominantly on sloped surfaces would perform play-chasing and locomotor play preferentially on sloped surfaces. He found that Siberian Ibex kids performed more locomotor and play-chasing behaviour on sloped surfaces but did not show this same preference for play-fighting. This behaviour must be very strongly selected for because play is a very risky behaviour and even more so on sloped surfaces. Dolhinow and Bishop (1972) reported that another example of animals playing hazardously is that of young monkeys dashing through trees at high speeds and making risky jumps while chasing each other. It is thought that this behaviour is teaching young animals the skills that they need to escape from predators when threatened, a very important survival technique. With many play patterns it is important to see the animals using the skills in "real" situations, to understand the benefits of play.

3.2.4.2 Social development

Social development is another suggested function of play behaviour. It has been noted many times that play is important for normal psychosocial development (Baldwin & Baldwin, 1977; Bekoff, 2001; Chalmers & Lock-Haydon, 1984;

Dolhinow & Bishop; Miller, 1973; Hinde, 1983; Markus & Croft, 1995; Poirier & Smith, 1974, Welker, 1961). Social play is very often the only social experience for young animals and thus the only method for them to develop social skills (Waterman, 1988).

3.2.4.3 Dominance hierarchy

Another function of play could be the establishment of a dominance hierarchy. Play may allow animals to learn their place in the social order (Smith, 1978). Rhine (1973) considered that play serves as a type of behaviour testing and allows animals to learn each other's strengths and weaknesses, without resorting to serious aggression that can be costly. Through the repetition in play behaviour, animals practice and learn the rules of dominance. The animals learn the differences in size, strength, reaction times and tolerance of their play partners and the total experience makes ranking almost inevitable. In the species that include the communication of submission, dominance and appeasement in their behaviour patterns, these activities are inevitably seen in play long before they are used in 'serious' situations. (Dolhinow & Bishop, 1972)

3.2.4.4 Social communication

Social communication is another suggested function of play behaviour (Smith, 1978). Play is suggested as the mechanism by which animals learn appropriate communicative responses and develop communication skills (Poirier & Smith, 1974). This may include the development of social perception or the ability to predict another animal's behaviour and respond accordingly, a skill that is essential for any social situation (Poirier & Smith, 1974). It has also been found that play can be one way for animals to learn appropriate methods of recognizing and responding to aggression (Potegtal & Einon, 1989).

3.2.4.5 Social integration

Social integration, whereby animals maintain social familiarity with other members of their group, is another suggested function of play behaviour (Etkin, 1967). Play can facilitate a young animal's integration into a group and the formation of social bonds within that group (Poirier, Bellisari & Haines, 1978; Smith, 1974). Poirier, Beillisari and Haines (1978) have concluded that this may explain why adults do not play as much with each other but do play with juveniles. Social cohesion is an important function of social play behaviour, especially for a social species such as the collared peccary. It may be the way that these animals maintain a cohesive social group (Miller & Byers, 1998).

Associated with the benefits or functions of play behaviour mentioned above are the costs or risks that animals take when engaging in play behaviours (Biben, 1998).

3.2.5 Costs of play behaviour

Biben (1998) has recently reported that animals face an increase in physical risks and social risks and expend more energy when they engage in play behaviours. These risks must be balanced against the benefits and, if the benefits are greater, then animals will play. Animals firstly face the risk that play will breakdown into serious aggression, a risk that appears to be minimal since it has rarely been observed (Biben, 1998). Another physical risk is that of the increased threat of predation and injury from falls. Adult squirrel monkeys do not monitor the play environment of their offspring but do become more vigilant for predators, indicating that the young animals are more likely to be preyed upon (Biben et al., 1989). Caro (1995) found that the overall cost of play behaviour for cheetah cubs was low. However, the play behaviour of the cheetah cubs was found to influence their mother's hunting ability.

Another risk may be in expending the energy required to play. It has been shown that squirrel monkeys in the field and the laboratory do not play when there is an energy shortage (Baldwin & Baldwin, 1973; 1974; 1976). In the Baldwin and Baldwin studies, there was a shortage of food and more energy had to be expended foraging than usual. As a consequence, there was no energy left for play behaviour. A further risk is that play-fighting may benefit some animals while disadvantaging others, by reconfirming the already existing dominance relationships (Biben, 1998). Despite all these risks, animals still play and therefore the benefits of playing must outweigh the risks. However, play behaviour can vary greatly in form and frequency between species, indicating that it may have different benefits and risks associated with it for different species.

3.2.6 Phylogenetic status and play behaviour

White (1977) reported that play is generally restricted to warm-blooded vertebrates. This was thought to be because species have to have the advanced phylogenetic status and central nervous system that allow them to control play behaviours. Similarly, Aldis (1975) reported that play does not occur in invertebrates, fish, amphibians or reptiles and only in a few species of bird. The species that play are advanced primates and carnivores with complex skills and a long period of immaturity involving dependence on parents and protection from predators. All these statements are generally considered to be outdated today and all animals from all taxa and of all ages are thought to play (Hall, 1998).

Burghardt (1984) stated that not having found play behaviour in non-mammals and other orders of animals may be due to a lack of research rather than its non-occurrence. However, the occurrence of play behaviour in groups such as reptiles is controversial and poorly documented (Burghardt et al., 1996). A reason for this may be that play is hard enough to recognize in mammals and as a consequence may be even harder to recognize in non-mammals. In a recent study Iwaniuk, Nelson and Pellis (2001) found that the species more likely to exhibit play behaviours were those with larger brains rather than smaller ones. Moreover, Heinrich and Smolker (1998) reported that the avian species more likely to play are those with the most developed forebrains. Therefore, it would be appropriate to look for evidence of play behaviour in the species with the largest brain size in each of the taxonomic groups.

Researchers are beginning to search more extensively for play in other species and there has been report of play in an adult captive Nile soft-shelled turtle *(Trionyx tringuis)* (Burghardt et al., 1996). This animal exhibited quite complex object play behaviours when subjected to an enrichment program and it also decreased abnormal behaviour significantly. In addition, Wood and Wood (1999) believe that they have observed play behaviours in a number of octopuses, in response to an enrichment program involving novelty. Thus, it is possible that even reptiles and an advanced invertebrate exhibit behaviours that can be called play.

It has previously been reported that play can incorporate some elements of species-typical behaviour (Dollhinow & Bioshop, 1972; Thompson, 1996). An example of this is the jumping bounce of the Patas monkey. Furthermore, White (1977) reported that the play of individual species could be affected by that species' real-life role. For example the play of carnivores is very often characterized by prey-hunting behaviour, as seen by the stalking and pouncing seen frequently in young cats (Thompson, 1996). Ungulate play is generally thought to consist of flight responses and is characterised by the leaping and gamboling of young lambs (Thompson, 1996). Ungulate survival techniques are thought to be primitive compared to the behaviour of other animals, such as primates, and as a consequence their play behaviour is often considered to be simplified, relative to carnivore and primate play (Aldis, 1975; Byers, 1984). Another element that can affect an animal's play behaviour is whether they are a neophilic or neophobic species. Neophilic species tend to have a more flexible behavioural style and occupy a wide variety of ecological niches, compared to neophobic species, which have more rigid behavioural styles and occupy conservative niches. The play behaviour of neophilic species tends to be more varied and complex than that of neophobic species (Baldwin & Baldwin, 1977; Welker, 1961). Irrespective of what species is being considered, other elements, such as environmental stimuli, can affect play behaviour.

3.2.7 Environmental effects on play behaviour

Play behaviour will only occur when the animal is free of conflicting environmental factors (such as excessive heat, cold or wet) and physiological factors (whether the animal is tired or hungry) (Brownlee, 1984). In addition, young animals and those in captivity tend to play more when others cater for their needs (Aldis, 1975). Baldwin and Baldwin (1976) found that squirrel monkeys (*Simiri sciureus*) decreased their play behaviour when food was presented in a difficult to consume manner. Play decreased even more dramatically when there was a decreased supply of food and when access to the food was restricted. Barret, Dunbar and Dunbar (1992) found that when free-ranging gelada baboons (*Theropithecus gelada*) had an abundance of food, they spent less time foraging and more time playing. These studies showed that the environment can have a profound effect on the animal's daily activities. If a predator is threatening a group then play behaviour is one of the first behaviours to cease (Dolhinow & Bishop, 1972). Generally, play is more frequent in situations that lack pressure, whether physiological, psychological or environmental. Play normally occurs in an atmosphere of familiarity, emotional reassurance and lack of tension or danger (Dolhinow & Bishop, 1972).

3.3 Chapter summary

Two of the most significant effects of novelty are that it increases exploratory and play behaviour. These two behaviours have been shown to be important for the healthy social and physical development of animals. It has also been shown that different species react differently to novel objects and perform different amounts of exploratory and play behaviour. In addition a number of theories have been postulated concerning both exploratory and play behaviour. For exploratory behaviour the Optimal Arousal and Information Primacy theories have received the most support recently. For play behaviour the Practice and Surplus Resource theories have received the most recent support. In addition to this, functions and costs of both exploratory and play behaviour were considered. The differences between species with respect to exploratory and play behaviour were also discussed. It is these species differences and also the qualities of the novelty that are to be discussed in the next chapter.

Chapter 4: Summary of Approach

> *...enrichment strategies can be tailored to benefit all captive animals, regardless of the magnitude of their curious, exploratory, or manipulative propensities.* (Maple & Perkins, 1996, p. 214).

4.1 Past studies into novelty

Past studies on novelty have concentrated on general reactions of animals to novel objects and not what features of the objects themselves elicit the reactions (Burghardt et al., 1996; Glickman & Sroges, 1966; Renner et al., 1992; Russel & Pearce, 1971; Wood & Wood, 1999). It should not be assumed that because an animal does not react to novel objects in one situation that they are not exploratory by nature. A possibility is that the situation was too novel or that the objects were of no biological significance to the animal. Even studies that have looked at the features of objects tend to focus on primates, such as orang-utans (Wilson, 1982) and chimpanzees (Paquette & Prescott, 1988). Sambrook and Buchanan-Smith (1996) emphasized that the individual properties of novel objects have to be taken into account in terms of generating appropriate responses. It has also been found that behaviours used to investigate novel objects can vary according to the individual characteristics of the objects (Renner et al, 1992). Therefore, it is important to consider the qualities of an object and determine the features suitable for each species. The present research aimed to determine which specific features of objects elicit the greatest reactions from different species. In addition, the research tested how the reactions to different objects varied between and within the species. In a series of related studies the animal's reactions to the movability of novel objects, novel odours and novel auditory stimuli were investigated.

4.2 Types of novelty that were investigated

4.2.1 Movability

It has been found that some species react more, by increasing exploratory behaviour and general activity levels, to movable objects rather than non-movable objects. Examples of this are provided by Sambrook and Buchanan-Smith (1996), with Diana monkeys, Hamlyn's owl-faced monkey, deBrazza's monkey and Allen's swamp monkey, Wilson (1982), with orang-utans, Paquette and Prescott (1988), with chimpanzees, Jaenicke and Ehrlich (1982), with the greater galago and slow loris, and Carlstead, Seidensticker and Baldwin (1991) with the American black bear and brown bear. Aldis (1975) has argued that *all* animals prefer movable objects. However, Glickman and Sroges (1966) and Maple and Perkins (1996) have reported that some species were more reactive to novelty than other species. They found that higher primates and carnivores were more reactive to novelty than reptiles and ungulates. As suggested, one reason for this may have been that some of the animals found the situation and the objects too novel. If two objects are identical in all ways except that one is movable and the other is non-movable, then the object that is movable is arguably the more complex of the two (See Section 2.2.1 for a discussion of the novelty and complexity of objects). This is because of the added dimension of the movability associated with the object. It is possible that some animals may require a more complex level of novelty while for others any kind of novel object may be stimulating enough. Researchers have also found that monkeys (Sambrook & Buchanan-Smith, 1996), chimpanzees (Paquette & Prescott, 1988) and orang-utans (Wilson, 1982) spend more time playing with movable objects than with non-movable objects. The current studies investigated how four different species, zebras, Barbary sheep, otters and peccaries, reacted to both movable and non-movable objects.

4.2.2 Olfactory Stimuli

Sense of smell is more biologically significant to some animals than to others, and can be particularly important for animals with poor hearing or eyesight (Ostrower & Brent, 1997). In particular, olfactory stimuli are more important for carnivores than diurnal primates. Odour can influence the selection of food items and can alert an animal to the presence of a predator. As previously stated, Ostrower and Brent (1997) found that chimpanzees spent less time with cloth that was impregnated with odour, but when they were handling the cloth they sniffed it more. Ward, MacDonald and Doncaster (1997) found that hedgehogs avoided feeding in areas tainted with badger (predator species) odour but did not avoid areas with bat and squirrel (non-predator species) odours. Tresz, Ambrose, Halsch and Hearsh (1997) found that when given rhinoceros faeces, lions would roll in it and use it to change their scent, a behaviour that they perform in the wild. The provision of prey faeces to lions has also been found to increase activity and specifically exploratory behaviour (Baker, Campbell & Gilbert, 1997). Interestingly, Baker et al. (1997) reported that the provision of prey faeces was the only enrichment technique to have had any effect on the behaviour of these particular lions. Maple and Roper (1996) found that some odours affected the length of time that chickens avoided food. Schuett and Frase (2001) found that lions spent more time exploring novel stimuli associated with odour rather than a purely visual stimulus. Moreover, Hall (1998) has reported that animals can take longer to habituate to objects if they have a sensory component associated with them. Therefore, odour has been found to affect exploratory behaviour, general activity levels, where animals will feed, and how long it takes for them to feed. The present studies investigated the effects that four different food-related odours had on the behaviour of Barbary sheep, otters and peccaries.

4.2.3 Auditory Stimuli

Auditory stimuli can be important to different species for different reasons. Some species use audition as a way of detecting the presence of predators, while sound may alert other animals to the presence of prey animals. Conover (1994) found that when novel distress calls were played to animals of a predator species, some animals attacked more aggressively. Prey calls have also been played to a captive African leopard as a means of stimulating predatory behaviour (Markowitz, Aday & Gavazzi, 1995). Animals can react to some novel auditory stimuli whereas they show only indifference to others. Hutson et al. (1993) found that pigs reacted to a buzzer by moving to the rear of their stall whereas they showed no reaction to a cap gun.

One emerging idea, among zoological researchers, is that the total isolation for captive animals from selected stimuli, such as predator-associated stimuli, may actually stress the captives (Hayes et al, 1998). In addition, Moodie and Chamove (1990) have reported that brief threatening events can be beneficial for captive animals to help maintain their full repertoire of species-specific behaviours. One way in which this can be achieved is by playing either the alarm calls of conspecifics or predator calls to animals in captivity. The alarm calls of conspecifics were found to increase the amount of fleeing behaviour when played to chipmunks (Weary & Kramer, 1995). Gebo, Chapman, Chapman and Lambert (1994) found that red colobus monkeys showed rapid fleeing movements and increased vertical leaping and bounding when aerial predator sounds were played to them. Animals have also been found to react differently to the type of predator calls that have been played to them. Hanson and Coss (1997) found that Californian ground squirrels reacted differently to avian and terrestrial predator auditory stimuli. When played the avian predator auditory calls, some squirrels would retreat to their burrows while others monitored the situation from an elevated position in response to the mammalian predators. In the current studies the responses of three species, Barbary sheep, peccaries and otters, to avian and mammalian predator auditory stimuli were investigated. The choice of species was very important for the present series of studies. This was because the aim was not only to explore how animals reacted to various types of novelty, but also to investigate species and taxonomic groups that had not previously been studied in this way.

4.3 Choice of species

4.3.1 Species included in the study

It is beneficial at this point to provide a summary of some of the physiological and behavioural characteristics of each of the species that were included in the current series of studies. It is important when designing enrichment programs, for particular species, to thoroughly consider all the available information about those species and how this may influence the enrichment program. In the next section, based on these accounts, it will be explained why these particular species were chosen. Refer to Appendix A for a detailed ethogram for each of the species involved in the present studies.

4.3.1.1 Plains zebra (Equus burchelli)

Zebras are medium-sized herbivores with long heads and slender necks. Each species of zebra is distinguishable from the others by their stripe patterns, ear size and shape and body size. Individual zebras are recognizable from each other by their stripe patterns. Plains zebra herds occur in East Africa, ranging from Kenya to the Cape (MacDonald, 1984). They occupy various habitats including savannah, light woodland, open scrub and grassland. Zebras are entirely vegetarian and their diet includes grass and some browse including bark, leaves, buds, fruits and roots (Nowak, 1999; Timms, 1998). Zebras spend most of the day and night foraging and this can occupy up to 80% of their time (Timms, 1998). In addition to this, zebras can go no longer than three days without water and prefer a daily supply (Haltenorth & Diller, 1980). The plains zebra is generally active throughout the day (Grzimek, 1990; Nowak, 1999). The main predators of zebras are lions, hyaenas, leopards, and cheetahs (Timms, 1998). Their main forms of defence are to remain in the herd, possibly cause confusion with their stripes, attack back if confronted and finally to flee at speeds of up to 65 km per hour. When they flee the lead mare will take the front position and the dominant stallion protects the rear (Haltenorth & Diller, 1980).

Zebras have their best vision during the day but their night vision ranks with dogs and owls (MacDonald, 1984). The zebra's large ears can rotate to locate sounds and they can detect sounds at great distances (Haltenorth & Diller, 1980). Zebras have a moderate sense of smell (Haltenorth & Diller, 1980). At least one member of the herd stays alert to danger at all times, especially at the sleeping area. The plains zebra is the only species of zebra that is not yet endangered. Nonetheless, populations of plains zebra have declined in recent years because of hunting for their skins and competition for habitat with domestic livestock (Nowak, 1999).

In summary, zebras were chosen for the present series of studies because they are herbivorous, belong to the Perssiodactyla or odd-toed ungulates, and they are a prey species. They were also chosen because they have good hearing and vision and a moderate sense of smell. In addition, there has been a lack of research into the effects of novelty on ungulates and what types of novelty stimulate activity in these species.

4.3.1.2 Oriental small-clawed otter (Aonyx cinerea)

Otters are aquatic and terrestrial carnivores and their body is elongated, lithe and built for swimming. The oriental small-clawed otter differs from most other otters in that it only has small claws that do not project past the ends of the pads of their fingers. In addition, they do not have swimming membranes between their fingers, but do have small membranes between their toes. Another distinguishing feature of the oriental small-clawed otter is that their forepaws are very sensitive and they have considerable digital movement (Nowak, 1999). They are found in rivers, creeks, estuaries, coastal waters, and rice paddies from northwestern India to southeastern China and in the Malay Peninsula, southern India, Hainan, Sumatra, Java, Borneo, Riau Archipelago and Palawan (MacDonald, 1984). The diet of the oriental small-clawed otter includes fish, frogs, snails, birds, small mammals, snakes, molluscs, clams, crayfish, crabs, and other crustaceans (Grzimek, 1990; MacDonald, 1984;

Nowak, 1999). Unlike other species of otter, fish do not form the majority of their diet, although they do catch slow moving fish such as eels (Grzimek, 1990; Timms, 1998). Oriental small-clawed otters, unlike most other otters, catch their prey with their hands and use their hands to assist with eating of the prey. Grzimek (1990) has reported that the predators of the oriental-small-clawed otters are not known. Otters have been referred to as "top carnivores" because they are at the top of their food chain.

Otters have small ears but their hearing is still very good. Their sense of smell is acute and forms an important part of communication between them (Chanin, 1985). Oriental small-clawed otters rely on their visual sense and sense of touch to locate prey under water. In bright light otters can see as well underwater as in air but in dim light their vision is poorer in water than in air (Chanin, 1985). Oriental small-clawed otters are active during the day and can have as many as four hunting sessions during the day. These hunting sessions are interspersed with rest periods on land (MacDonald, 1984). All species of otter have been hunted extensively for their fur and the oriental small-clawed otter has suffered because of habitat loss and pollution (Timms, 1998). They have been designated as near threatened by the International Union for the Conservation of Nature and Natural Resources (IUCN) and are on listed on Appendix II by CITES (Nowak, 1999).

The oriental small-clawed otter was chosen for this series of studies because they are carnivorous, belong to the taxonomic group the Carnivores, and are a predatory species. They were also chosen because they have good hearing and vision and an acute sense of smell. It was thought that these features might affect the type of reactions that the animals had to the novelty that was presented to them.

4.3.1.3 Collared peccary (Tayassu tajacu).

The collared peccary is similar to pigs in body shape and the presence of a distinctive snout, but they have long, slim legs and small hooves (Nowak, 1999). They are found in a variety of habitats including rainforest, arid woodland and desert scrub in South America, Central America and South-western North America (Nowak, 1999). The collared peccary is an omnivorous species and they feed on cactus fruit, berries, tubers, bulbs, rhizomes, roots, seeds, fruit, grubs and other insects, small reptiles and snakes and other small vertebrates (Nowak, 1999; MacDonald, 1984; Grzimek, 1990; Corn & Warren, 1985). They have also been seen eating bird and turtle eggs, fungi, nuts, carrion, leaves, frogs and fish (Grzimek, 1990). Collared peccaries have different activity cycles according to the season. In winter they forage during the daytime to make use of the heat and also have to spend more time foraging because their metabolism increases. During the hot summer peccaries forage in the early morning and late evening, and rest for up to 10 hours during the day in the shade (Grzimek, 1990).

The main predators of collared peccaries are dogs, coyotes, bobcats, jaguars, and mountain lions (MacDonald, 1984; Nowak, 1999). Predators are only successful if they prey on a young animal or on an animal that has been separated from the rest of the group. The collared peccaries' speed, agility and group defence render them more than a match for most predators (Nowak, 1999). When confronted by a predator, the group will either scatter or one animal will confront the predator, even though this can be fatal for that animal. Males usually take turns to stand guard at the resting site (MacDonald, 1984). Peccaries have poor eyesight, but an exceptional sense of smell and good hearing (Byers & Bekoff, 1981; Sowls, 1984; Grzimek, 1990). Their sense of smell is keen enough for them to locate small covena bulbs up to eight centimetres underground, before the new shoots are visible (Nowak & Paradiso, 1983). Peccaries have a scent gland on their rump in front of their tail and when excited it emits a musky secretion that can be detected many meters away (Nowak & Paradiso, 1983). Collared peccaries have been hunted extensively for their skins and much of their habitat has also been destroyed to make way for crops and pastures. This has led to a decline in collared peccary numbers and also the fragmentation of their populations (Nowak, 1999). Except for the populations in Mexico and the United States the collared peccary is listed on Appendix II by CITES (Nowak, 1999).

Collared peccaries were chosen for the current series of studies because they are omnivorous, belong to the Artiodactyla or even-toed ungulates and because they are both a predatory and prey species. In addition, they have poor eyesight, good hearing and an exceptional sense of smell. They were also chosen because, as an ungulate, they have not been the focus of studies into the effects of novelty.

4.3.1.4 Barbary sheep (Ammotragus lervia)

The external appearance of the Barbary sheep is closer to goats, but biochemically they are closer to sheep (MacDonald, 1984). Barbary sheep inhabit the rocky mountain ranges and highlands within desert to sub-desert regions of North Africa (Haltenorth & Diller, 1980; Nowak, 1999). Like many of the species that reside in hot regions, the Barbary sheep feed mainly in the early morning and late evening and rest in the shade of overhanging rocks during the heat of the day (Haltenorth & Diller, 1980). Barbary sheep forage primarily on grass, herbage, and the foliage of bushes and trees. They can exist for a substantial time without water and they get what fluids they need from vegetation and the dew that forms on the plants during the cold desert nights. The main predators of the Barbary sheep are the leopard, caracal and lion (Grzimek, 1990; Haltenorth & Diller, 1980). Barbary sheep inhabit areas where the vegetation is not tall enough for them to hide so they have developed the mechanism of hiding from predators by remaining motionless whenever they are threatened (Nowak, 1999). Barbary sheep are extremely sure-footed in their rocky habitat and have been known to jump a two-meter high fence in captivity from a standing start (Grzimek, 1990).

The Barbary sheep's visual and auditory senses are reported as being very good and their olfactory sense as good (Haltenorth & Diller, 1980). Barbary sheep have been hunted by the native people of the Sahara for their meat, hide, hair, and sinew and it has only been since the introduction of modern weapons that they have become endangered (Nowak, 1999). Formerly widespread in the Sahara, they are now extinct over much of their former range and are declining rapidly in other parts. The populations of Barbary sheep still number in the thousands but these animals are spread across a large area. The Barbary sheep is classified as vulnerable by the IUCN and is on Appendix II of CITES (Nowak, 1999).

Barbary sheep were chosen for the present series of studies because they are herbivorous, belong to the Artiodactyla or even-toed ungulates, and they are a prey species. They were also chosen because they have a good sense of smell and very good visual and auditory senses. As with the peccaries and zebras, Barbary sheep have not been studied in relation to how they respond to different types of novelty.

4.3.2 Reasons for the choice of species

The species included in the current series of studies were chosen primarily because they had not been studied with reference to these types of novel stimuli previously. The ungulates were chosen as a focus because there has been a lack of studies involving novel stimuli for these species. In addition to this the species were chosen because they allowed comparisons to be made between a range of different diet styles, sensory capabilities, taxonomic classifications and predator and prey species. The choice of species allowed comparisons to be made between:

- Two even-toed ungulates (peccaries and Barbary sheep), an odd-toed ungulate (zebra), and a carnivore (otters).
- Two grazing herbivorous species (Barbary sheep and zebras), an omnivorous species and a carnivorous species.
- Two purely prey species (Barbary sheep and zebras), a predator species (otters), and a species that is both predator and prey (peccaries).
- Species with different sensory capabilities, particularly with reference to olfaction (peccaries and otters both have a more refined olfactory sense than Barbary sheep and zebras) and audition (otters, Barbary sheep and zebras have a better auditory sense than peccaries).

As discussed in Chapter 2, it has been suggested that taxonomic classification (Glickman & Sroges, 1966; Maple & Perkins, 1996) and the ecological niche that a species occupies (Glickman & Sroges, 1966; Mench, 1998) can affect how that species responds to novelty. The species were selected to include species from a variety of ecological niches and taxonomic classifications and thus allow comparisons to be made between them.

4.4 Chapter summary

This chapter has focussed on reasons for the selection of the types of novelty and species used in these studies. The fact that past studies have tended to focus on how novelty affects the animal and not what features of the novelty have the most impact were considered. This, combined with the fact that these types of novelty have been ignored, led to three types of novelty being chosen, including movability of novel objects, olfactory stimuli, and auditory stimuli.

Movability was chosen because studies in the past have found that a number of species have reacted more to movable stimuli than non-movable stimuli. However, none of these studies have included ungulates or otters, and many of them have concentrated on primates. The olfactory stimuli were chosen because, although a number of studies have examined the effects of providing predator species with the faeces of prey species, none has studied the effects of giving novel food odours to animals. Finally, the predator auditory stimuli were chosen because a number of studies have shown that the reverse can be beneficial; that is, predator species can benefit from being played prey sounds. In addition, it is now thought that it is important to provide prey species with access to predatory stimulation. A number of studies have done this but have only included primates and squirrels and have not looked at ungulates.

Reasons were also given in this chapter as to why these particular species were chosen. Reasons included the same as for the choice of novelty; that is that these species have not been studied previously in this manner. In addition to this, the species were selected to allow comparisons to be made between various taxonomic groups and species with different feeding styles, sensory capabilities and to include predatory and prey species. The choice of species was also limited to those that were available at the Adelaide Zoo at the time. Working in an environment such as a zoo can also have effects on other methodological aspects of research and these will be discussed in the next chapter.

Chapter 5: Methodological Issues

5.1 Summary of research

The experimental component of this thesis consisted of three studies:

1. Comparison between novel movable and non-movable objects
2. Comparison of different novel olfactory stimuli
3. Comparison of different novel auditory stimuli

The subjects were selected to allow a comparison to be made between a climbing herbivorous ungulate (Barbary sheep), a plains dwelling ungulate (zebra[2]), an omnivorous ungulate (collared peccary), and a carnivorous species (oriental small-clawed otter). In addition to this, they were selected to allow comparisons to be made between predator and prey species. These species have not been studied in respect to these types of novelty previously.

5.2 Research in a zoo setting

Many factors influence the results that are obtained when performing research. Different factors influence the results in a laboratory situation as compared to a zoo setting. In a zoo setting, the researcher has less control than in the more traditional laboratory setting. In the strictly controlled laboratory experiment, it is possible to dictate subject numbers. In addition, the researcher has control over other factors such as temperature, people who enter the laboratory and the food the animals are given. However, in the relatively uncontrolled zoo environment there is a notable lack of control over many factors such as subject numbers, the weather, number of zoo visitors and also variation in keeper's rosters. In addition, there may also be variation in the amount, type and time that food is given, and changes may be made to exhibits at any time. The needs of the zoo must also be taken into account. For example anything put in the cages must look natural and be safe for the animals. It is important that any research that will ultimately be used to benefit animals in a zoo setting be performed using animals in a zoo environment. Validity in a zoo study is

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[2] Unfortunately, it was only possible to study the zebras for the movability study as the male died before the rest of the studies could be started and the zoo had not replaced him at the time of the studies.

also not achieved in the same way as in the laboratory so different statistics must be used. This will be discussed further in section 5.4.

5.3 Experimental design considerations

5.3.1 Equipment

One of the major considerations when planning a study in a zoo environment is that anything put in the animal's enclosure will be on show to the public. Consequently, a primary consideration must be the aesthetic appeal of the apparatus. There is a need to keep the additions looking as natural as possible, and to hide anything that can be hidden. This must be done so that they do not detract from the exhibit itself and create an "eyesore" to the public. The zoos rely on the public for a large portion of their income and it is necessary to keep them interested in the zoos so that they will return.

A further requirement of the apparatus is that the equipment must be safe for the animals. This is especially difficult because animals are prone to biting, chewing, and scratching anything within reach. A consequence of this is that any novel object placed in an animal's enclosure could be potentially fatal for the animal. It is essential that as much equipment as possible be installed outside of the animal's reach. Everything that the animals do have access to, such as a novel object, must be "animal proofed" so it does not have any loose wires or anything else that could cause injury. Equipment must also be installed so it does not aid in the escape of animals from their enclosure. The enclosure itself will also limit what can be built and installed in the enclosure. Factors influencing this will be the size and shape of the enclosure and the textures in the enclosure as well as any other materials that are already present. The design of equipment will also be limited by human technology and ingenuity so that it withstands the strength, size and destructive capabilities of the animals.

5.3.2 Reconnaissance Observations

Other important factors when designing a study in a zoo environment are reconnaissance or preliminary observations. Reconnaissance observations are important to enable the observer to become familiar with all the animals so they are easily recognisable at a glance. This period of time also allows the animals to become accustomed to the observer so as to reduce observer effects. Reconnaissance observations also help the researcher to determine what behaviours to record and to become familiar with these behaviours. This information is then essential in designing and refining the check sheets and determining the sampling method and interval to be used. It is also important to keep a track of any biological cycles, such as the oestrus cycle, or anything else that may affect an animal's behaviour. In the current research, if data were collected on days when there were extreme disruptions to the animal's routine or if any disrupting activities were occurring in the vicinity of the enclosure then these days were disregarded. These collection sessions were then rescheduled and the data collected at another time when the disruption was not present.

5.3.3 Experimental design

Another factor that must be considered is the actual experimental design. As has been mentioned, it is not possible in a zoo situation to achieve the standard large group design where there are high subject numbers and comparison groups are matched (Saudargas & Drummer, 1996). In the zoo situation, where subject numbers are low and comparison groups are rarely matched (if they exist), it is necessary to employ various techniques to achieve an acceptable level of validity. Saudargas and Drummer (1996) have suggested that the best way to achieve this is by utilising the repeated measures design. They suggest that the most appropriate repeated measure design is that of ABAB. This is where A is the baseline, B is the experimental condition and A is the reinstatement of the baseline conditions. Research that is carried out in a zoo setting is often restricted by time constraints because the research must be carried out when the animals are available and they are not breeding or maintenance is not being carried out on their enclosure. This means that there is often not enough time to carry out the ABAB repeated measures design. The current design is based around the withdrawal method in the ABA model with some variations where necessary. This should result in an increase in internal validity by reducing the effects of history, maturation, exhibit design, age and sex.

5.3.4 Data collection

Data collection methods were devised using the reconnaissance observations as a guide. Data were collected over four to six weeks (for each species involved in the individual studies), and involved recording a number of behaviours for each species.

The instantaneous scan sampling method was thought to be the most appropriate because it can provide an estimate of the percentage of time animals spend in particular activities (Altmann, 1974; Crockett, 1996). This is where the animals are scanned at pre-set time intervals, in this case one-minute intervals, and the behavioural state of the animal at that time is recorded onto a check sheet. The check sheets for each of the studies are available in Appendix B. To avoid bias the animals were observed in the same order each time. This ensured that the correct amount of time had elapsed before they were observed again, to avoid bias.

5.4 Data analyses and dealing with low subject numbers

As noted previously, in a zoo study subject numbers are low and the usual statistics employed with traditional laboratory experiments are not appropriate. In a repeated measures design, such as the one in these studies, parametric statistics are traditionally used to test for significance. The most appropriate of these are the multivariate analysis of variance (MANOVA) and related samples t-test. However, these standard parametric methods of data analysis are not appropriate in zoo studies for two reasons. First, parametric tests require a larger sample size than is available in many zoo studies. Second, the data may violate the homogeneity of variance assumption, because of its erratic nature, a factor that could not be controlled for.

In zoo studies, non-parametric tests are more appropriate than parametric versions. This is because they are more robust and do not require as many assumptions about the population from which they are drawn. The Friedman test and Wilcoxon matched-pairs signed ranks test are the most suitable of the non-parametric tests for the present data. Problems with using these tests include the fact that they are less powerful then their parametric equivalents. Thus, there is also an increase in the risk of committing a *Type II error*, due to reduction in the power of the tests, because of the low subject numbers. The Wilcoxon test can show statistical significance where there is a minimum of five subjects and the Friedman test where there is a minimum of three subjects. The subject numbers in the current studies ranged between 2 and 9 animals. Even though these tests could be used for some of the species, it would be inappropriate to use them for some and not others.

As a result of the problems with statistical analysis mentioned above, the primary method of data analysis will be visual inspection. Visual inspection is the method favoured by the *Journal of the Experimental Analysis of Behaviour (JEAB)*. In addition, visual inspection has been used by Mills (1998) and Kardos (1999) for analysing the results of recent studies conducted in zoos. For all the conditions, the small subject number will allow individual and group results to be analysed to test whether behaviours vary across the conditions. In a setting such as the zoo the size of the effect is more important than its statistical significance, in terms of whether keepers and curators decide to carry on the enrichment on a more permanent basis (Kardos, 1999).

5.5 Magnitude of Effects

The definitions of the magnitude of changes to behaviour levels will follow the format of Kardos (1999). These are as set out below:

Small changes or effects are: 0.01% to 7.5%
Moderate changes or effects are: 7.51% to 15.0%
Large changes or effects are: 15.01% and higher.

5.6 Intra- and Inter-observer Reliability.

Lehner (1979) recommends that data be subjected to a reliability assessment to assess the accuracy and consistency of the observations made. A 40-minute videotape was made, consisting of 10 minutes of footage from each species. This footage included the range of behaviours that the animals exhibited. Two untrained observers were recruited and the behavioural categories were explained to them. They were both given a list of these categories to facilitate accurate scoring of the footage. The observers were not asked to record individual animals since this took the experimenter some time to be able to achieve accurately. To assess intra-observer reliability the experimenter scored the same video footage on two separate occasions. The observers were asked to record the behavioural state of the animals at one-minute intervals, indicated by the beeping of a stopwatch.

Kappa scores were then calculated. These scores take into account the agreement between the observers and also the agreement due to chance (Lehner, 1979). The Kappa and uncorrected scores are shown in Table 5.1.

Table 5.1 The Kappa scores for the two independent observers and the experimenter. The uncorrected scores are shown in brackets.

	Agreement	**Total identifications**
Observer 1	92 % (93%)	40
Observer 2	91% (93%)	40
Experimenter	96% (98%)	40

The high percentage of agreement for the experimenter's observations meant that there was consistency for these across the three studies (i.e. high intra-observer reliability). The agreement between the untrained observers and the experimenter was slightly lower but still high considering the untrained observers had no previous experience in scoring behaviour. This indicates that there was good inter-observer reliability across the three studies and that the data were reliable.

Chapter 6: The effects of movable versus non-movable novel objects on animals in captivity.

6.1 Introduction

This chapter is concerned primarily with the experimental results obtained by providing four different species with two different types of novel objects, one movable and the other non-movable. As previously addressed, one of the main differences between captivity and the wild is the lack of variability or novelty associated with the captive situation. This lack of variability can affect animals by decreasing their level of stimulation and increasing stereotypical behaviour and inactivity. It would benefit both the animals and zoo visitors to provide all species with novelty and decrease stereotypical behaviours by increasing activity levels.

Many studies on the effects of novelty have concentrated primarily on primates and carnivores, possibly because they have been found to be more reactive to novelty than species such as ungulates (Fragaszy et al., 1997; Glick-Bauer, 1997; Hall, 1998; Mellen, 1998; Paquette & Prescott, 1988; Sambrook & Buchanan-Smith, 1996; Wilson, 1982). In addition, it has been suggested that carnivores and primates require a higher level of stimulation in captivity than species such as ungulates (Maple & Perkins, 1996). However, novelty may also benefit other species and the effects on these species should be studied fully to understand how novelty affects all animals in captivity. Barbary sheep, zebras, peccaries and otters have been included in the present series of studies to allow comparisons to be made between various species and taxonomic groups.

6.1.1 Hypotheses and rationale

Hypothesis One: *It was predicted that all the animals would display higher levels of exploratory behaviour with the movable object than with the non-movable object.*

Wilson (1982) found that the presence of movable objects influenced the activity levels of orang-utans, more than did the non-movable objects. In fact the presence of movable objects were found to stimulate activity levels more than enclosure size. Monkeys (Sambrook and Buchanan-Smith, 1996), the greater galago and the slow loris (Jaenicke & Ehrlich, 1982), chimpanzees (Paquette and Prescott,

1988) and the American black bear and brown bear (Carlstead, Sediensticker & Baldwin, 1991) have all also been found to be more reactive to movable objects than non-movable objects.

It was predicted that all four species would explore the movable objects more than the non-movable object because the movable object was defined as the more complex of the two; i.e. the movable object had more information for the animal to assimilate because of the added dimension of movability. In addition, Thompson (1996) has suggested that one of the most important elements of novelty is that it stimulates multiple senses. In these studies, it was probable that the movable object stimulated more senses than the non-movable object because it was reactive.

Hypothesis Two: *It was predicted that all the animals would display higher levels of play behaviour with the movable object than with the non-movable object.*

It has been found that monkeys (Sambrook & Buchanan-Smith, 1996), chimpanzees (Paquette & Prescott, 1988), and orang-utans (Wilson, 1982) spend more time playing with objects that are reactive or movable, rather than non-movable objects. Other species including ferrets (Russell, 1990), domestic cats (Hall, 1995), and Northern elephant seals (Rasa, 1971) all revealed preferences for playing with objects that incorporated characteristics of prey species. One of these characteristics was that of movability of the stimulus and therefore these species played more with movable objects than with non-movable objects. These results suggest that animals prefer to play with objects that are reactive and therefore it was expected in the current studies that all four species would play more with the movable objects than with the non-movable objects.

Hypothesis Three: *It was predicted that the introduction of novel objects into the animal's enclosure would increase the overall levels of exploratory behaviour.*

Hypothesis one predicted that different types of novelty would stimulate different amounts of exploratory behaviour in each of the four species included in the current studies. In addition, it is also suggested that both types of novelty, the movable and non-movable objects, will stimulate exploratory behaviour in each of the four species. As discussed, exploratory behaviour occurs when an animal is exposed to moderate levels of uncertainty. The animal explores to reduce the anxiety through the acquisition of information about the novel aspect of the environment (Weisler & McCall, 1976). It has been found that pigs (Wood-Gush & Vestergaard, 1991), tamarins (Glick-Bauer, 1997), the greater bushbaby (Renner et al., 1992), orang-utans (Wilson, 1982), chimpanzees (Paquette & Prescott, 1988), birds (Sandos, 1999) and many other species perform more exploratory behaviour when confronted with novelty. When exposed to each type of novelty it was expected that the animals would be confronted with uncertainty and therefore explore the source of the uncertainty to reduce their anxiety.

Hypothesis Four: *It was predicted that overall levels of play behaviour would increase with the introduction of the novel objects.*

Hypothesis two predicted that the two different types of novelty would stimulate different amounts of exploratory behaviour in each of the species. As mentioned, moderate levels of novelty can stimulate fear in animals and as a consequence elicit *first* exploratory *then* play behaviour (Aldis, 1975). Once the fear associated with novelty has been reduced through exploratory behaviour there will be an increase in play behaviour. The play behaviour may not be with the novel object but rather amongst the animals themselves (Loizos, 1966). Therefore it was expected that both types of novelty would stimulate an increase in play behaviour that does not necessarily incorporate the objects. In addition, when confronted with novelty, species such as pigs (Wood-Gush & Vestergaard, 1991), ravens (Heinrich & Smolker, 1998), a Nile soft-shelled turtle (Burghardt et al., 1996) and even an octopus (Wood & Wood, 1999) have been observed to perform increased amounts of play behaviour. As with all the species mentioned above, it was expected that the Barbary sheep, peccaries, otters and zebras would perform more play behaviour when exposed to the novel objects.

Hypothesis Five: *It was predicted that the level of stereotypical behaviour would decrease with the introduction of the novel objects.*

The captive environment can provide animals with too little stimulation and therefore lead to an increase in stereotypical behaviours (Mason, 1991). The provision of novel objects has been shown to reduce the amount of stereotypical behaviours that certain animals exhibit by increasing activity and stimulation levels (Glick-Bauer, 1997; Mellen, 1998; Paquette & Prescott, 1988; Renner et al, 1992; Wilson, 1982). The increase in exploratory and play behaviour that is associated with novelty can also contribute to a decrease in stereotypical behaviour by engaging the animals in functional behaviours. It was expected that the novelty would engage the animals in activity and therefore reduce the levels of stereotypical behaviours.

Hypothesis Six: *It was predicted that the peccaries and otters would explore the objects more than the Barbary sheep and zebras.*

Glickman and Sroges (1966), Russell and Pierce (1971) and more recently Maple and Perkins (1996) have all found that some animals show a tendency to be more exploratory than others. They suggest that omnivores and carnivores are more likely to be exploratory than herbivores. As discussed, this is a result of how much exploration the species performs when hunting or foraging and how high the threat of predation is for the species. The peccary is an omnivorous species, the otter a carnivorous species and the Barbary sheep and zebra are both prey species. It was expected that, regardless of the type of novelty, the otters and peccaries would perform more exploratory behaviour than the Barbary sheep or zebras.

Hypothesis Seven: *It was predicted that the peccaries and otters would play with the novel objects more than the Barbary sheep and zebras.*

As was discussed earlier all species from all taxa and of all ages are thought to play (Hall, 1998). However, in the past, it has been suggested that species such as ungulates do not play at all. It is now thought that they do play, but less and with less complexity than carnivores, primates and omnivores (Maple & Perkins, 1996). Carnivores and omnivores have a long period of immaturity during which they are dependant on their parents. It has been suggested that during this period they develop complex play routines that regularly incorporate objects. Iwaniuk, Nelson, and Pellis (2001) found that larger brained species played more than smaller brained species. In this study, the larger brained species were the peccaries and otters and were therefore expected to play more with the novel objects. The two ungulate species, the Barbary sheep and zebras were expected to spend less time playing with the objects than the carnivorous otters and the omnivorous peccaries.

Hypothesis Eight: *It was predicted that the peccaries and otters would habituate to the novel objects faster than the Barbary sheep and zebras.*

As discussed, different species take different amounts of time to habituate to novel stimuli (Xavier, Saito & Stein, 1991). Neophobic species, such as prey animals, will tend to take longer to habituate to novel objects than a neophilic species such as an omnivore or carnivore. This is expected because animals such as ungulates have to avoid some novelty in order to survive in the wild whereas animals such as carnivores and opportunistic species have to seek out novelty in order to survive (Baldwin & Baldwin, 1977). It was expected that the two prey species, the Barbary sheep and the zebras would take longer to habituate to the novel stimuli than the opportunistic species, the peccary and the carnivorous species, the otter.

6.2 Methodology and Data Collection

6.2.1 Subjects

Subjects were nine Barbary sheep (*Ammotragus lervia*), two Chapman's zebras (sub-species of plains zebra, *Equus burchelli chapmani*), two oriental small-clawed otters (*Aonyx cinerea*) and eight collared peccaries (*Tayassu tajacu*). The taxonomic details for the Barbary sheep group are shown in Table 6.1. The coloured tags attached to the Barbary sheep's ears were originally used to distinguish them from each other. After a short period of time the researcher could recognize the animals by distinguishing features, such as size and colour (See Figure 6.1). The researcher still had to rely on the coloured tags for the juvenile twins, as they were otherwise indistinguishable from each other.

The age groups used by Gray and Simpson (1980) and Nowak (1999) were adopted for the current studies. Juvenile Barbary sheep were defined as animals under 8 months of age and sub-adult animals were those between 8 months and 1.5 years of age. Any animal over 1.5 years was considered to be sexually mature and therefore an adult.

Table 6.1 – Taxonomic details for the Barbary sheep group.

Name	Sex	Age (as at 26/10/98)	Birth Date	Born	Origin	Arrived Adelaide
Yellow1	Male	3y 1m 3d	23/9/95	Captive	Adelaide	-
White1	Female	4y 1m 23d	3/9/94	Captive	Adelaide	-
Green	Female	9y 0m 2d	24/10/89	Captive	Monarto	10/11/93
Orange	Female	4y 1m 2d	5/9/94	Captive	Adelaide	-
Brown	Male	10m 21d	5/12/97	Captive	Adelaide	-
Pink	Female	1y 1m 1d	25/9/97	Captive	Adelaide	-
Blue	Male	4m 3d	23/6/98	Captive	Adelaide	-
Black	Unknown	1m 2d	24/9/98	Captive	Adelaide	-
Yellow2	Unknown	1m 2d	24/9/98	Captive	Adelaide	-

The zebra group consisted of a pair of animals, one adult female and one adult male. The female was easily recognised from the male because she was visibly pregnant and her coat was also a lighter shade of brown than the male (See Figures 6.2 and 6.3). The taxonomic details for the two zebras are shown in Table 6.2. The zebras were both considered adults because they had both produced young.

Figure 6.1 – The Barbary sheep group. The adult male is at the top of the mountain, and the rest of the animals spread on the levels below.

Figure 6.2 – The male zebra.

Figure 6.3 – The female zebra.

Table 6.2 – Taxonomic details for the zebras.

Name	**Sex**	**Age (as at 26/10/98)**	**Birth Date**	**Born**	**Origin**	**Arrived Adelaide**
Fleta	Male	24y 8m 2d	24/2/74	Captive	Ravensden	3/4/80
Hatari	Female	18 y 7m 2d	1/3/80	Captive	Marwell	16/6/81

The otter pair included one adult male and one adult female. They were easily distinguished from each other because the male otter was larger and had a fatter tail than the female (See Figure 6.4). The taxonomic details for the otter pair are included in Table 6.3. Both the otters were considered to be adults because they had both produced young.

Table 6.3 – Taxonomic details for the otter group

Name	**Sex**	**Age (as at 19/7/99)**	**Birth Date**	**Born**	**Origin**	**Arrived Adelaide**
Female	Female	6y 0m 19d	30/6/93	Captive	Surabaya	10/3/94
Male	Male	3y 4m 18d	1/3/96	Captive	Adelaide	-

The peccary group included four adult females, one adult male and three neutered adult males. The taxonomic details for the peccary group are shown in Table

5.4. Initially the researcher relied on coloured tags on the ears of the peccaries to identify them. After a short time the researcher was able to identify each individual by the various differences in colour, size and positioning of their collar (See Figures 6.5 and 6.6). The age groups suggested by MacDonald (1984) have been adopted in the present study. Females were considered to be adults between 33 and 34 weeks of age and males between 46 and 67 weeks of age.

Table 6.4 – Taxonomic details for the collared peccary group.

Name*	**Sex**	**Age (as at 19/7/99)**	**Birth Date**	**Born**	**Origin**	**Arrived Adelaide**
Blue(R)	Female	9y 4m 9d	10/3/90	Captive	Adelaide	-
White(R)	Male	8y 1m 7d	12/10/90	Captive	Edinburgh	11/7/90
Red(R)	Female	6y 6m 9d	10/1/93	Captive	Adelaide	-
Red(L)	Male (Neut)	4y 2m 11d	8/5/95	Captive	Adelaide	-
White(L)	Male (Neut)	4y 2m 11d	8/5/95	Captive	Adelaide	-
Green(L)	Male (Neut)	3y 8m 14d	5/11/95	Captive	Adelaide	-
Orange(R)	Female	3y 8m 14d	5/11/95	Captive	Adelaide	-
Yellow(R)	Female	3y 2m 19d	30/4/96	Captive	Adelaide	-

*The letter in the bracket refers to the ear that the coloured tag was placed on, that is the right or the left.

Figure 6.4 - The two otters with the male at the back left and the female at the front on the right.

Figure 6.5 – Six of the peccaries, starting from the left Orange (R), Green (L), Red (L), White (R), White (L), and Blue (R).

Figure 6.6 – The peccary at the front is Red (L) and the one in the middle is Yellow (R).

6.2.2 Diet

The Barbary sheep were fed pellets each night when they were locked in their sleeping quarters. During the day they were given a variety of leaves and branches to browse on. In addition to this they browsed on the edible material in their enclosure such as grass and the leaves off the trees.

The zebras were fed on a diet of hay and a variety of other browse materials. They too grazed on the grass and other plants in their enclosure.

The otters were fed three times a day on a diet of fish, shellfish, crabs and other seafood. They were fed in their enclosure and the meals were given to them whole so it took quite some time for them to be consumed.

The peccaries were fed pellets in the evening when they were locked in their sleeping quarters. During the day they were given a variety of leaves, branches and assorted fruit. In addition, they often browsed on the edible materials in their enclosure (whenever a fig fell from the tree in their enclosure the peccaries would run from all corners of their enclosure to be the first to find and eat it).

6.2.3 Enclosure

The Barbary sheep were housed in an outside enclosure. The most prominent feature of the enclosure was a stone mountain in the centre. This mountain was hollow allowing the animals some protection from the elements. There was also some grass in the area, a few trees, scattered logs and dirt. A small pond filled with water was also in the enclosure. The animals could be viewed from two sides of the enclosure, along the front and to the left hand side. The dirt had been dug out around the edge of the enclosure to form a dry moat so the animals could not leap over the fence. The animals' sleeping quarters were located at the back of the enclosure. See Figure 6.7 for a detailed diagram of the Barbary sheep enclosure.

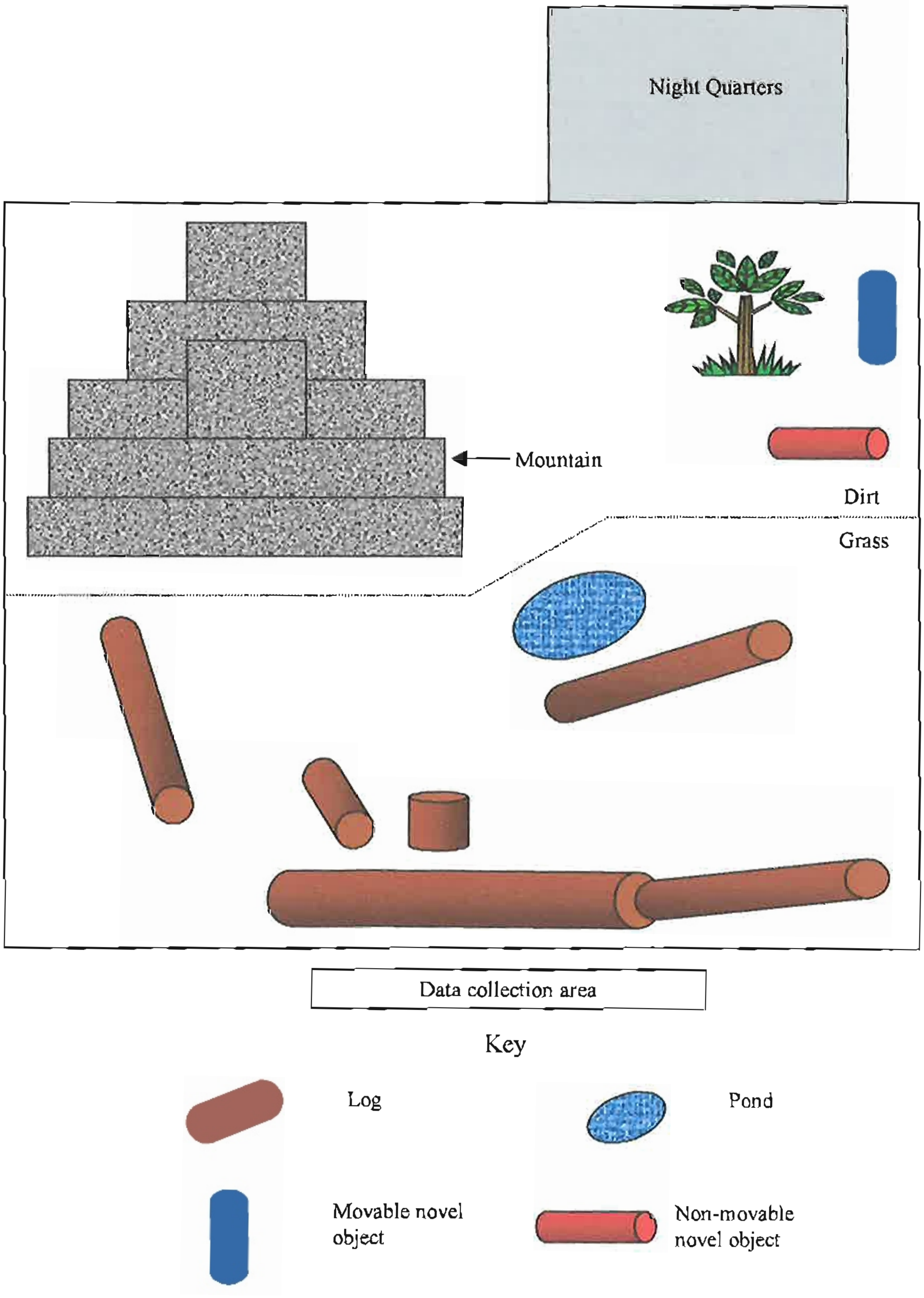

Figure 6.7 – Diagrammatic representation of the Barbary sheep enclosure showing the location of the novel objects (not drawn to scale).

The zebra enclosure was fairly large allowing the animals room to move and run. There were a large number of shrubs and trees in the enclosure that provided plenty of shade for the animals. There was also a substantial amount of grass providing the zebras with the opportunity to graze. The animals could be viewed along the front of the enclosure and to the right hand side. The zebras sleeping quarters were at the back of the enclosure. See Figure 6.8 for a detailed diagram of the zebra enclosure.

The central feature in the otter's enclosure was a small river starting at a pond at the rear of the enclosure and ending in another pond near the front of the enclosure. There were many small pebbles in the pond at the front of the enclosure. There was also a large amount of dirt, many small shrubs and a couple of palms planted in the enclosure. In addition, there were also some larger logs and a small den located towards the rear of the enclosure near the large pond. The otters' sleeping quarters were located to the right hand side of the enclosure and the animals could be viewed from the front of the enclosure. See Figure 6.9 for a detailed diagram of the otter enclosure.

A predominant feature in the peccary enclosure was the base of a large fig tree located towards the rear left hand corner of the enclosure. Next to this, on both sides, was a large pile of branches and leaves that the animals used as sleeping quarters during the day. There were also a number of palms planted in the enclosure and a small drinking trough was located in the middle. The peccaries spent a large amount of their time rooting for food through the dirt that was almost always muddy. The peccaries sleeping quarters were located to the rear left of their enclosure. At the front of the enclosure was a dry moat that prevented the animals from escaping and also from people touching the animals. See Figure 6.10 for a detailed diagram of the peccary enclosure.

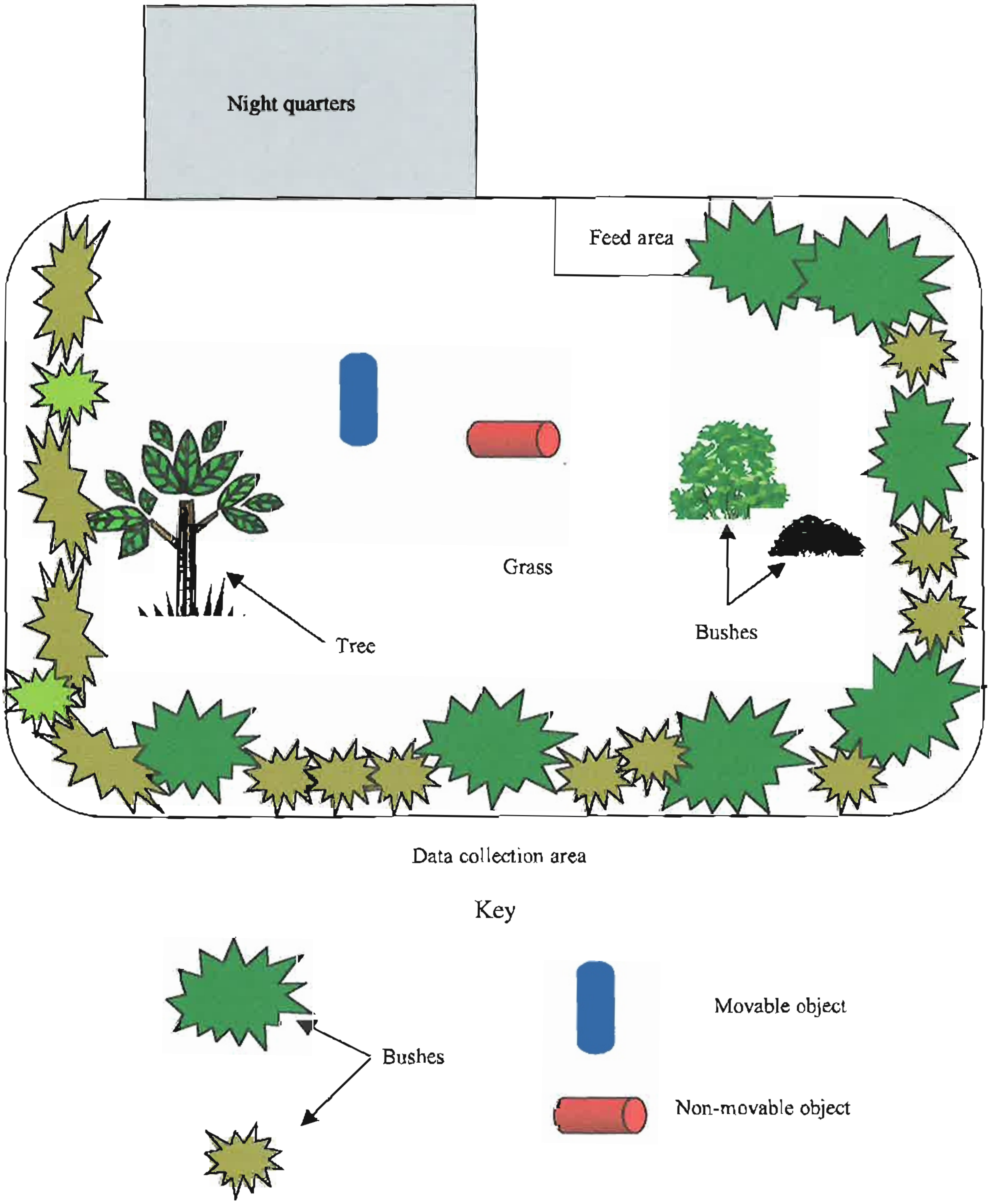

Figure 6.8 – Diagrammatic representation of the zebra enclosure showing the location of the novel objects (not drawn to scale).

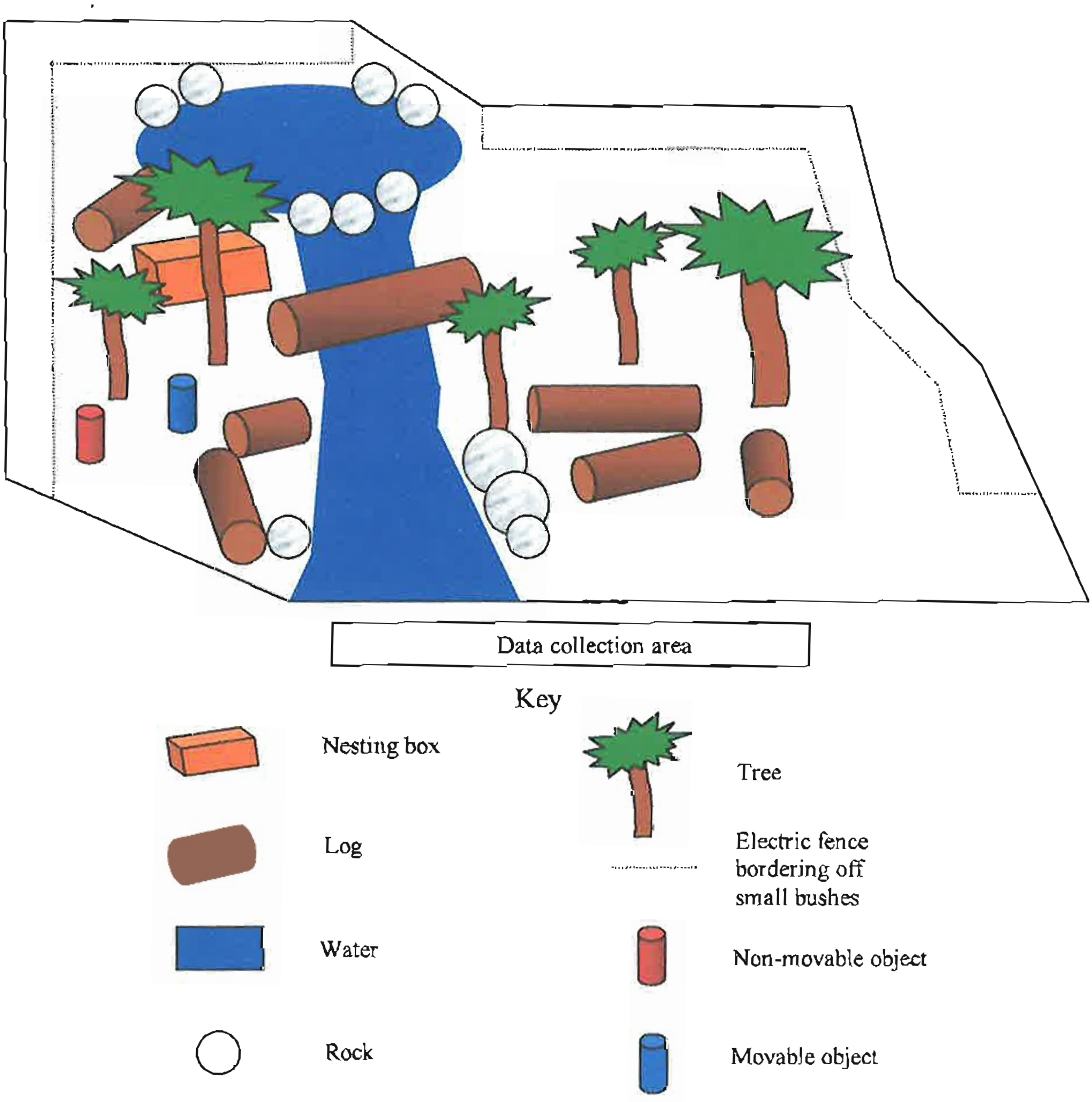

Figure 6.9 – Diagrammatic representation of the otter enclosure showing the location of the novel objects (not drawn to scale).

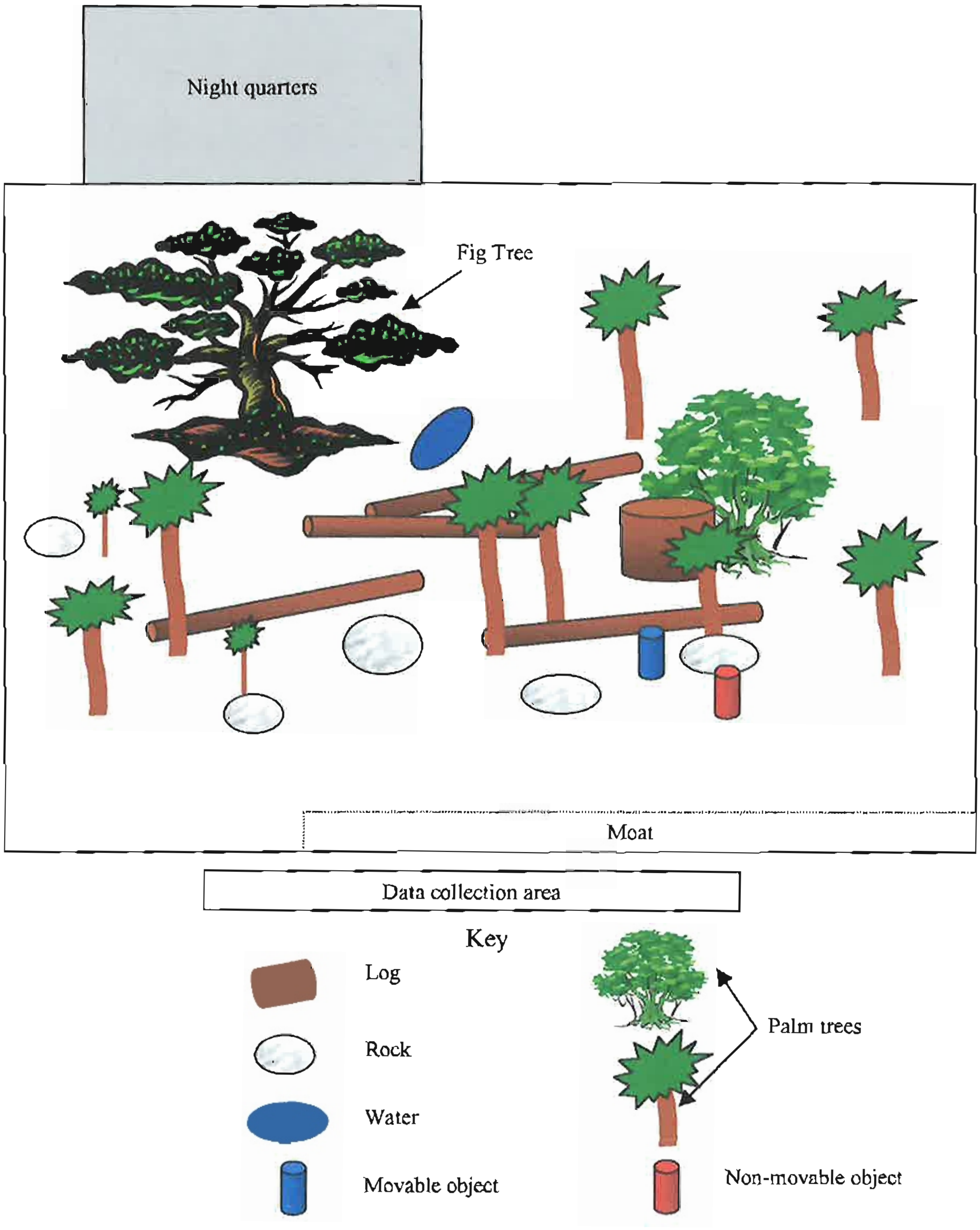

Figure 6.10 – Diagrammatic representation of the peccary enclosure showing the placement of the novel objects (not drawn to scale).

6.2.4 Apparatus and Equipment

Two sets of novel objects were used; one set of objects was used for the Barbary sheep and the zebras and one set was used for the otters and peccaries. This was necessary because of the large size differences in the animals and also in the destructive capabilities of the animals. It was possible that the otters and peccaries would be capable of destroying the objects used for the zebras and Barbary sheep in a short space of time. In addition the objects used for the Barbary sheep and zebras were too large and would have dwarfed the peccaries and otters and their enclosures[1]. Each set of novel objects included one that was movable and one that was non-movable or fixed.

The objects for the zebras and Barbary sheep were constructed using a metallic frame to form the general shape of the objects. This was then filled with inflated plastic wine casks and covered with canvas. The non-movable (NO1) object was cylindrical in shape and lay on the ground in the enclosures. The movable (NO2) object was cylindrical in shape with a wider top than base (See Figure 6.11a and 6.11b for diagrams of the objects). The base was curved like a metallic wok and was then filled with cement. The movable object could wobble on its base when pushed and would even right itself if pushed completely horizontal. The variation in design between the two novel objects was necessary because of difficulties in getting the non-movable object to stand up without being movable. The non-movable object was about 1.5m long 30 cm wide. The movable object was about 1.5m high and at the base was 45cm wide while the top was 60cm wide.

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[1] *The objects were all designed by the researcher and built by Mr. Steve Tupper in the workshop at the Adelaide University Psychology Department.*

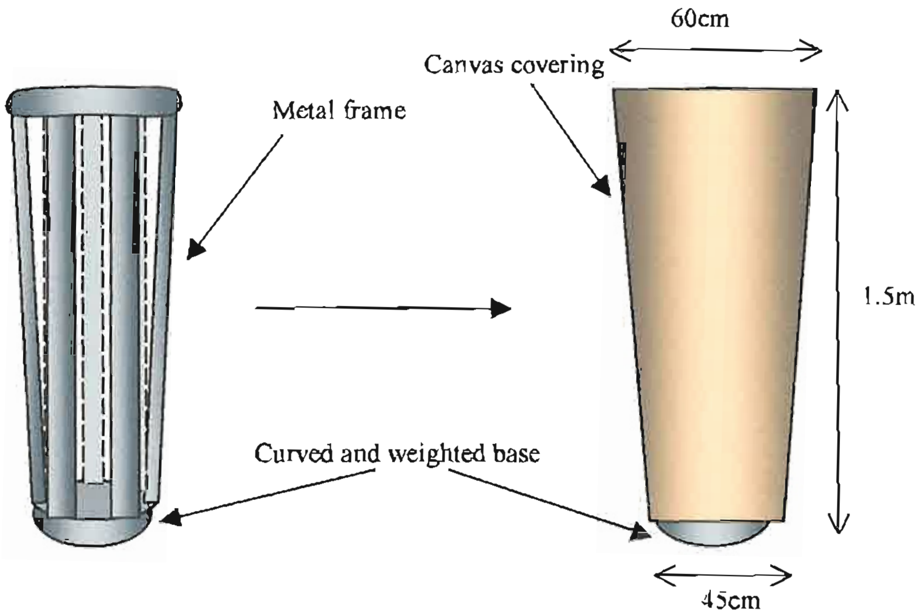

Figure 6.11a – Diagrams showing the frame on the left and the finished product on the right for the movable novel objects used for the Barbary sheep and zebras.

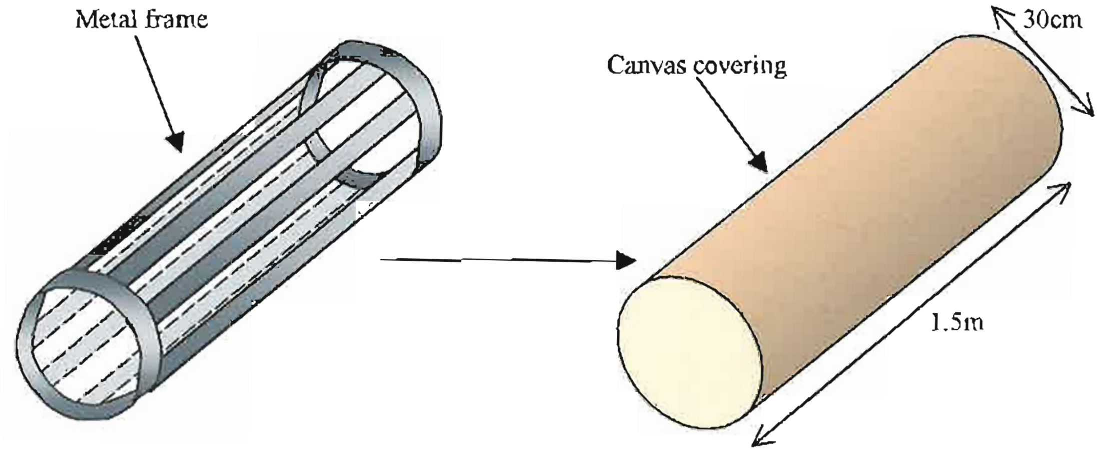

Figure 6.11b – Diagrams showing the frame on the left and the finished product on the right for the non-movable novel objects used for the Barbary sheep and zebras.

The objects for the otters and the peccaries were made from wood so as to be more solid and not allow any damage to be caused to the object by excessive chewing. It was also considered that it would be more appropriate for the objects to be made of wood as opposed to metal for the safety of the animals. This is because it was considered easier to keep the wood free from any sharp edges and the animals would not harm themselves by ingesting any of it. These objects were all a triangular cone type and were then mounted onto a curved wok shaped base (See Figure 6.12a and 6.12b for detailed diagrams of the objects). The non-movable objects were then fitted onto a flat wooden base to prevent them from wobbling. The objects were all 1m high and 60cm wide at the base. The non-movable object was fixed onto a base that was 90cm square.

A sign was placed on both the Barbary sheep, zebra, peccary and otter enclosures to explain to the public the general nature of the study (See Appendix B). All observation sessions were recorded directly onto checksheets designed during the reconnaissance observation sessions. See Appendix C for examples of the checksheets used in the study. Random sessions were taped to allow inter- and intra-observer reliability assessments to be performed.

Other miscellaneous equipment included:

- Video Camera (NV-M7A)
- 2 x 12 Volt Panasonic batteries
- Recharged using an AC Adaptor (VW-AM7A
- Tripod (SLIK 505QF)
- Blank video tapes
- Pentax camera for still photographs
- Stopwatch

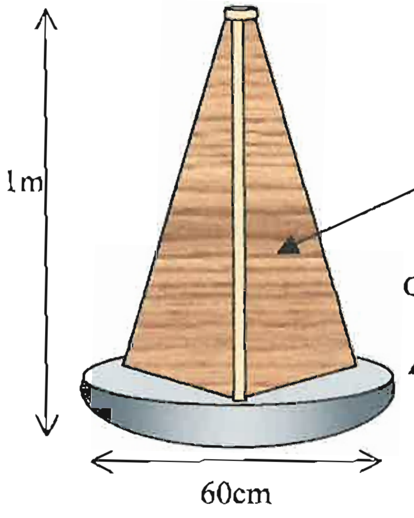

Figure 6.12a – Movable novel object for the peccaries and otters.

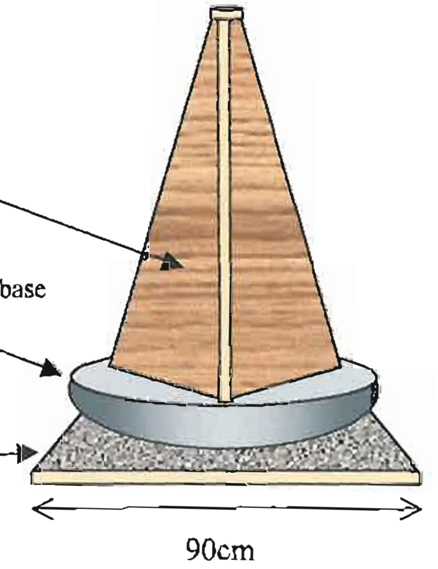

Figure 6.12b – Non-movable novel object for the peccaries and otters.

6.2.5 Procedure

6.2.5.1 Reconnaissance observations

Reconnaissance observations were performed for one week prior to the commencement of the study for each of the species. This time allowed the researcher to become familiar with each of the animals and helped with the fast recognition of each of the individuals. It also allowed time to design and refine the checksheets to allow quick recording of the behaviours. Observations were made using the instantaneous sampling method at one-minute intervals for all animals. It was determined that observations could be made at intervals of one minute. Shorter intervals meant that the behaviours could not be recorded properly because of the large number of Barbary sheep and peccaries included in the study.

6.2.5.2 Behavioural categories

The behaviours recorded included:

1. Locomoting - Any form of travel where the animal was not engaged in any other behaviour such as play, exploration, eating or foraging and so on.
2. Sleeping – Where the body is immobile and parallel to the ground, the eyes could be opened or closed and the head could be on the ground or held up.
3. Standing still or sitting – Standing was where the animal was immobile and standing on all four legs. Sitting was where the hind legs were folded beneath the rump and the forelegs were outstretched holding the forequarters up.
4. Eating/foraging – Involved the location and ingestion of food.
5. Grooming – Licking or scratching themselves or another animal
6. Sexual behaviour – Included courtship routines and mating.
7. Agonistic behaviour – Any aggression between the animals.
8. Flight behaviour – Any behaviour including the running, leaping or fleeing movements associated with fleeing from a fright.
9. Stereotypical Behaviour - Any behaviour that was identical, repeated regularly and had no observable function.

10. Exploratory behaviour - Involved the sniffing, tasting, touching or any other method of investigation of an object where the animals appear tense and proceed deliberately and with caution.
11. Play behaviour – Overall play category that was then broken down into the following sections:
    - Locomotor Play: Solitary or non-social play where the emphasis is on the individual and includes exaggerated and repetitive elements of locomotion seen in other contexts. For example running, leaping and climbing.
    - Social Play: Sequences of play involving two or more individuals.
    - Object Play: Includes interactions with objects that are considered inappropriate for those objects. The animal appears relaxed and unrestrained and the play can be social or solitary. For example shaking or biting an object.

6.2.5.3 Experimental design

The Barbary sheep and zebras were observed for a total of 40 hours each, over a 4 week period from 26th October to 22nd November 1998. The peccaries and otters were observed for a 4-week period from 19th July to the 15th August 1999. Observation periods were made from 10-12 in the morning, 12-2 and 2-4 in the afternoon to rule out any effect due to the time of day. Weekday and weekend sessions were included to control for attendance effects. The animals were observed from the front of the enclosure.

One movable and one non-movable object was placed in each of the exhibits at the beginning of the novelty phase for each of the species. The novel objects were then left in the enclosures for a period of two weeks and the behaviours of the animals were observed during this time. See Table 6.5 for more details of the experimental design.

Table 6.5 – Experimental design

Phase	**Baseline**		**Novelty Phase**		**Novelty Phase**		**Post-Experimental**	
Species involved	Barbary Sheep and Zebras	Peccaries and Otters	Barbary Sheep and Zebras	Peccaries and Otters	Barbary Sheep and Zebras	Peccaries and Otters	Barbary Sheep and Zebras	Peccaries and Otters
Timespan	26/10/98-1/11/98	19/7/99-25/799	2/11/98-8/11/98	26/7/99-1/8/99	9/11/98-15/11/98	2/8/99-8/8/99	16/11/98-22/11/98	9/8/99-15/8/99
Number of Sessions	5 each group		5 each group		5 each group		5 each group	
Number of Hours	10 each group		10 each group		10 each group		10 each group	
Function	Record data to establish baseline		Movable and non-movable objects in enclosure		Movable and non-movable objects in enclosure		Both objects removed and animals observed	

6.2.5.4 Data collection

Data points were collected using the instantaneous scan sampling method every minute. The animals were observed in the same order so that their behaviours were recorded at precisely one-minute intervals. To enable comparisons to be made between the species the data were totalled for each time block and totals were converted into percentages. The following formula was used to do this, as used by Kardos (1999):

$$\frac{\text{Total times behaviour occurred in a time block x 100}}{\text{Total number of hours in a time block x 60}}$$

This allowed comparisons to be made between each week of the study and for this to be clearly illustrated using graphs.

6.3 Results

As stated in section 5.5 the definitions of the magnitude of changes to behaviour levels followed the format of Kardos (1999). These are as set out below:

Small changes or effects are: 0.01% to 7.5%
Moderate changes or effects are: 7.51% to 15.0%
Large changes or effects are: 15.01% and higher.

Hypotheses

6.3.1 Hypothesis One

It was predicted that all the animals would display increased levels of exploratory behaviour with the movable object as compared to the non-movable object.

Barbary sheep

Figure 6.13 indicates the levels of exploratory behaviour with the non-movable and movable objects for the Barbary sheep. It is apparent that all of the animals performed more exploratory behaviour with the non-movable than the movable object. The animals spent between 2.17 and 6.99 percent more time exploring the non-movable object than the movable object. Although these differences are defined as being small they are large when it is considered that no animal performed more than 10.00 percent exploratory behaviour for both the objects combined. The levels of exploratory behaviour can be seen in Table 6.6. All the Barbary sheep performed between 0.50 and 1.84 percent exploratory behaviour with the movable object whereas they performed between 3.17 and 8.83 percent with the non-movable object. This does not support the hypothesis but rather suggests that the Barbary sheep showed a preference for exploring the non-movable over the movable object.

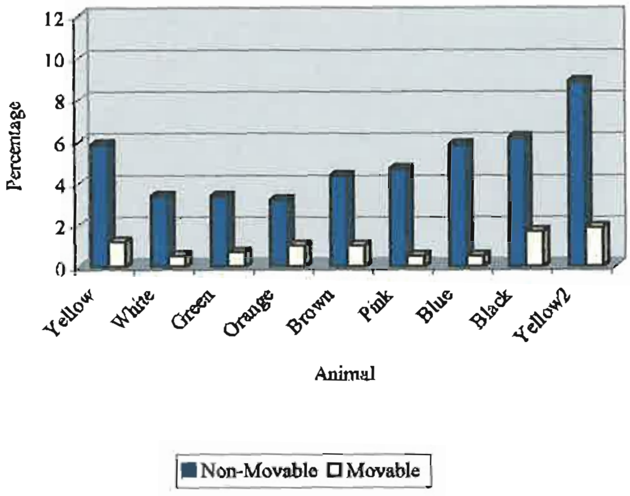

Figure 6.13: Exploratory behaviour with the novel objects for the Barbary sheep.

Table 6.6 – Exploratory behaviour with the non-movable and movable objects for the Barbary sheep.

Animal	**Non-Movable** **Mean (SD)**	**Movable** **Mean (SD)**
Yellow	5.84 (10.33)	1.17 (2.45)
White	3.34 (6.75)	0.50 (1.07)
Green	3.34 (7.50)	0.67 (1.80)
Orange	3.17 (6.80)	1.00 (2.70)
Brown	4.34 (8.67)	1.00 (2.35)
Pink	4.67 (8.55)	0.50 (1.35)
Blue	5.83 (12.53)	0.50 (0.90)
Black	6.16 (12.84)	1.67 (4.49)
Yellow2	8.83 (14.98)	1.84 (4.45)

Zebras

Figure 6.14 indicates the levels of exploratory behaviour with the non-movable and movable objects. Both the male and female zebras performed slightly more exploratory behaviour with the non-movable rather than the movable object. These differences can be seen in Table 6.7. The animals spent between 1.50 and 1.67 percent more time exploring the non-movable object than the movable object. These differences are small and so was the overall exploratory behaviour, a total of 3.50 and 4.33 percent. Although these differences are too small to support or not support the hypothesis it should be noted that both the zebras did explore the non-movable object more than the movable object.

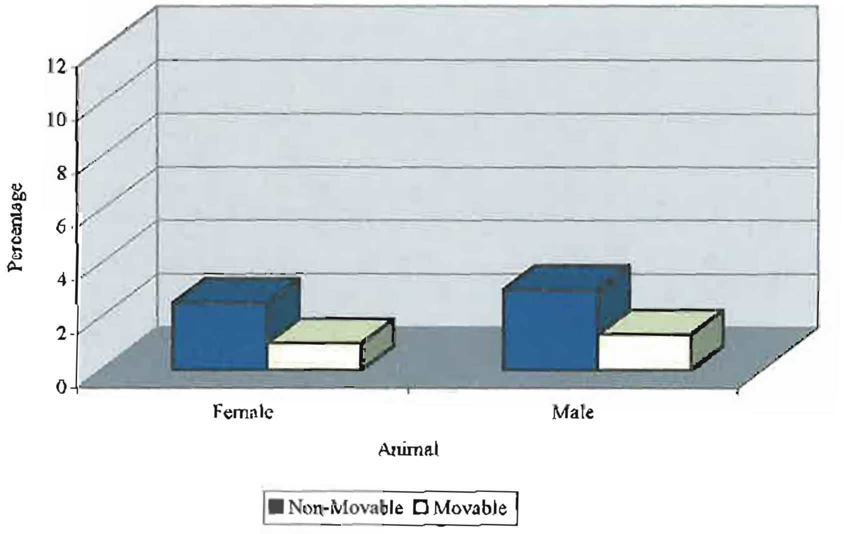

Figure 6.14: Exploratory behaviour with the novel objects for the zebras.

Table 6.7 – Exploratory behaviour with the non-movable and movable objects for the zebras.

Animal	Non-Movable Mean (SD)	Movable Mean (SD)
Female	2.50 (4.16)	1.00 (1.80)
Male	3.00 (4.39)	1.33 (2.63)

Otters

Figure 6.15 and Table 6.8 indicate the levels of exploratory behaviour with the non-movable and movable novel objects. The otters spent between 4.83 and 6.17 percent more time exploring the movable object rather than the non-movable object.

Once again these differences were small but so was overall exploratory behaviour, less than 3.50 percent for the female and less than 4.33 percent for the male. As a result the differences could only be small. This supports the hypothesis that the animals would spend more time exploring the movable objects over the non-movable objects.

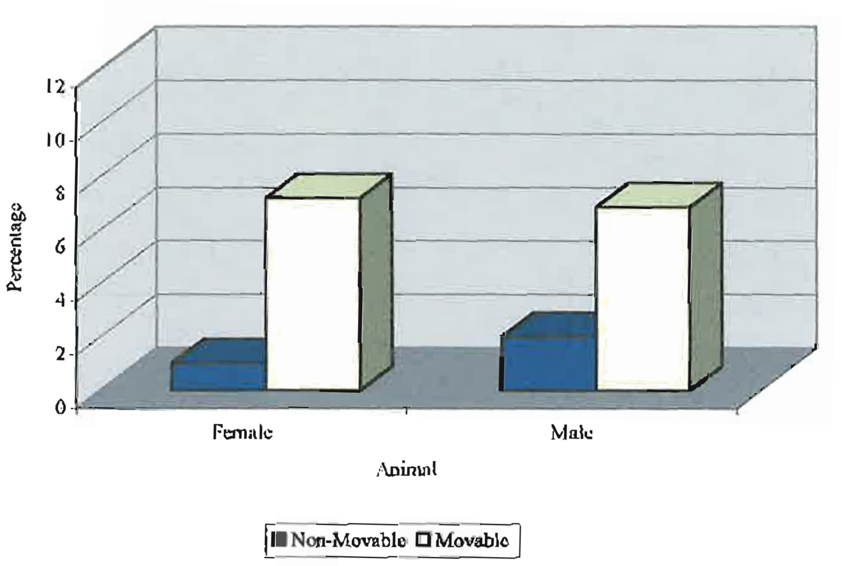

Figure 6.15: Exploratory behaviour with the novel objects for the otters.

Table 6.8 – Exploratory behaviour with the non-movable and movable objects for the otters.

Animal	Non-Movable Mean (SD)	Movable Mean (SD)
Female	1.00 (5.39)	7.17 (8.78)
Male	2.00 (1.32)	6.83 (11.13)

Peccaries

Figure 6.16 indicates the levels of exploratory behaviour with the non-movable and movable novel objects. The peccaries spent between 4.16 and 8.50 percent more time exploring the movable object rather than the non-movable object. The levels of exploratory behaviour can be seen in Table 6.9. The peccaries spent between 0.50 and 1.83 percent exploring the non-movable objects whereas they spent between 5.17 and 10.17 percent exploring the movable object. These results support the hypothesis that the animals would spend more time exploring the movable objects over the non-movable objects.

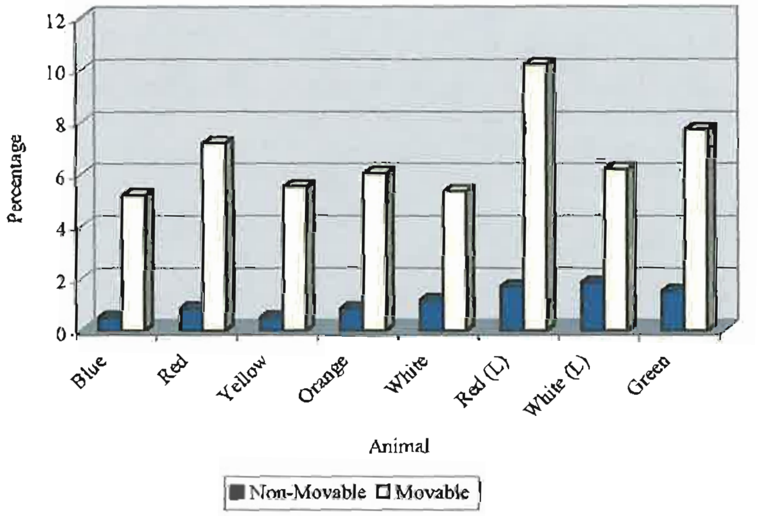

Figure 6.16: Exploratory behaviour with the novel objects for the peccaries.

Table 6.9 – Exploratory behaviour with the non-movable and movable objects for the peccaries.

Animal	Non-Movable Mean (SD)	Movable Mean (SD)
Blue	0.50 (1.35)	5.17 (8.92)
Red	0.83 (1.43)	7.17 (7.64)
Yellow	0.50 (1.35)	5.50 (9.29)
Orange	0.83 (2.24)	6.00 (5.87)
White	1.17 (2.62)	5.33 (7.50)
Red (L)	1.67 (3.10)	10.17 (8.62)
White (L)	1.83 (3.52)	6.17 (9.68)
Green	1.50 (2.00)	7.67 (7.40)

Summary

In summary the data from the peccaries and otters supported the hypothesis whereas the Barbary sheep and zebra results did not support the hypothesis. The Barbary sheep were found to show a preference for exploring the non-movable object as opposed to the movable object. While both the zebras explored the non-movable objects more than the movable, the differences were too small to make any conclusions. Therefore the hypothesis was not supported and it can be assumed that not all species show a preference for exploring movable objects over non-movable objects.

6.3.2 Hypothesis Two

It was predicted that all the animals would display increased levels of play behaviour with the movable object as compared to the non-movable object.

Barbary Sheep

Figure 6.17 shows that the adult Barbary sheep did not play with either of the novel objects. The sub-adult and juvenile animals played more with the non-movable objects than the movable objects. The levels of object play behaviour can be seen in Table 6.10. The Barbary sheep sub-adult and juvenile animals differences ranged from 0.84 to 1.67 percent. Although the differences were small so was the total object play behaviour (4.17 percent at the most) indicating that the difference might have still been meaningful. These differences are too small to support the hypothesis but instead suggest that the Barbary sheep did not show a preference for playing with the movable or non-movable objects. However, it is interesting to note that of the Barbary sheep that did play with the novel objects, all of them performed more play behaviour with the non-movable object.

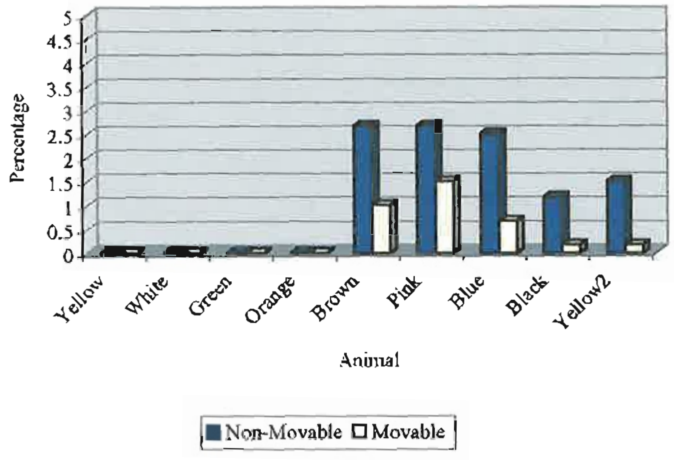

Figure 6.17: Play behaviour with the novel objects for the Barbary sheep.

Table 6.10 – Play behaviour with the non-movable and movable objects for the Barbary sheep.

Animal		**Non-Movable Mean (SD)**	**Movable Mean (SD)**
Yellow	Mean	0 (0)	0 (0)
White	Mean	0 (0)	0 (0)
Green	Mean	0 (0)	0 (0)
Orange	Mean	0 (0)	0 (0)
Brown	Mean	2.67 (3.91)	1.00 (1.80)
Pink	Mean	2.67 (6.50)	1.50 (3.11)
Blue	Mean	2.50 (6.74)	0.66 (1.96)
Black	Mean	1.17 (3.14)	0.17 (0.45)
Yellow2	Mean	1.50 (2.98)	0.17 (0.45)

Zebras

The zebras did not perform any play behaviour with either the movable or the non-movable objects.

Peccaries

Figure 6.18 indicates that all the peccaries performed more play behaviour with the movable as opposed to the non-movable objects. They spent between 1.67 and 3.20 percent more time playing with the movable rather than the non-movable object. The levels of play behaviour can be seen in Table 6.11. The peccaries spent between 0 and 0.33 percent time playing with the non-movable object whereas they spent between 1.67 and 3.20 percent time playing with the movable object. This supports the hypothesis and indicates that the peccaries show a preference for playing with movable objects over non-movable objects.

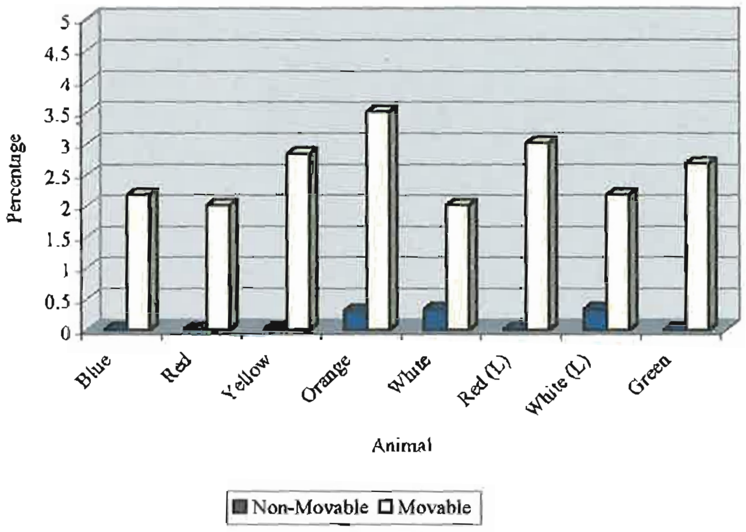

Figure 6.18: Play behaviour with novel objects for the peccaries.

Table 6.11 – Play behaviour with the non-movable and movable objects for the peccaries.

Animal	**Non-Movable** **Mean (SD)**	**Movable** **Mean (SD)**
Blue	0 (0)	2.17 (4.99)
Red	0 (0)	2.00 (2.74)
Yellow	0 (0)	2.83 (4.27)
Orange	0.30 (0.90)	3.50 (6.78)
White	0.33 (0.90)	2.00 (3.39)
Red (L)	0 (0)	3.00 (4.21)
White (L)	0.33 (0.90)	2.17 (4.80)
Green	0 (0)	2.67 (4.34)

Otters

Figure 6.19 indicates that the male and female otters performed more play behaviour with the movable as opposed to the non-movable objects. In fact they spent no time playing with the non-movable object at all whereas they spent between 4.00 and 5.00 percent time playing with the movable object. The levels of play behaviour with the objects are shown in Table 6.12. This supports the hypothesis and indicates that the otters show a preference for play behaviour with a movable object rather than a non-movable object.

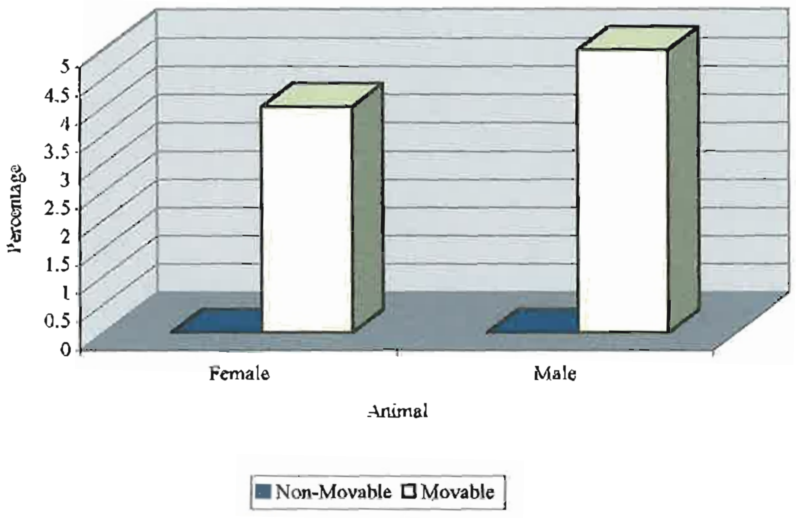

Figure 6.19: Play behaviour with the novel objects for the otters.

Table 6.12 – Play behaviour with the non-movable and movable objects for the otters.

Animal	Non-Movable Mean (SD)	Movable Mean (SD)
Female	0 (0)	4.00 (5.53)
Male	0 (0)	5.00 (7.88)

Summary

The results obtained for the otters and peccaries supported the hypothesis whereas the results for the Barbary sheep did not. The Barbary sheep did play more with the non-movable object rather than the movable object but these differences were too small to conclude that they revealed a preference for the non-movable objects. The zebras did not perform any play behaviour with either of the novel objects.

Therefore these results did not completely support the hypothesis, and contradict the statement that all animals prefer to play with movable objects over non-movable objects.

6.3.3 Hypothesis Three

It was predicted that the introduction of novel objects into the animal's enclosure would increase the overall levels of exploratory behaviour.

Barbary Sheep

Figures 6.20 – 6.22 indicate the level of exploratory behaviour during each week of the study. All of the animals performed more exploratory behaviour during the two novel weeks as opposed to the two weeks when there was no novelty. The animals spent between 0.84 and 4.34 percent more time exploring during the first novelty week as compared to the baseline week. This difference is described as a small increase. During the second novelty week, the animals spent between 1.84 and 4.84 percent more time exploring compared to the baseline week, and this is considered a small increase. The two exceptions to this were the two juveniles, Blue and Yellow2. They both performed the most exploratory behaviour in the first novelty week and then decreased to the second novelty week, while still performing more than during the baseline week. The results for the Barbary sheep support the hypothesis that the presence of novel objects would increase the quantity of exploratory behaviour.

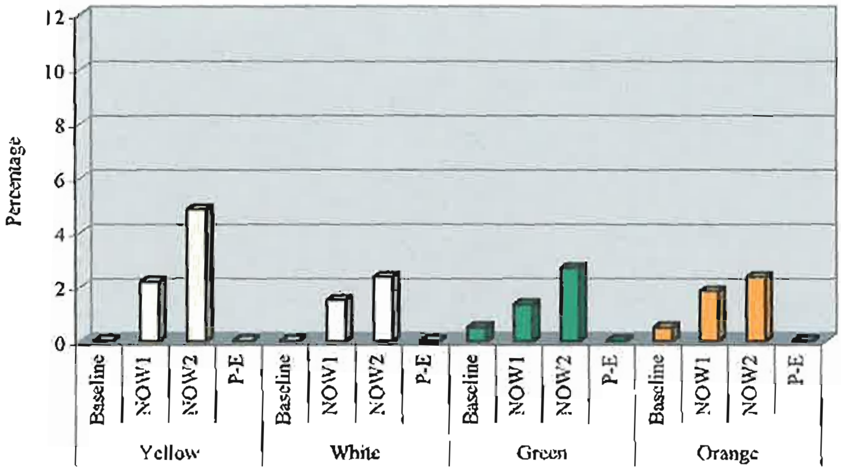

Figure 6.20: Exploratory behaviour levels for the adult Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

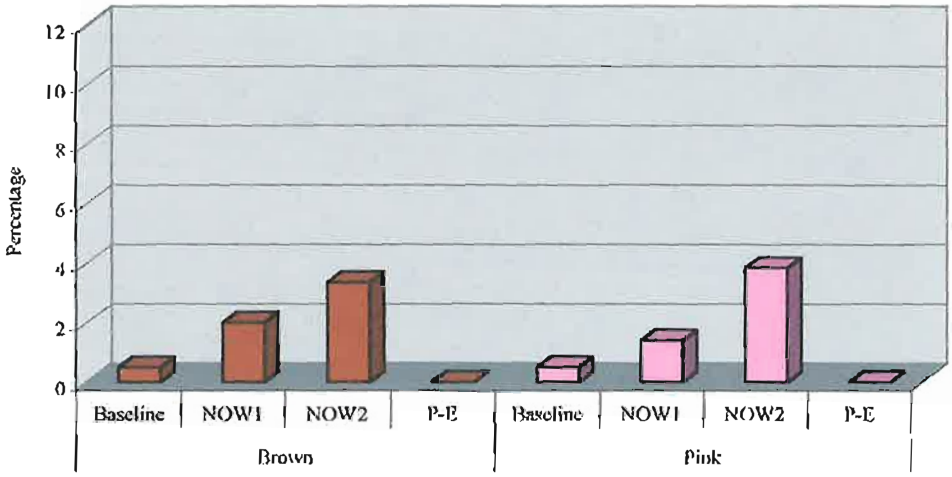

Figure 6.21: Exploratory behaviour levels sub-adult Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

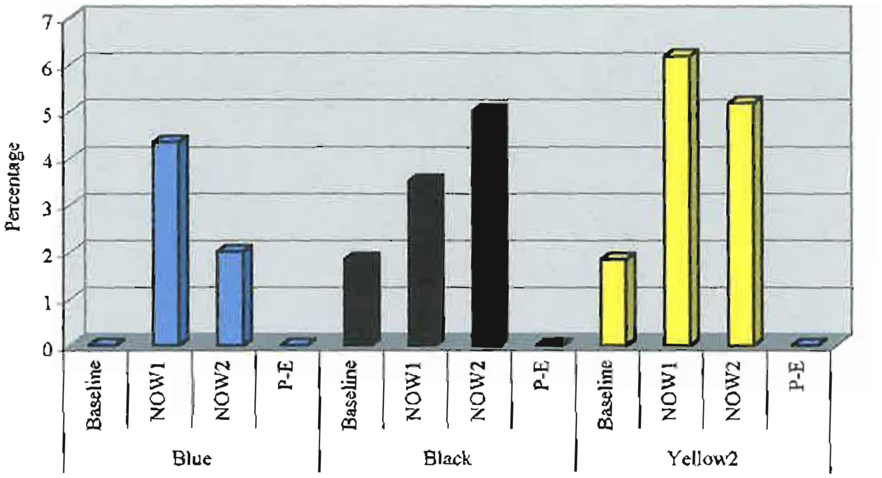

Figure 6.22: Exploratory behaviour levels for the juvenile Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.13 – Exploratory behaviour during the experimental weeks for the Barbary sheep.

Animal	**Baseline** **Mean (SD)**	**Novelty week one** **Mean (SD)**	**Novelty week two** **Mean (SD)**	**Post-Experimental** **Mean (SD)**
Yellow	0 (0)	2.17 (5 84)	4.84 (6.94)	0 (0)
White	0 (0)	1.50 (4.04)	2.34 (3.78)	0 (0)
Green	0 (0)	1.34 (3.59)	2.67 (5.71)	0 (0)
Orange	0.50 (1.35)	1.83 (4.94)	2.34 (4.56)	0 (0)
Brown	0.50 (1.35)	2.00 (3.65)	3.34 (7.37)	0 (0)
Pink	0.50 (1.35)	1.40 (3.59)	3.83 (6.31)	0 (0)
Blue	0 (0)	4.33 (10.35)	2.00 (3.08)	0 (0)
Black	1.83 (3.22)	3.50 (9.43)	5.00 (9.70)	0 (0)
Yellow2	1.83 (2.80)	6.17 (11.13)	5.17 (10.10)	0 (0)

Zebras

Figure 6.23 indicates the level of exploratory behaviour during each of the conditions of the study. It is apparent that both the animals performed more exploratory behaviour during the first novelty week with a small increase of between 3.50 and 4.33 percent compared to the baseline week. These levels of exploratory behaviour can be seen in Table 6.14. The exploratory behaviour returned to baseline levels during the second novelty week. This may indicate that by the second week the objects were no longer novel to the animals. These results support the hypothesis that the presence of the novel objects would increase the levels of exploratory behaviour while the objects remain novel to the animals.

Table 6.14 – Exploratory behaviour during the experimental weeks for the zebras.

Animal	**Baseline Mean (SD)**	**Novelty week one Mean (SD)**	**Novelty week two Mean (SD)**	**Post-Experimental Mean (SD)**
Female	0 (0)	3 50 (4.33)	0 (0)	0 (0)
Male	0 (0)	4.33 (7.02)	0 (0)	0 (0)

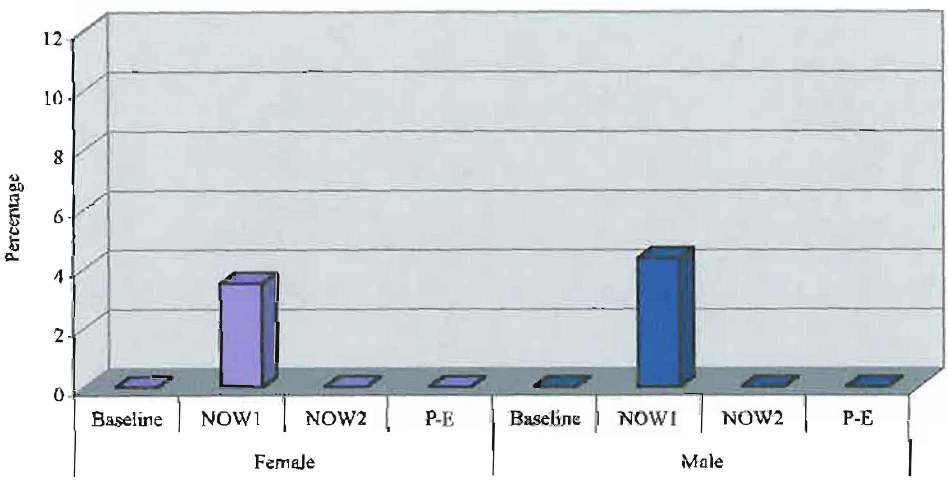

Figure 6.23: Exploratory behaviour levels for the zebras.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Otters

Figure 6.24 indicates the levels of exploratory behaviour during each week of the study. It is apparent that all the animals performed more exploratory behaviour during the first week when the novel objects were present than any other week. During this time there was a moderate increase in exploratory behaviour of between 8.67 and 8.83 percent when compared to the baseline levels. The levels of exploratory behaviour can be seen in Table 6.15. The exploratory behaviour returned to baseline levels during the second novelty week suggesting that the objects were no longer perceived to be novel by the animals during this time. This supports the hypothesis that the presence of novelty would increase the quantity of exploratory behaviour while the objects are considered to be novel by the animals.

Table 6.15 – Exploratory behaviour during the experimental weeks for the otters.

Animal	**Baseline** **Mean (SD)**	**Novelty week one Mean (SD)**	**Novelty week two Mean (SD)**	**Post-Experimental Mean (SD)**
Female	0 (0)	8.67 (13.80)	0.50 (1.35)	0 (0)
Male	0 (0)	8.83 (14.17)	0 (0)	0 (0)

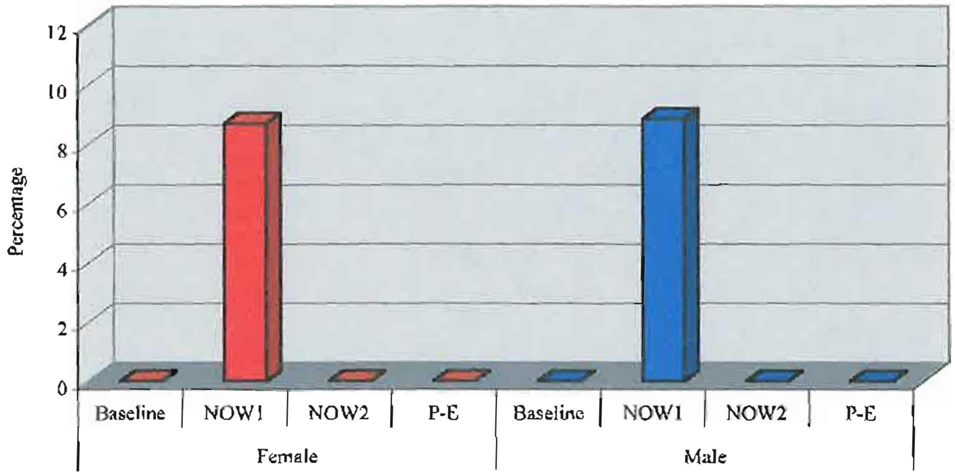

Figure 6.24: Exploratory behaviour levels for the otters.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Peccaries

Figures 6.25 and 6.26 indicate the level of exploratory behaviour during each of the conditions of the study. It is apparent that all of the animals performed more exploratory behaviour during the first week when the novel objects were present. During this time there was an increase in exploratory behaviour of between 5.67 and 11.84 percent. This increase is defined as being a small to moderate increase. These levels of exploratory behaviour can be seen Table 6.16. The exploratory behaviour returned to baseline levels during the second novelty week. It is possible that the animals no longer perceived the objects to be novel during this second week. These results support the hypothesis that the presence of novelty would increase the quantity of exploratory behaviour while the objects remain novel.

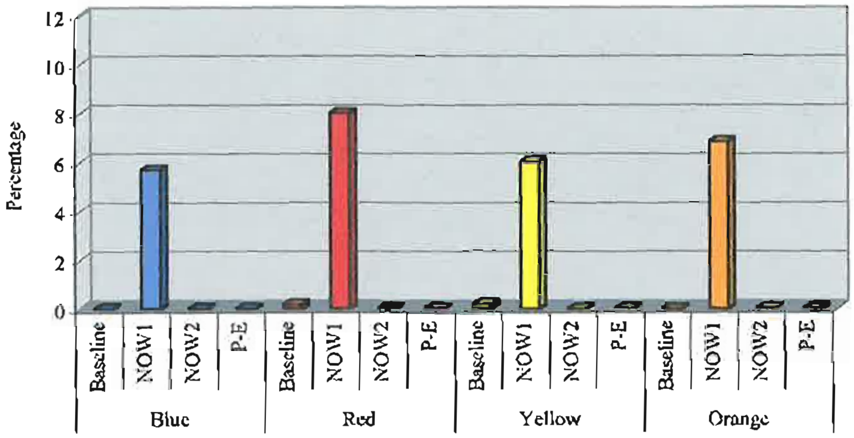

Figure 6.25: Exploratory behaviour levels for the female peccaries.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

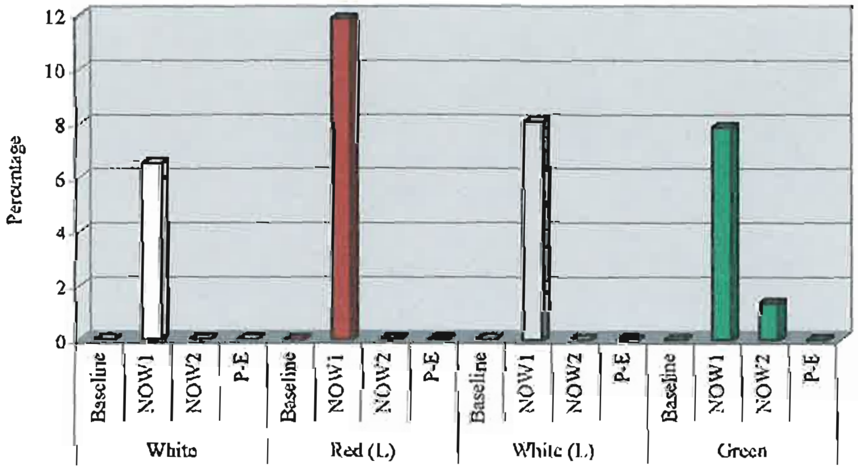

Figure 6.26: Exploratory behaviour levels for the male peccaries.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.16 – Exploratory behaviour during the experimental weeks for the peccaries.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-Experimental Mean (SD)
Blue	0 (0)	5.67 (10.27)	0 (0)	0 (0)
Red	0.17 (0.45)	8.00 (9.07)	0 (0)	0 (0)
Yellow	0.17 (0.17)	6.00 (10.64)	0 (0)	0 (0)
Orange	0 (0)	6.83 (8.11)	0 (0)	0 (0)
White	0 (0)	6.50 (10.12)	0 (0)	0 (0)
Red (l)	0 (0)	11.84 (11.72)	0 (0)	0 (0)
White (L)	0 (0)	8.00 (13.20)	0 (0)	0 (0)
Green	0 (0)	7.83 (6.33)	1.34 (3.07)	0 (0)

Summary

The hypothesis that the novel objects would increase exploratory behaviour was supported for all the species. The Barbary sheep exploratory behaviour levels were higher for both the first and second novelty weeks the baseline and post-experimental weeks. The levels of exploratory behaviour for the peccaries, otters and zebras were higher only during the first week of the novelty phase. Therefore, the exploratory behaviour levels remained increased while the animals perceived the objects as novel.

6.3.4 Hypothesis Four

It was predicted that overall play behaviour would increase with the introduction of the novel objects.

Barbary Sheep

Figures 6.27 – 6.29 indicate the levels of play behaviour for each condition of the study. It is apparent that all of the animals performed more play behaviour during the novelty weeks than when the novelty was not present. The Barbary sheep performed between 0.83 and 17.07 percent more play behaviour during the first novelty week than the baseline. This difference is defined as between a small and large increase. They also performed between 2.50 and 10.50 percent more play behaviour during the second experimental week than the baseline week. These differences are defined as between a small and moderate increase. The levels of play behaviour can be seen in Table 6.17. The animals White, Green, Black and Yellow2 spent more time playing during the second novelty week than the first novelty week.

The rest of the animals were the opposite of this and spent more time playing during the first novelty week. These results support the hypothesis that play behaviour will increase when the novel objects were present.

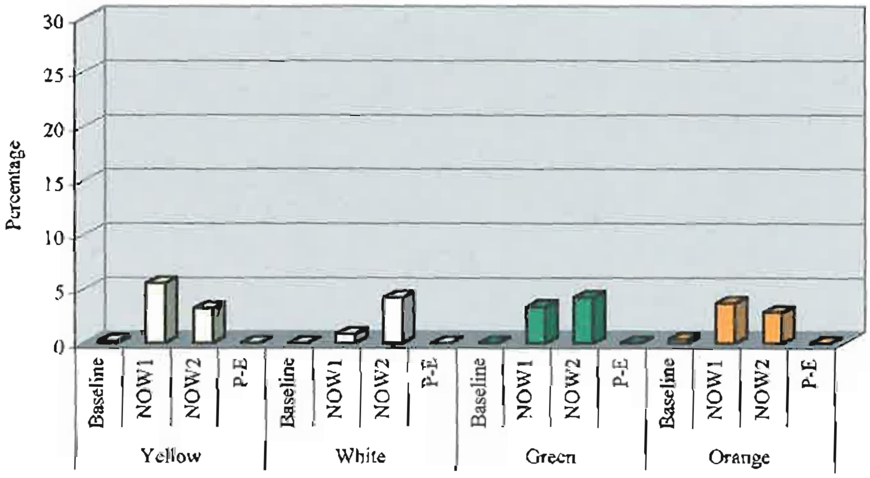

Figure 6.27: Play behaviour levels for the adult Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

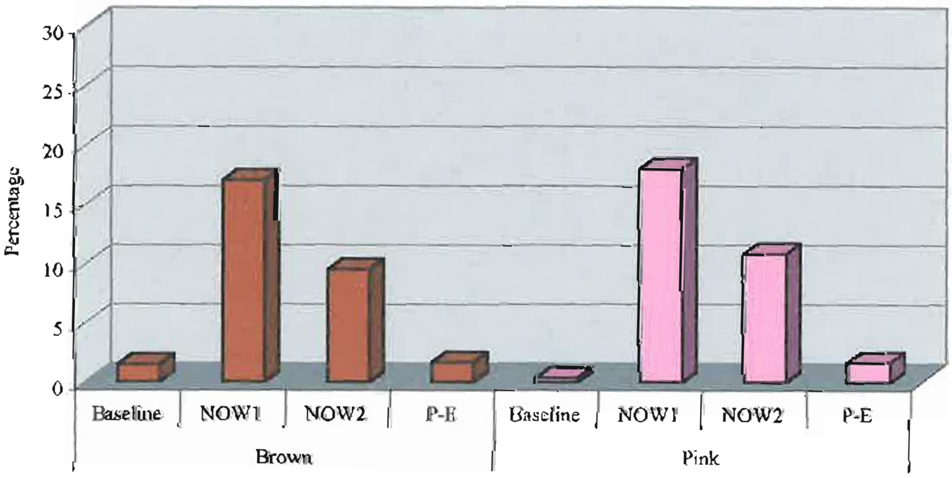

Figure 6.28: Play behaviour levels for the sub-adult Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

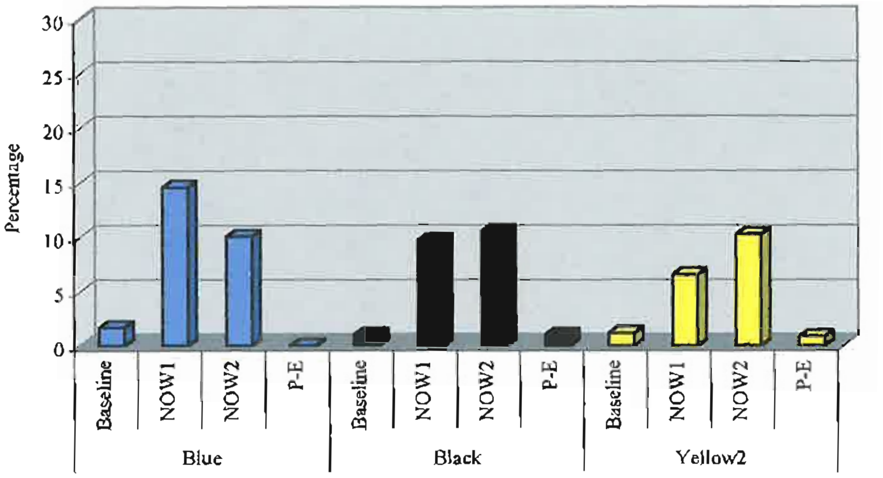

Figure 6.29: Play behaviour levels for the juvenile Barbary sheep.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.17 – Play behaviour during the experimental weeks for the Barbary sheep.

Animal	**Baseline Mean (SD)**	**Novelty week one Mean (SD)**	**Novelty week two Mean (SD)**	**Post-Experimental Mean (SD)**
Yellow	0.17 (0.45)	5.50 (8.27)	3.17 (7.01)	0 (0)
White	0 (0)	0.83 (2.24)	4.17 (6.92)	0 (0)
Green	0 (0)	3.33 (7.42)	4.17 (6.92)	0 (0)
Orange	0.33 (0.90)	3.67 (6.24)	2.83 (5.68)	0 (0)
Brown	1.50 (2.70)	17.0 (14.86)	9.50 (10.13)	1.67 (2.31)
Pink	0.33 (0.80)	18.0 (18.08)	10.83 (9.22)	1.67 (2.31)
Blue	1.67 (2.58)	14.50 (17.37)	9.99 (13.02)	0 (0)
Black	1.00 (0.45)	9.67 (17.41)	10.50 (11.70)	1.00 (1.66)
Yellow2	1.16 (3.14)	6.50 (11.00)	10.16 (9.85)	0.83 (1.43)

Zebras

Figure 6.30 indicates the levels of play behaviour for each condition of the study. It is apparent that both the animals performed their only play behaviour during the first novelty week with no play behaviour occurring during the baseline, second novelty week or the post-experimental weeks. The play behaviour decreased back to baseline levels once the objects were no longer perceived as novel. The zebras performed between 4.67 and 4.83 percent more play behaviour during the first novelty week compared to the baseline. These differences are defined as small and can be seen in Table 6.18. The zebra results support the hypothesis that the presence of novel objects would increase the amount of play behaviour that the animals exhibit but only while the novel objects were perceived as novel.

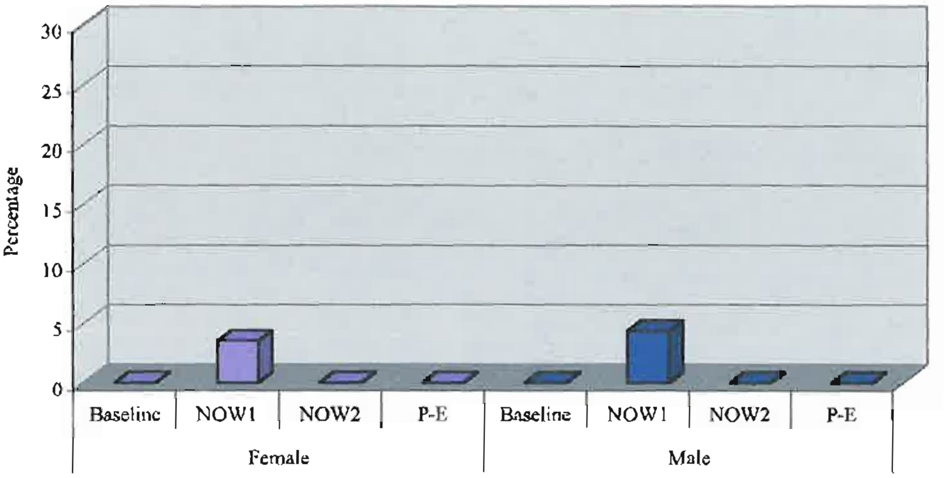

Figure 6.30: Play behaviour levels for the zebras.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.18 – Play behaviour during the experimental weeks for the zebras.

Animal	**Baseline** **Mean (SD)**	**Novelty week 1** **Mean (SD)**	**Novelty week 2** **Mean (SD)**	**Post-Experimental** **Mean (SD)**
Female	0 (0)	4.67 (10.99)	0 (0)	0 (0)
Male	0 (0)	4.83 (11.43)	0 (0)	0 (0)

Otters

Figure 6.31 indicates the levels of play behaviour for each condition of the study. It is apparent that the animals performed the most play behaviour during the first novelty week followed by the second novelty week. The otters performed more play behaviour during both the novelty weeks than during the baseline or post-experimental weeks. The otters performed between 12.17 and 14.0 percent more play behaviour during the first experimental week than the baseline. During the second novelty week they spent between 7.50 and 8.00 percent more time playing than during the baseline week. The otters spent moderately more time playing during the novelty weeks than when there was no novelty present. This supports the hypothesis that the presence of novelty will increase the amount of play behaviour that the animals exhibit.

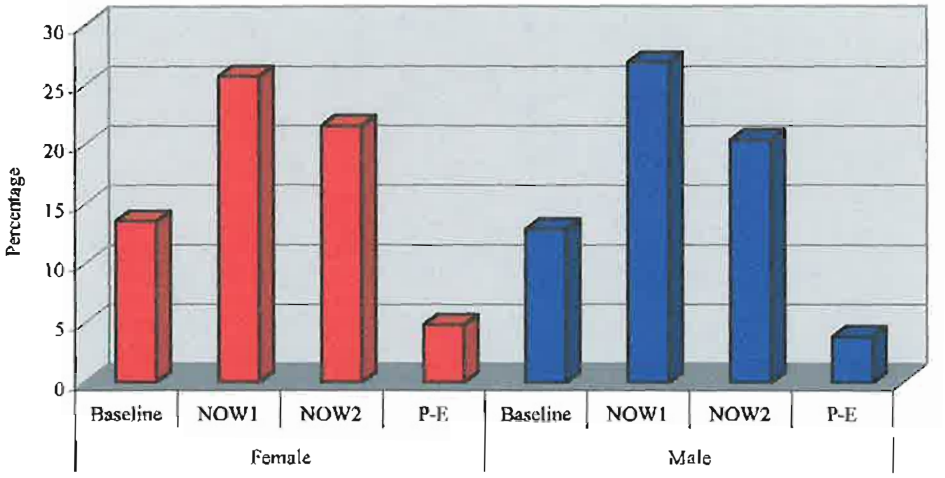

Figure 6 31: Play behaviour levels for the otters.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.19 – Play behaviour during the experimental weeks for the otters.

Animal	**Baseline** **Mean (SD)**	**Novelty week 1 Mean (SD)**	**Novelty week 2 Mean (SD)**	**Post-Experimental Mean (SD)**
Female	13.50 (7.24)	25.67 (15.72)	21.50 (12.27)	4.83 (1.84)
Male	12.83 (6.13)	26.83 (17.20)	20.33 (11.35)	3.83 (3.09)

Peccaries

Figures 6.32 and 6.33 indicate the levels of play behaviour for each condition of the study. It is apparent that the peccaries performed more play behaviour during the first and second novelty weeks than during the baseline or post-experimental weeks. They performed between 10.00 and 11.50 percent more play behaviour during the first novelty week than the baseline. During the second novelty week they spent between 10.17 and 13.84 percent more time playing than during the baseline week. This difference is defined as a moderate increase in play behaviour. The peccaries, with the exception of the female Blue, spent more time playing in the second novelty week than during the first novelty week with small differences of between 0.16 and 3.47 percent. The levels of exploratory behaviour for each week of the study can be seen in Table 6.20. These results support the hypothesis that the presence of novelty will increase the amount of play behaviour in which the animals engage.

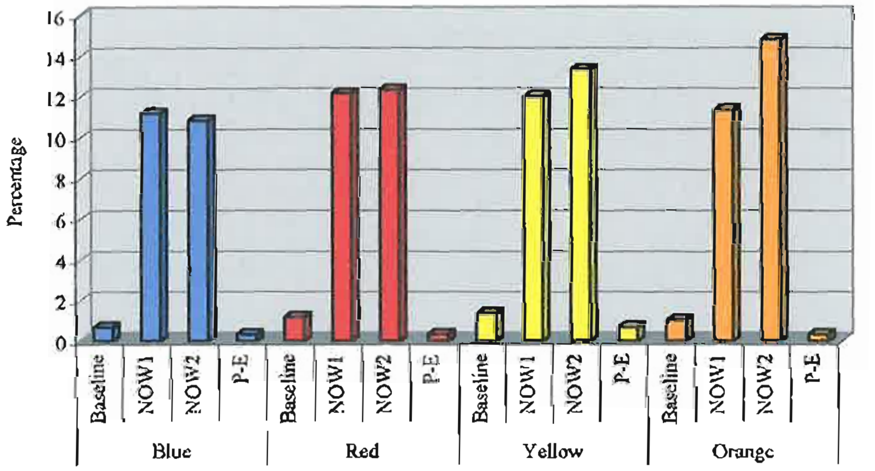

Figure 6.32: Play behaviour levels for the female peccaries.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

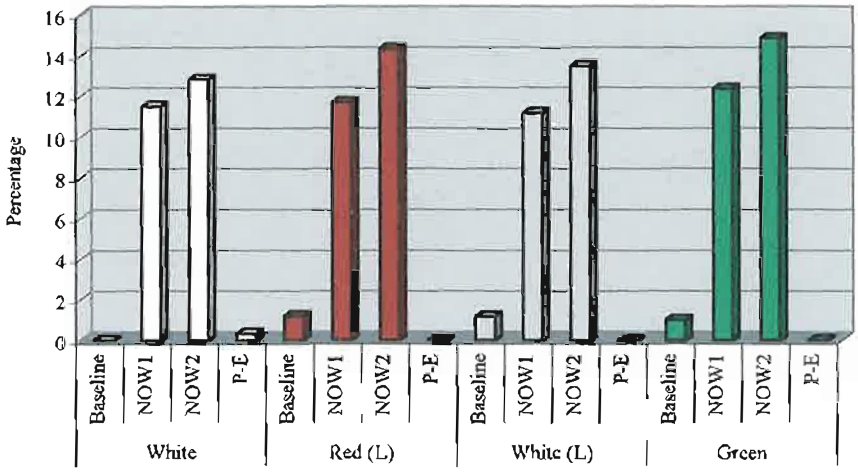

Figure 6.33: Play behaviour levels for the male peccaries.

*NOW1 – Novelty week 1, NOW2 – Novelty week 2, P-E – Post-Experimental.

Table 6.20 – Play behaviour during the experimental weeks for the peccaries.

Animal	**Baseline** **Mean (SD)**	**Novelty week 1** **Mean (SD)**	**Novelty week 2** **Mean (SD)**	**Post-Experimental** **Mean (SD)**
Blue	0.67 (1.80)	11.17 (15.36)	10.84 (8.08)	0.33 (0.90)
Red	1.17 (1.97)	12.17 (17.06)	12.33 (8.14)	0.33 (0.90)
Yellow	1.33 (2.21)	12.00 (17.16)	13.33 (8.55)	0.33 (1.11)
Orange	1.00 (1.80)	11.33 (15.79)	14.80 (14.44)	0.67 (0.90)
White	0 (0)	11.50 (15.85)	12.83 (20.14)	0.33 (0.9)
Red	1.17 (1.97)	11.67 (15.65)	14.33 (8.76)	0 (0)
White	1.17 (2.21)	11.17 (15.36)	13.50 (10.47)	0 (0)
Green	1.00 (1.80)	12.33 (17.10)	14.84 (11.02)	0 (0)

Summary

The play behaviour levels for the zebras were higher than baseline levels during the first novelty week but not during the second novelty week. The novel objects stimulated an increase in play behaviour but only during the first week. The Barbary sheep, otters, and peccaries all played more during both the novelty weeks than during the baseline or post-experimental weeks. Therefore, the hypothesis that play behaviour would be increased by the presence of novelty was supported for the Barbary sheep, otters and peccaries but only partially supported for the zebras.

6.3.5 Hypothesis Five

It was predicted that the level of stereotypical behaviour would decrease with the introduction of the novel objects.

This hypothesis could only be tested for the otters since they were the only species that performed any stereotypical behaviour. Figure 6.34 indicates that levels of stereotypical behaviour for each condition of the study. It is apparent that the stereotypical behaviour decreased by a moderate amount of between 10.67 and 11.00 percent when the novel objects were introduced. The stereotypical behaviour then remained at this level until the objects were removed and then increased by a small amount of 2.67 percent for both the male and female during the post-experimental week. Therefore this supports the hypothesis that the novel objects would decrease the level of stereotypical behaviour that the animals exhibit.

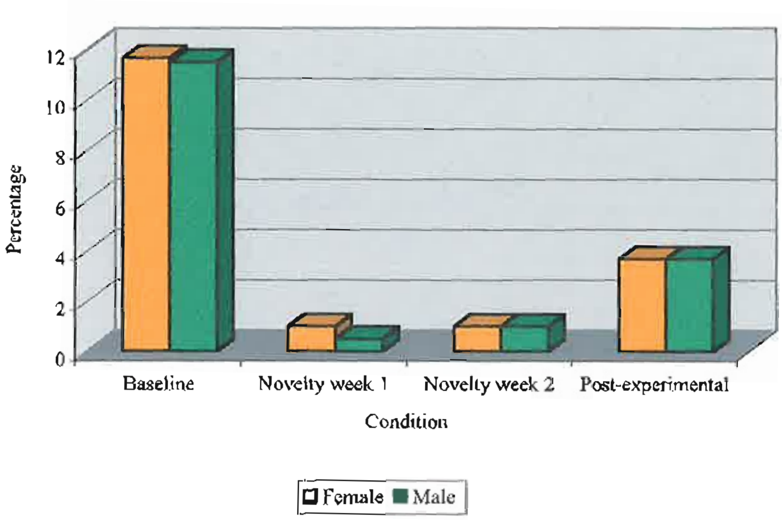

Figure 6.34· Stereotypical behaviour across the condition for the otters.

Table 6.21 – Stereotypical behaviour during the experimental weeks for the otters.

Animal	**Baseline** **Mean (SD)**	**Novelty week 1** **Mean (SD)**	**Novelty week 2** **Mean (SD)**	**Post-Experimental** **Mean (SD)**
Female	11.67 (5.08)	1.0 (1.66)	1.0 (1.8)	3.67 (1.40)
Male	11.50 (5.13)	0.50 (1.35)	1.0 (1.8)	3.67 (1.40)

6.3.6 Hypothesis Six

It was predicted that the peccaries and otters would explore the objects more than the Barbary sheep and zebras.

Figure 6.35 indicates the overall levels of exploratory behaviour for each species in the study during the first week of the novelty phase. It is apparent that the Barbary sheep performed the least exploratory behaviour followed by the zebras, and then the peccaries and finally the otters performed the most exploratory behaviour. The difference between the Barbary sheep and zebras was small, 1.38 percent. The peccaries performed 3.68 percent more exploratory behaviour with the objects than the zebras. This difference was also a small difference. Finally the difference between the peccaries and otters was 0.9 percent, once again a small difference. The levels of exploratory behaviour can be seen in Table 6.22. These results support the hypothesis that the otters and peccaries would perform more exploratory behaviour with the objects than the Barbary sheep and zebras.

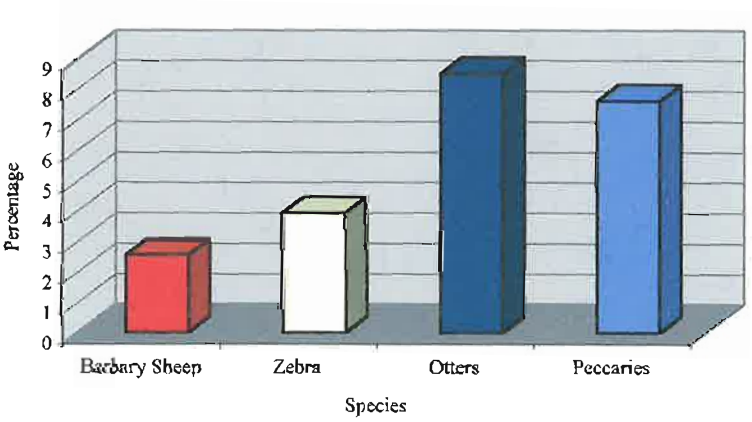

Figure 6.35 - Exploratory behaviour with the novel objects the first novelty week.

Figure 6.36 indicates the overall levels of exploratory behaviour for each species during the second week of the study. It is apparent that during this time the Barbary sheep were the only species to spend any time exploring the novel objects. They spent 3.50 percent more time exploring than either the zebra or otters. This difference was only a small difference but so were overall levels of exploratory behaviour. The peccaries only spent a very small amount time exploring during this time, a percentage of 0.17 percent. These results do not support the hypothesis that the peccaries and otters would spend more time exploring the novel objects than the Barbary sheep.

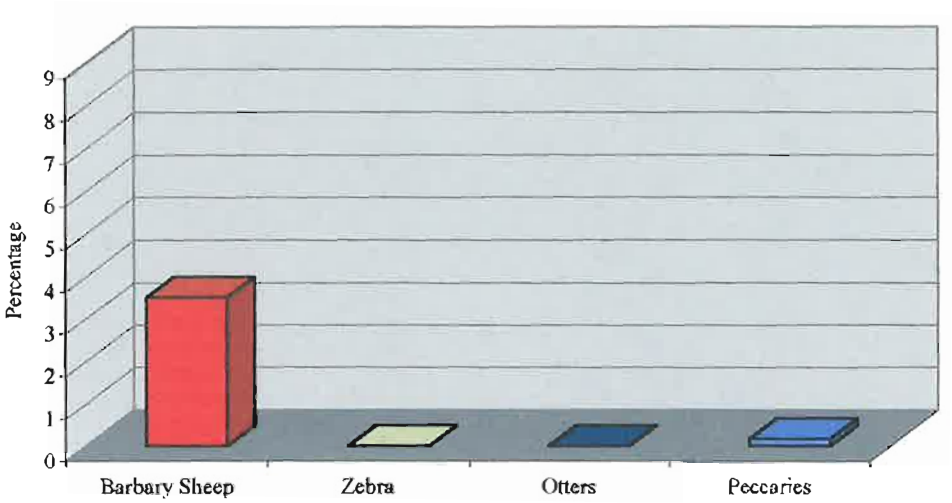

Figure 6.36: Exploratory behaviour with the novel objects during the second novelty week.

Table 6.22 – Exploratory behaviour for each of the species during the two novelty weeks.

Species	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)
Barbary sheep	2.54 (1.66)	3.50 (1.25)
Zebras	3.92 (0.59)	0 (0)
Otters	8.50 (0.11)	0 (0)
Peccaries	7.60 (1.94)	0 17 (0.48)

6.3.7 Hypothesis Seven

It was predicted that the peccaries and otters would play with the novel objects more than the Barbary sheep and zebras.

Figure 6.37 indicates the level of play behaviour for each species during the first week of the novelty phase. It is apparent that the Barbary sheep and otters were the only animals to perform any play behaviour during the first novelty week of the study. The Barbary sheep performed 1.09 percent and the otters performed 1.84 percent play behaviour, both of these results were defined as small. These results do not support the hypothesis that the otters and peccaries would perform more play behaviour than the Barbary sheep and zebras.

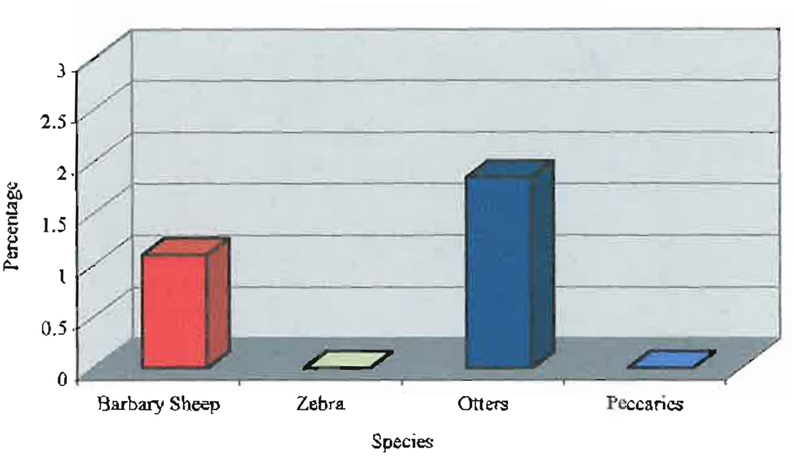

Figure 6.37: Play behaviour with the novel objects for the first novelty week.

Figure 6.38 indicates the level of play behaviour during the second week of the novelty phase. During this time the Barbary sheep performed only a small amount of play behaviour, the zebras none and the otters and peccaries about the same amount. The Barbary sheep spent 0.46 percent of their time engaged in play behaviour. The otters performed 2.21 percent and the peccaries performed 2.20 percent more play behaviour than the Barbary sheep. Even though both these differences were small, so was the overall play behaviour and so the differences could only be small. The results from the second week support the hypothesis that the otters and peccaries would play more than the Barbary sheep and zebras.

Table 6.23 – Play behaviour for each of the species during the two novelty weeks.

Species	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)
Barbary sheep	1.09 (1.22)	0.46 (0.77)
Zebras	0 (0)	0 (0)
Otters	1.84 (0.94)	2.67 (0.24)
Peccaries	0 (0)	2.66 (0.57)

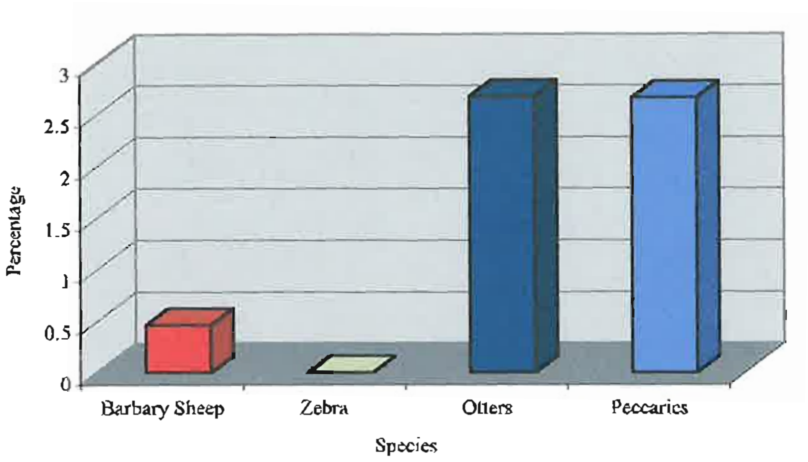

Figure 6.38: Play behaviour with the novel objects during the second novelty week.

6.3.8 Hypothesis Eight

It was predicted that the peccaries and otters would habituate to the novel objects faster than the Barbary sheep and zebras.

Figure 6.39 indicates the habituation times for each species over the novel period of the study. Habituation was said to have occurred once the animals were no longer exploring the novel objects. It is apparent that the otters had habituated to the objects by day four and were the fastest species. The zebras followed this and had habituated to the objects by day five. The peccaries then took until day eight to habituate to the objects. Finally the Barbary sheep were the slowest to habituate to the objects and took until day nine. The patterns of exploratory behaviour leading to habituation were quite different for the Barbary sheep, in particular, as compared to the three other species. The otters, peccaries and zebras all performed the highest amount of exploratory behaviour on the first day of exposure to the novel objects. The Barbary sheep, on the other hand, performed no exploratory behaviour on the first two days of exposure to the novel objects and then only small amounts of exploratory behaviour on days three and four leading to a peak on day five. These results do not support the hypothesis that the peccaries and otters would habituate to the novel objects faster than the Barbary sheep and zebras.

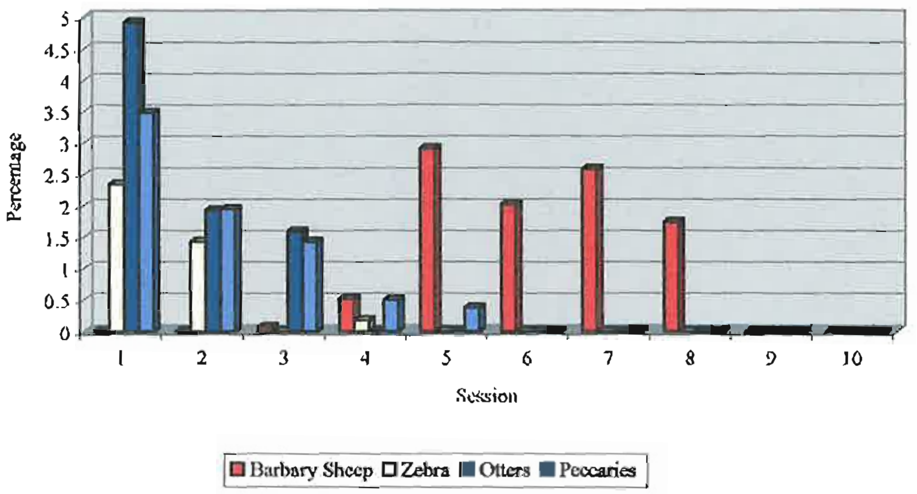

Figure 6.39: Habituation times for each of the species.

6.4 Discussion

6.4.1 Exploratory behaviour

The present studies focussed on the different reactions of four different species to two types of novel stimuli. The reactions of the four species to the movable and non-movable stimuli were varied. The results from the peccaries and otters supported the hypothesis that the animals would show a preference for exploring movable rather than non-movable novel stimuli. These results were consistent with the previous findings of Sambrook and Buchanan-Smith (1996) with monkeys, Wilson (1982) with orang-utans, Paquette and Prescott (1988) with chimpanzees and Jaenicke and Ehrlich (1982) with the greater galago and the slow loris. In contrast, however, the Barbary sheep were found to show a preference for exploring non-movable objects as opposed to movable objects and thus did not support the hypothesis. The zebras performed slightly more exploratory behaviour with the non-movable object than the movable object but there was not enough of a difference for any conclusions to be made. The results from the Barbary sheep and zebras contradict the findings of the studies listed above. These results highlight the suggestion that environmental enrichment programs must be tailored to suit the needs of each individual species.

Hall (1998) has suggested that animals will play more with objects that include prey-like stimuli. Examples of prey-like stimuli include size, texture, shape, odour and movability. Ferrets (Russell, 1990), adult domestic cats (Hall, 1995), and Northern elephant seals (Rasa, 1971) have all been found to prefer playing with movable novel objects. It is suggested that the same could be said for exploratory behaviour: That is, the species that explored the movable objects more focussed their attention on them because of their resemblance to prey species. The question that then has to be considered is why some species were attracted to the movable stimuli whereas others avoided the movable stimuli or did not show a preference for either.

According to Glickman and Sroges (1966), the differences in life styles of the animals would be related to the *amount* of exploratory behaviour that animals perform. It is also possible that it could be related to the *type of objects* that animals spend time exploring. To explain these results, each species has to be considered in view of their differing phylogenetic status, feeding patterns and habitat that they inhabit. The differences that are found between these species in each of these areas may affect the relevance that the movable stimulus has for each species. Firstly, examining the results of previous studies, orang-utans are a species that spend a large proportion of their time exploring and foraging for food. They also consume foods that require extensive manipulation, such as fruits that need to be opened, and their only threat is humans. The remaining species, chimpanzees, ferrets, cats and seals are all predatory species that are not often predated on themselves. In the current studies, the species that preferred the movability were the otters and peccaries. Otters are a predatory species that are rarely preyed upon. Peccaries are an omnivorous species that eat small mammals and spend a large proportion of their time exploring for food. In addition, attempts at preying on them are rarely successful. The common links between all these species are that they either hunt for food or spend large amounts of time exploring for it and are rarely predated on themselves. In contrast to these results, the Barbary sheep avoided the movable stimuli in favour of the non-movable stimuli and the zebras did not show a preference for either. Neither of these species hunt or have to explore to find food or manipulate the food once found but both of them do run a high risk of being predated upon. It is possible that the movability of the stimulus was negative for these two species because the movement resembled a prey species and in the wild they have to avoid moving stimuli in order to survive.

Birke and Archer (1983) report that while animals are exploring they run the risk of being predated on and are using up valuable energy resources. Animals have to balance the risks and costs of exploring with the benefits gained by exploring. Another way of examining the differences between the species, with relation to the movable and non-movable stimuli, is in terms of the risks and benefits associated with exploring. Orang-utans and peccaries can take the risk of being inquisitive to moving stimuli because there is only a small possibility that they may be predated on. Chimpanzees, ferrets, cats, elephant seals and otters hunt for their food. Therefore, the movable stimuli have the significance of possibly being food. All of these species risk little and have much to gain by exploring movable stimuli in their environment. On the other hand, movable stimuli are more likely to have negative consequences for Barbary sheep and zebras. In the wild, movement for these two species would generally indicate a predator, whereas non-movable stimuli could be food. Therefore these two species have more to gain and less to risk by exploring non-movable stimuli. Consequently, whether a species explores movable or non-movable stimuli can be influenced by the biological significance of the stimulus in terms of feeding patterns, risk of predation and phylogenetic status.

The Barbary sheep (See Figure 6.40) and zebras (See Figure 6.41) performed more exploratory behaviour than the otters (See Figure 6.42) and peccaries (See Figure 6.43) during the first week of novelty. These results support the hypothesis that the omnivores and carnivores would explore more than the herbivores. This also supports the results of Glickman and Sroges (1966), Russell and Pierce (1971) and Maple and Perkins (1996) that some animals show a tendency to be more exploratory than others. As discussed above, the ecological niche that a species occupies can affect the type of objects that animals explore but it can also affect the amount of exploratory behaviour that an animal performs. Section 3.1.5 examined some species differences between exploratory behaviour and it was reported that Mench (1998) has suggested that the species that were generalists, had complex antipredator behaviours, and were highly social, would be the most exploratory. In terms of the current studies the otters, because they are highly social animals, and peccaries, because they have complex anti-predator behaviours and are highly social, would be the most exploratory. The Barbary sheep and zebras were the least exploratory because of the high risk of them being predated on and exploring was too much of a risk.

During the second week of exposure to novelty, the Barbary sheep were the only species to engage in any exploratory behaviour. These results suggest that the Barbary sheep took longer than the other species to habituate to the novel objects. By the second week the peccaries, otters, and zebras no longer found the objects to be novel. Rather than not support the hypothesis above these results suggest that the four species took different amounts of time to habituate to the novel objects. Habituation to the novel objects will be discussed further in Section 6.4.3.

Figure 6.40 – A sub-adult Barbary sheep exploring the non-movable novel object.

Figure 6.41 – The male zebra exploring the movable novel object.

Figure 6.42 – The two otters exploring the non-movable novel object.

6.43 – A male peccary exploring the non-movable novel object.

6.4.2 Play behaviour

As mentioned, the zebra did not play with the objects at all and there was very little object play within the Barbary sheep group. Amongst the Barbary sheep that did play with the objects they were not found to show a preference for either the non-movable object or the movable object. These results contradict the statement made by Aldis (1975) that all animals prefer to play with movable objects. A possible explanation for this could be for similar reasons as discussed above for exploratory behaviour. That is, the Barbary sheep found the movable stimuli aversive because of its resemblance to predatory species. It is possible that the animals may have become more accustomed to the movable objects over a longer period of time and then played with them. The objects themselves may also explain the low-level object play behaviour for the zebras and Barbary sheep. The Barbary sheep frequently played with the branches that they were given as food once the leaves had been eaten (See Figure 6.44). The animals would line the branches up and then butt them with their own horns. These branches resembled the horns of Barbary sheep and this factor may have been an important element in eliciting object play behaviour for this species. The low level of play behaviour with the movable and non-movable novel objects may be explained by the objects not including the correct elements to stimulate play behaviour from this species. In addition, any initial fear that the Barbary sheep may have had of the branches was quickly overcome because they were associated with food. Therefore, it is possible that object play behaviour could be promoted by initially associating novel objects with food to overcome fear and then by tailoring them to suit specific species needs.

Figure 6.44 –Two sub-adult Barbary sheep playing with their food branches.

The results from the peccaries and otters supported the hypothesis that the animals would prefer to play with movable objects rather than non-movable objects. This supports the results found by Paquette and Prescott (1988) with chimpanzees, Wilson (1982) with orang-utans, Sambrook and Buchanan-Smith (1996) with a species of monkey, Russell (1990) with ferrets, Hall (1995) with cats, and Rasa (1971) with the Northern elephant seal. As discussed above, all these species have few predators, spend large amounts of exploring and manipulating for food or are predatory species. This is true of the peccaries and otters as well and suggests that primates, carnivores and omnivores prefer to play with movable objects.

The results from the first week of the novelty phase only partially supported the hypothesis that the otters and peccaries would play with the objects more than the Barbary sheep and zebras. The otters did perform more object play behaviour than the Barbary sheep and zebras, however, the peccaries did not perform any object play. A possible reason for this is that although the peccaries do not often fall victim to predation it is often because they fend off the attack (Nowak & Paradiso, 1983). They still have to remain alert and wary, suggesting that they would have to explore new elements of their environment thoroughly to ensure there was no threat before playing.

During the second novelty week the otters and peccaries both performed more object play behaviour than the Barbary sheep or zebras, supporting the hypothesis. This supports the view that neophilic species, such as otters and peccaries, are more likely to incorporate novel objects into their play routines than neophobic species, such as Barbary sheep and zebras (Heinrich & Smolker, 1998). The neophilic species tend to have a more flexible behavioural style and occupy a wide variety of ecological niches. In comparison, neophobic species have more rigid behavioural styles and occupy conservative niches (Baldwin & Baldwin, 1977; Heinrich & Smolker, 1998; Welker, 1961). In addition, the play behaviour of neophilic species tends to be more complex and varied whereas the play of the neophilic species tends to be more conservative. The results also supported the findings of Iwaniuk, et al. (2001) that the larger brained species tend to play more than smaller brained species.

6.4.3 Habituation

The results did not support the hypothesis that the otters and peccaries would habituate faster to the novel stimuli than the Barbary sheep and zebras. In contrast the results actually suggested that the otters habituated the fastest, followed by the zebras, then the peccaries and finally the Barbary sheep took the longest. The increased length of time that the peccaries took could be because they are a highly exploratory species that takes advantage of every opportunity in their environment. This suggests that the length of time that a species takes to habituate to an object may be more complex than whether they are a neophilic or neophobic species (Cowan, 1983). It may also be influenced by how appropriate the object is in terms of the animal's survival and how important it is to explore it. By providing the animals with novel experiences this maintains their level of stimulation and helps to reduce the level of anxiety when they encounter something new. If the animals are ever to be reintroduced to the wild it is important that they are not too reactive to novel experiences. The zebras explored the objects as soon as they were exposed to them and then continued to explore them for the next couple of days intermittently. The otters and peccaries both explored the objects the first time they were exposed to them. When the otters were allowed access to the objects they both headed straight for the objects and explored them thoroughly. They then explored them intermittently for the next couple of days. The peccaries performed the most exploratory behaviour on the first day and then explored the objects periodically over the next six days. The Barbary sheep, on the other hand, avoided the objects for two days before exploring them. Therefore the four species took different amounts of time to approach, explore and habituate to the novel objects.

6.5 Conclusions

The procedure used in the present study could be utilised in the future to promote exploration and play and reduce stereotypical behaviour in animals in captivity. This should promote the healthy social and physical development of animals in captivity. Despite the earlier findings that all animals prefer movable novel objects to explore and play with, two species in the current study were found to have a preference for non-movable objects. Suggested reasons for this included how the niche that a species occupies influences the type of objects that they are drawn to or try to avoid. Despite the conclusions of Maple and Perkins (1996), it was found that two species of ungulate, the Barbary sheep and zebra, were reactive to novelty. Differences were also found in the amount of time that the animals devoted to exploring and playing with the novel objects. This was related back to whether the animals were members of a neophilic species or neophobic species but was found to be somewhat more complex than just this.

Chapter 7: The effects of different novel odours on the behaviour of animals in captivity.

7.1 Introduction

This chapter is concerned primarily with the results obtained by providing three different species with one control novel object and four other novel objects impregnated with different novel odours. The zoo environment can be a stagnant unchanging place and the enclosures are often lacking in novel odours because they need to be kept clean to prevent the animals from getting infections (Forthman, 1998). Many species rely on odour to orient themselves, find food, and defend themselves from predators. The provision of novel odours can provide the animals with another source of exploratory behaviour thereby keeping them active and reducing the incidence of stereotypical behaviours.

The use of olfactory novel stimuli as a form of enrichment for zoo animals has been a largely ignored area of research. The few studies that have concentrated on this area have looked primarily at apes (Ostrower & Brent, 1997), focussed on the provision of predator odour (Ward, MacDonald, & Doncaster, 1997) or how odour can delay the length of time that animals take to feed (Maple & Roper, 1996). Mellen et al. (1998) found that novel odours produced intense interest and were very important for captive felids. Hayes et al. (1998) have suggested that novel olfactory stimuli could be used to stimulate reproduction in snakes and turtles that have been housed together for some time. Consequently olfactory stimulation is an important, although largely ignored, area of environmental enrichment.

7.1.1 Hypotheses and rationale

Hypotheses One: *It was predicted that each species would:*

(a) Spend more time exploring the novel objects impregnated with the odours than the control object.

(b) Take longer to habituate to the novel objects impregnated with the odours than the control object.

Thompson (1996) has suggested that the most important features of objects are novelty and the ability to stimulate multiple senses. The novel objects impregnated with odour have the added complexity of the odour for the animals to explore when compared to the same object with no odour. Ostrower and Brent (1997) found that chimpanzees spent more time sniffing cloth impregnated with odour than cloth that was not. Schuett and Frase (2001) found that lions spent more time exploring novel stimuli associated with odour rather than a purely visual stimulus. It has also been found that animals can take longer to habituate to novel objects if they have a sensory component to them (Hall, 1998). In this case that means that the animals will take longer to habituate to the novel objects that are impregnated with odour. It is suggested that the Barbary sheep, peccaries and otters will spend more time exploring and take longer to habituate to the objects with the odour than the one without.

Hypothesis Two: *It was predicted that each species would:*

(a) Spend more time exploring the odours with more biological significance for their species.

(b) Take longer to habituate to the odours with more biological significance for their own species than the other odours.

Novel objects and odours have to have some degree of biological relevance for the animals to explore them; otherwise they would be wasting valuable time by exploring novel items of no relevance. Heinrich and Smolker (1998) found that ravens took longer to habituate to edible objects than to other non-edible novel items. Hall (1998) has reported that the overall sensory value of novel objects is important. He found that domestic cats explored, played with and took longer to habituate to "toys" that were covered in real fur and feathers than fake fur. This could be because the odours associated with the real fur and feathers were more biologically significant for the cats than their fake counterparts.

It was expected that the animals would explore more and take longer to habituate to the odours that form part of their regular diet rather than the novel odours that have no biological significance for their species. It was expected that the otters would find the fish odour more biologically significant than the meat, grass or fruit odours. The peccaries would be expected to find grass, meat and fruit more biologically significant than the fish odour. Finally, the Barbary sheep would find the grass odour more biologically significant than the meat, fish and fruit odours.

Hypothesis Three: *It was predicted that the:*

- *(a) Peccaries and otters would spend more time exploring the novel odours than the Barbary sheep.*
- *(b) Peccaries and otters would take longer to habituate to the novel odours than the Barbary sheep.*

Some species, such as carnivores, rely on their olfactory sense in their daily lives more than others species, such as diurnal primates (Ostrower & Brent, 1997). It was expected that these species would take longer to habituate to the novel odours than other species because they have more biological significance for them. This has been found previously with ravens (Heinrich & Smolker, 1998) and domestic cats (Hall, 1998). In addition to this some species, such as omnivores and carnivores, have been found to be more exploratory than others, such as ungulates (Glickman & Sroges, 1966; Maple & Perkins, 1996; Russell & Pierce, 1971).

Hypothesis Four: *It was predicted that the presence of the novel odours would stimulate an increase in overall exploratory behaviour.*

It has been found previously that pigs (Wood-Gush & Vestergaard, 1991), tamarins (Glick-Bauer, 1997), the greater bushbaby (Renner et al., 1992), orang-utans (Wilson, 1982), chimpanzees (Paquette & Prescott, 1988), birds (Sandos, 1999) and many other species perform more exploratory behaviour when confronted with novelty. As discussed previously, animals explore to reduce anxiety about novel aspects of their environment (Weisler & McCall, 1976). Novel odours have also been found to increase exploratory behaviour (Ostrower & Brent, 1997; Hall, 1998; Schuett & Frase, 2001). It has previously been suggested that animals will spend different amounts of time exploring different types of novelty according to their biological significance. In addition, it was expected that the Barbary sheep, peccaries, and otters would perform more exploratory behaviour when exposed to all the novel odours.

Hypothesis Five: *It was predicted that the presence of the novel odours would stimulate an increase in overall play behaviour.*

As discussed previously novelty has been found to stimulate an increase in play behaviour. This has been found with many species including pigs (Wood-Gush & Vestergaard, 1991), ravens (Heinrich & Smolker, 1998), a Nile soft-shelled turtle (Burghardt, 1995) and even an octopus (Wood & Wood, 1999). In addition domestic cats have been found to play more with objects impregnated with odours than objects that were not (Hall, 1998). As with the species mentioned above it was expected that the Barbary sheep, peccaries, and otters would perform more play behaviour when exposed to the novel odours.

Hypothesis Six: *It was predicted that stereotypical behaviour would be reduced by the presence of the novel odours.*

Low levels of stimulation in captivity can often mean that animals perform stereotypical behaviours (Mason, 1991). Exposure to novelty has been found to reduce the amount of stereotyping that animal's display (Glick-Bauer, 1997; Mellen et al., 1998; Paquette & Prescott, 1988; Renner et al, 1992; Wilson, 1982). Novelty decreases stereotypical behaviour by increasing activity, specifically through increasing exploratory and play behaviour. Carlstead and Seidensticker (1991) found that exposing bears to novel olfactory stimuli decreased stereotypical behaviour. It was expected that all the species would decrease the amount of stereotypical behaviour they perform when exposed to the novel olfactory stimuli.

7.2 Methodology and Data Collection

7.2.1 Subjects

The same peccary and otter groups as in the previous study were used for this study. Unfortunately it was not possible to use the zebra group again as the male had died on the 17th February 2000 and had not been replaced at the commencement of this study. It was therefore decided that the group had changed too radically to be of any use for comparisons between the studies. The Barbary sheep group had also changed slightly. Some of the younger animals had been transferred to Monarto Zoological Park and others had been born. The taxonomic details for the group are contained in Table 7.1.

Table 7.1 - Taxonomic details for the Barbary sheep group.

Name	**Sex**	**Age (as at 1/5/00)**	**Birth Date**	**Born**	**Origin**	**Arrived Adelaide**
Yellow1	Male	5 y 6m 22d	23/9/95	Captive	Adelaide	-
White1	Female	5y 7m 29d	3/9/94	Captive	Adelaide	-
Green	Female	10y 0m 8d	24/10/89	Captive	Monarto	10/11/93
Orange1	Female	5y 7m 27d	5/9/94	Captive	Adelaide	-
Brown	Male	2y 4m 27d	5/12/97	Captive	Adelaide	-
Pink	Female	2y 6m 7d	25/9/97	Captive	Adelaide	-
White2	Female	4m 25d	7/12/99	Captive	Adelaide	-
Orange2	Male	3m 5d	26/1/00	Captive	Adelaide	-

Figure 7.1 – Barbary sheep group with the adult male to the far right.

7.2.2 Diet

The species diets had not changed since the first study and a description can be found in Section 6.2.2.

7.2.3 Enclosure

The enclosures had not changed since the first study and a description of them can be found in Section 6.2.3. Figures 7.2, 7.3 and 7.4 show diagrams of the enclosures and positioning of the novel odours.

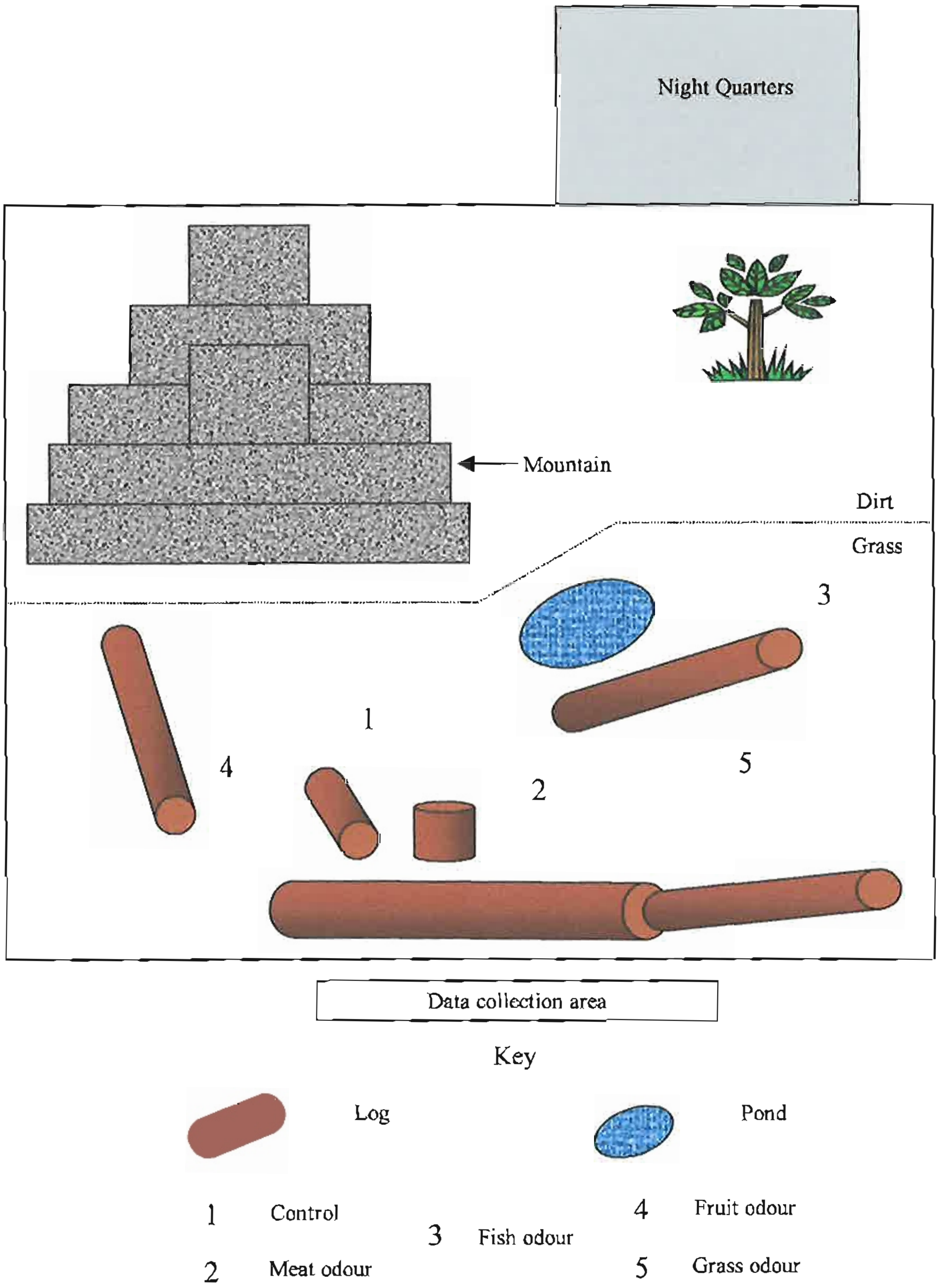

Figure 7.2 – Diagrammatic representation of the Barbary sheep enclosure showing the location of the novel odours (not drawn to scale).

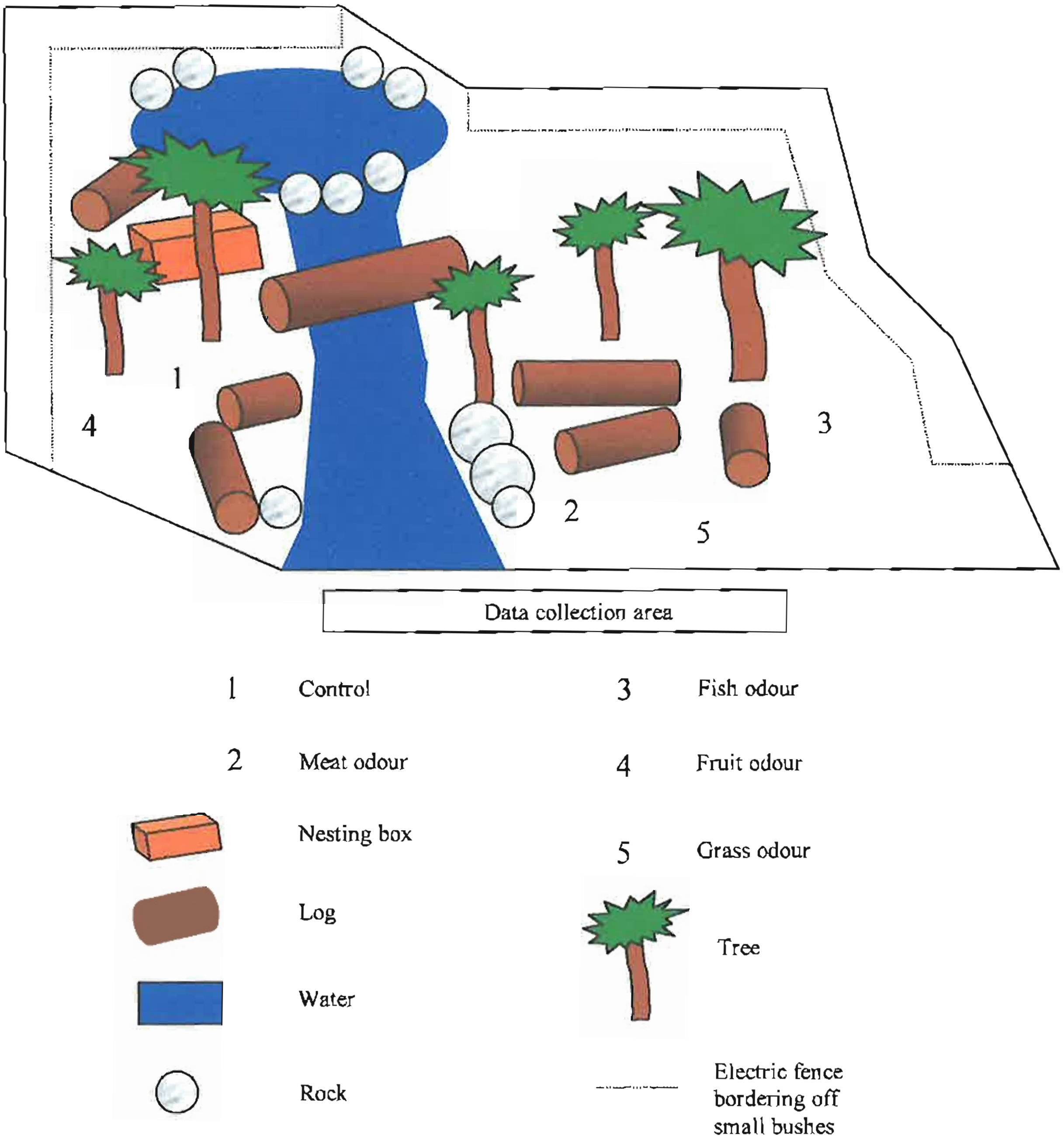

Figure 7.3 – Diagrammatic representation of the otter enclosure showing the location of the novel odours (not drawn to scale).

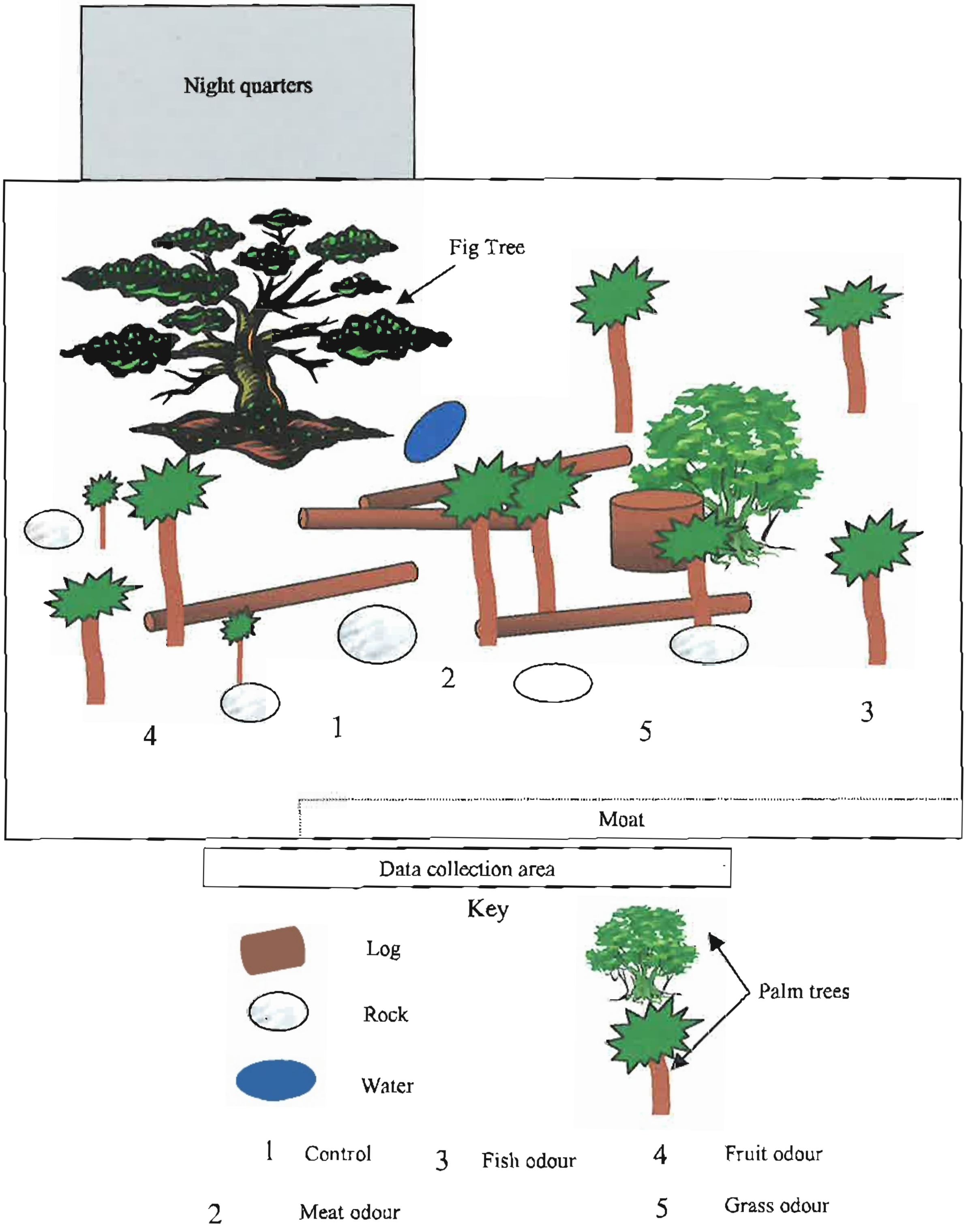

Figure 7.4 – Diagrammatic representation of the peccary enclosure showing the location of the novel odours (not drawn to scale).

7.2.4 Apparatus and Equipment

The purpose of this study was to compare the animals' reactions to various types of novel odours and to achieve this it was decided to use food related odours. This was so that it could be determined if the animals showed more interest in food related novel objects or non-food related novelty. Four different food items were chosen as the novel odours. These were oranges, freshly cut grass, fresh pilchards (*Sardinops neopilchardus*), and beef off-cuts. These particular items were chosen to provide a variety of novel odours that included items from each of the animal's diets and also items that the species would not have included in their diets. The peccaries are omnivorous and the only items that they did not include in their diet were the fish. In the wild they consume fruit and grass and occasionally small animals as well (Corn & Warren, 1985). The Barbary sheep are primarily grazing animals and the only item included in their diet was the grass (Nowak & Paradiso, 1983). The otters are primarily carnivores and the item that they consumed most of would be fish. In addition the otters occasionally hunted birds and small animals so the meat odour would be relevant as well (MacDonald, 1984). Grass and fruit do not form part of the diet of the otter.

In previous studies odours have been delivered by dragging items around the enclosures (Carlstead & Seidensticker, 1991) or having people walk around enclosures and leave an odour trail (Schuett & Frase, 2001). In the current study this was not appropriate because the experimenter needed to record what specific odour the animals were exploring. In addition in the other studies the animals may have been reacting to other elements of their enclosure rather than the novel odours. It was decided to make objects that the novel odours could be smeared onto. The experimenter could then be sure that the animals were exploring the odour and what odour was being explored.

To make the objects long pine logs 15cm in diameter were cut into lengths of 30cm. A metal strip 30 cm long with a hole in each end was then fixed across the logs with screws. See Figure 7.5 for a diagram of the logs. The logs could then be placed in the enclosures and fixed in place by putting tent pegs through the holes in the metal strips and hammering them into the ground. Fifteen logs in all were cut to enable five logs to be placed in each of the enclosures. The logs were numbered on the ends with black paint from 1 to 5. The odours were then smeared consistently on the same numbered logs for each species. Log number 1 was the control and had no odour placed on it. Number 2 had the meat odour smeared on it. Fish was number 3, fruit was 4 and grass was 5. This enabled the researcher to quickly identify what odour was on the log.

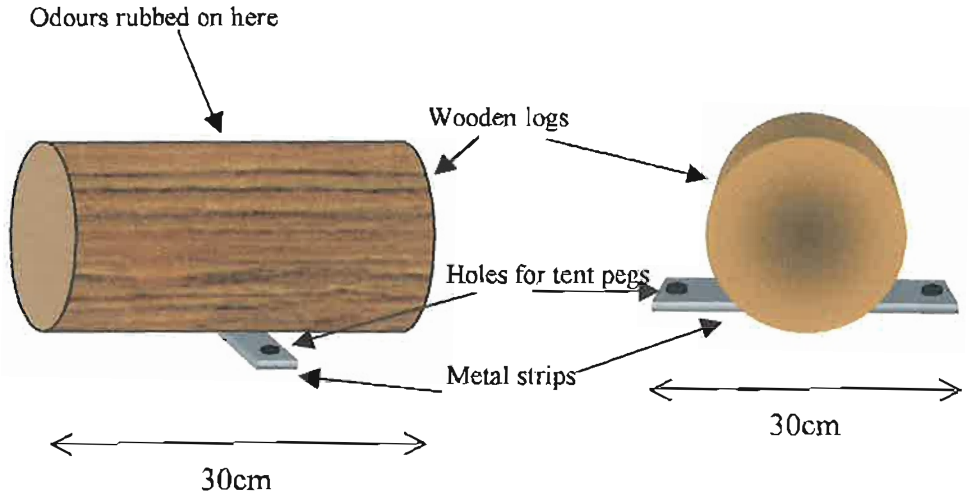

Figure 7.5 – Logs that the odours were rubbed on.

A sign was placed on the Barbary sheep, peccary and otter enclosures to explain to the public the general nature of the study (See Appendix B). All observation sessions were recorded directly onto check sheets designed during the reconnaissance observation sessions. See Appendix C for examples of the check sheets used in the study. Random sessions were taped to allow inter- and intra-observer reliability assessments to be performed.

Other miscellaneous equipment included:

- Video Camera (NV-M7A)
- 2 x 12 Volt Panasonic batteries
- Recharged using an AC Adaptor (VW-AM7A
- Tripod (SLIK 505QF)
- Blank video tapes
- Pentax camera for still photographs
- Stopwatch

7.2.5 Procedure

7.2.5.1 Reconnaissance observations

Reconnaissance observations were performed for one week prior to the commencement of the study for each of the species. This time allowed the researcher to become familiar with the animals and enabled fast recognition of them. This period also allowed time to design and refine the check sheets so as to allow fast recording of the behaviours.

7.2.5.2 Behavioural categories

The behaviours recorded were the same as for the previous study and a description of them can be found in Section 6.2.5.2.

7.2.5.3 Experimental design

The otters, peccaries and Barbary sheep were observed over a four-week period from the 1st May to the 28th May 2000. Before the logs were placed in the enclosures the odours were applied by smearing the material onto them. The logs were then placed in the enclosures in the same order of odours. Tent pegs were placed through the holes in the metal rod that was attached to the logs and then hammered into the ground to keep the logs in place. Once the logs were in the enclosure the odours were then re-applied every second day to prevent the odours from losing their intensity and that being the reason that the animals were no longer interested. A summary of the experimental design can be seen in Table 7.2.

Table 7.2 - Experimental design for the novel odour study

Phase	**Baseline**	**Novelty week 1**	**Novelty week 2**	**Post-Experimental**
Timespan	1/5/00-7/5/00	8/5/00-14/5/00	15/5/00-21/5/00	22/5/00-28/5/00
Number of Sessions	5 each group	5 each group	5 each group	5 each group
Number of Hours	10 each group	10 each group	10 each group	10 each group
Function	Record data to establish baseline	Odours in enclosure (odours reapplied every two days)	Odours in enclosure (odours reapplied every two days)	All odours removed and animals observed only

7.2.5.4 Data collection

The data collection was the same as for the previous study and a description of this can be found in Section 6.2.5.4.

7.3 Results

As stated in Section 5.5 the definitions of the magnitude of changes to behaviour levels will follow the format of Kardos (1999). These are as set out below:

Small changes or effects are: 0.01% to 7.5%

Moderate changes or effects are: 7.51% to 15.0%

Large changes or effects are: 15.01% and higher.

Hypotheses

7.3.1 Hypothesis One

It was predicted that each species would:

(a) Spend more time exploring the novel objects with the odours than the novel control object.

(b) Take longer to habituate to the novel objects impregnated with odours than the novel control object.

Barbary sheep

Figure 7.6 indicates the levels of exploratory behaviour with each of the odours for the adult Barbary sheep. It is apparent that levels of exploratory behaviour were small for all the odours, except the grass odour. The animals spent between 0.17 and 0.33 percent exploring the control novel object with no odour. The meat fruit and fish novel odours were explored for between 0.33 and 1.50 percent of the time. The grass odour was explored for between 7.17 and 8.33 percent. The only novel odour that was explored more than the control was the grass odour with a small to moderate increase. This did not support the hypothesis that the odours would be explored more than the control.

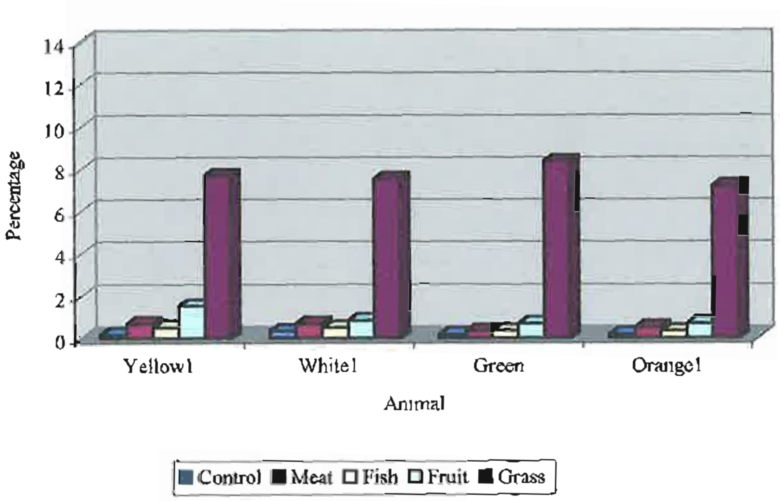

Figure 7.6 - Exploratory behaviour levels for each odour for the adult Barbary sheep.

Figure 7.7 indicates the exploratory behaviour levels for the sub-adult Barbary sheep with each of the odours. Once again levels of exploratory behaviour were very low for all odours except the grass odour. The animals spent between 0.33 and 0.50 percent of time exploring the control object with no odour. In contrast to this the grass odour was explored for between 8.00 and 10.83 percent of the time. The meat, fish, and fruit odours were explored for a small amount more or the same amount of time as the control. The exploratory behaviour levels can be seen in Table 7.3. These results supported the hypothesis for the grass odour but not for the meat, fish, and fruit odours.

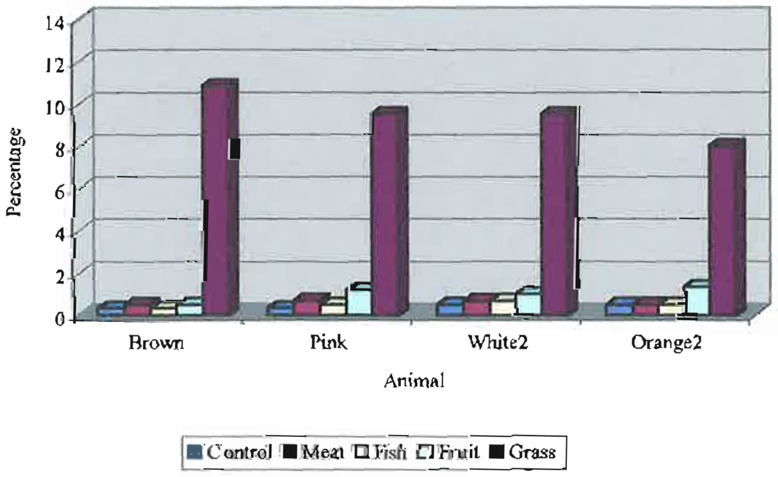

Figure 7.7 - Exploratory behaviour levels for each odour for the sub-adult Barbary sheep.

Table 7.3 – Exploratory behaviour with each of the novel odours for the Barbary sheep.

Animal	Control Mean (SD)	Meat Mean (SD)	Fish Mean (SD)	Fruit Mean (SD)	Grass Mean (SD)
Yellow1	0.17 (0.83)	0.67 (0.76)	0.50 (0.53)	1.50 (2.37)	7.67 (7.67)
White1	0.33 (0.44)	0.67 (0.76)	0.50 (0.53)	0.83 (1.14)	7.50 (7.58)
Green	0.17 (0.83)	0.33 (0.44)	0.33 (0.44)	0.67 (0.89)	8.33 (3.02)
Orange1	0.17 (0.83)	0.50 (0.71)	0.33 (0.44)	0.67 (0.76)	7.17 (8.11)
Brown	0.33 (0.44)	0.50 (0.53)	0.33 (0.44)	0.50 (0.71)	10.83 (8.56)
Pink	0.33 (0.44)	0.67 (0.76)	0.50 (0.53)	1.17 (1.20)	9.50 (7.44)
White2	0.50 (0.71)	0.67 (0.76)	0.67 (0.76)	1.00 (1.15)	9.50 (7.26)
Orange2	0.50 (0.53)	0.50 (0.53)	0.50 (0.53)	1.33 (1.27)	8.00 (6.04)

The Barbary sheep habituated to the control object faster than to any of the other novel odours. This is apparent in Figure 7.8. All the Barbary sheep had habituated to the control object by session five. They then took until sessions six, seven and eight for the other odours. This supported the hypothesis that the Barbary sheep would take longer to habituate to the objects impregnated with odour than the control novel object.

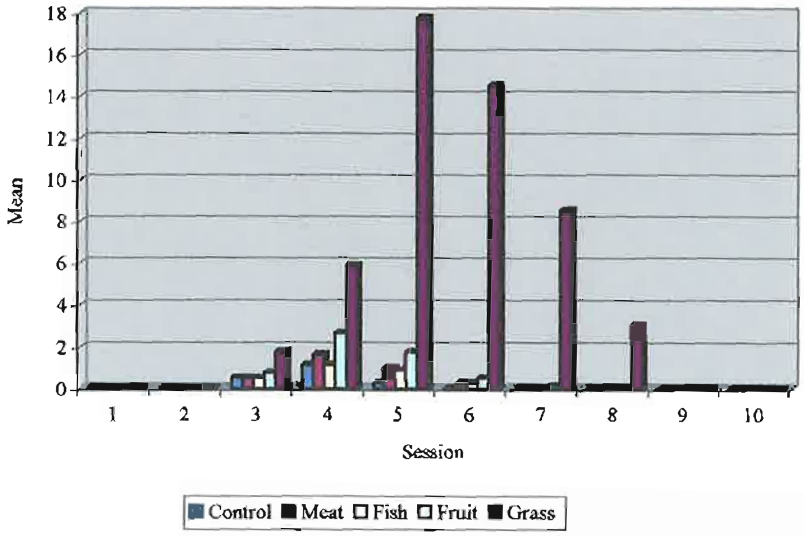

Figure 7.8 - Habituation times for the Barbary sheep

Otters

Figure 7.9 indicates the levels of exploratory behaviour with each of the novel odours for the otters. Levels of exploratory behaviour were small for the control, fruit and grass odours. The animals spent between 0.33 and 0.50 percent of the time exploring the control novel object. They spent between 0.67 and 1.00 percent exploring the fruit and grass odours, and this is defined as a small amount. These figures can be seen in Table 7.4. The animals spent a small to moderate amount of time exploring the fish and meat odours of between 2.50 and 13.0 percent. These results supported the hypothesis for the fish and meat odours but not for the fruit and grass odours.

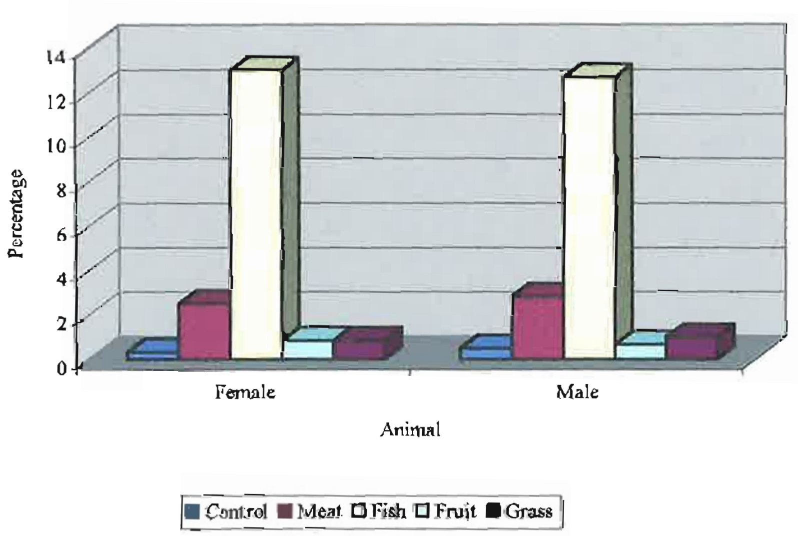

Figure 7.9 - Exploratory behaviour levels for each odour for the otters.

Table 7.4 – Exploratory behaviour with each of the novel odours for the otters.

Animal	Control Mean (SD)	Meat Mean (SD)	Fish Mean (SD)	Fruit Mean (SD)	Grass Mean (SD)
Female	0.50 (0.53)	2.83 (2.47)	12.67 (9.78)	0.67 (0.76)	1.00 (0.94)
Male	0.33 (0.44)	2.50 (2.55)	13.00 (2.91)	0.83 (0.92)	0.83 (0.79)

Figure 7.10 indicates the habituation times to the odours for the otters. It is apparent that the otters had habituated to the control and fruit odour by session 3. It then took between sessions 4 and 6 for the animals to habituate to the rest of the novel odours. This shows partial support for the hypothesis in that the otters had habituated to the control and fruit odours by the same session but took longer to habituate to the rest of the odours.

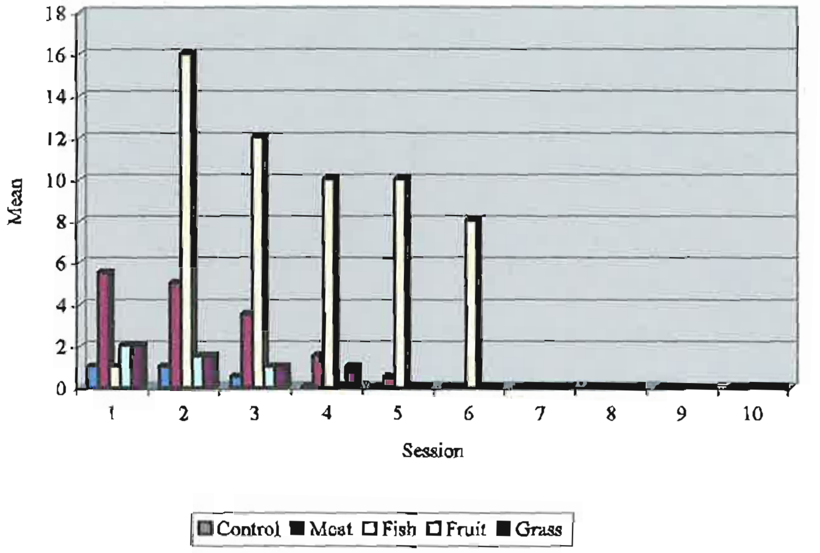

Figure 7.10 - Habituation times for the otters.

Peccaries

Figures 7.11 and 7.12 indicate the levels of exploratory behaviour with the novel odours for the peccaries. There were moderate differences in exploratory behaviour levels for the control novel object from the meat, fruit and grass odours. The control object was explored for between 0.33 and 0.67 percent. The peccaries explored the meat, fruit and grass odours for between 3.67 and 5.50 percent. The fish odour was only explored for between 0.67 and 0.83 percent. The exploratory behaviour levels can be seen in Table 7.5. This shows partial support for the hypothesis with the meat, fruit and grass odours but no support for the fish odour.

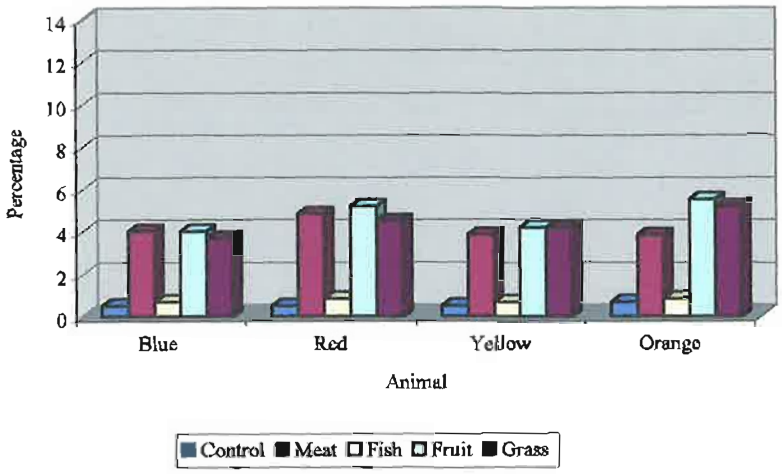

Figure 7.11 - Exploratory behaviour levels for each odour for the female peccaries.

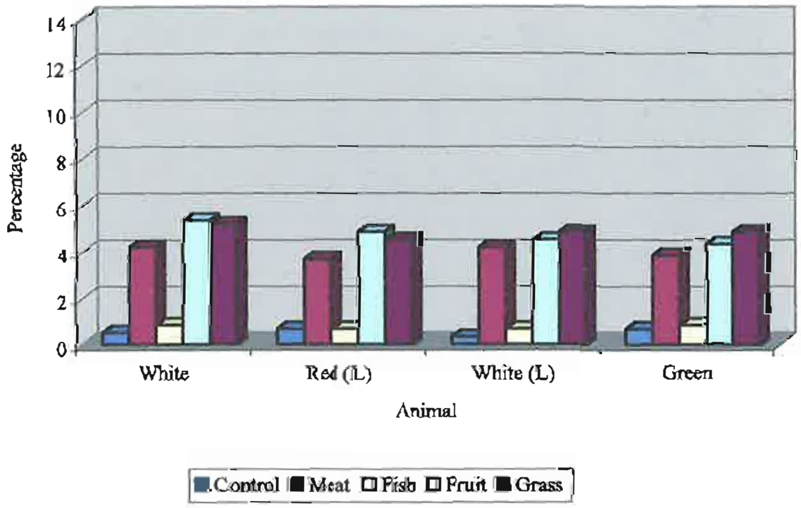

Figure 7.12 - Exploratory behaviour levels for each odour for the male peccaries.

Table 7.5 – Exploratory behaviour with each of the novel odours for the peccaries.

Animal	Control	Meat	Fish	Fruit	Grass
Blue	0.50 (0.71)	4.00 (3.80)	0.67 (0.76)	4.00 (3.74)	3.67 (3.35)
Red	0.50 (0.53)	4.83 (4.11)	0.83 (0.79)	5.17 (4.62)	4.50 (4.25)
Yellow	0.50 (0.71)	3.83 (3.67)	0.67 (0.76)	4.17 (3.72)	4.17 (3.89)
Orange	0.67 (0.76)	3.83 (3.08)	0.83 (0.79)	5.50 (4.33)	5.17 (4.08)
White	0.50 (0.53)	4.17 (3.63)	0.83 (0.79)	5.33 (4.31)	5.17 (4.24)
Red (L)	0.67 (0.76)	3.67 (3.32)	0.67 (0.76)	4.83 (4.34)	4.50 (4.79)
White (L)	0.33 (0.44)	4.17 (3.89)	0.67 (0.76)	4.50 (4.12)	4.83 (4.40)
Green	0.67 (0.76)	3.83 (3.42)	0.83 (0.79)	4.33 (3.86)	4.83 (4.32)

Figure 7.13 indicates the habituation times for the peccaries. It is apparent that the peccaries had habituated to the control object by the third session. It then took until between sessions 4 and 8 for the peccaries to habituate to the rest of the odours. This supports the hypothesis that the peccaries would habituate to the control novel object faster than the other novel odours.

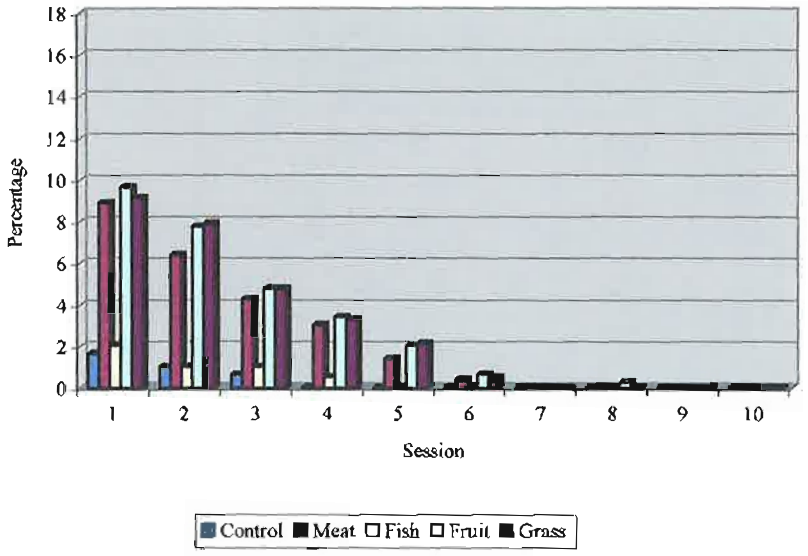

Figure 7.13 - Habituation times for the peccaries.

Summary

The data from the peccaries, Barbary sheep and otters partially supported the hypothesis that the animals would explore the novel odours more than the control novel object. The animals explored some of the odours more than the control but others they explored for the same amount of time. The hypothesis that the animals would habituate fastest to the control object was also partially supported. The peccaries and Barbary sheep habituated to the control object faster than all the novel odours. The otters habituated to the control object and the fruit odour faster than the other odours.

7.3.2 Hypothesis Two

It was predicted that each species would:

(a) Spend more time exploring the odours with more biological significance for their species.

(b) Take longer to habituate to the odours with more biological significance for their own species than the other odours.

Barbary sheep

Figures 7.6 and 7.7 indicate the overall levels of exploratory behaviour for the Barbary sheep with each of the novel odours. As expected the Barbary sheep performed the most exploratory behaviour with the grass odour, a moderate amount of between 7.17 and 10.83 percent. The levels of exploratory behaviour for the rest of the odours and the control were small, between 0.17 and 1.50 percent. This supported the hypothesis that the Barbary sheep would explore the grass odour more than the other novel odours.

Figure 7.8 shows the habituation times for the Barbary sheep to each of the novel odours. The Barbary sheep took until session 8 to habituate to the grass odour and this was the longest time taken to habituate to any of the odours. They only took until session 7 to habituate to the rest of the novel odours. These results supported the hypothesis that it would take the longest to habituate to the novel odour that has the most biological significance for the species. In this case the only odour that had any biological significance was the grass odour since this formed part of the Barbary sheep's diet.

Otters

Figure 7.9 shows the overall levels of exploratory behaviour for the otters with each of the novel odours. It is apparent that the otters performed the most exploratory behaviour with the fish odour, a moderate amount of between 12.67 and 13.00 percent. The levels of exploratory behaviour with the control, fruit and grass odours were all small, between 0.33 and 1.00 percent. The meat odour was explored for about 2.67 percent of the time. These results support the hypothesis that the otters would spend the most time exploring the fish odour that had the most biological significance for them.

Figure 7.10 indicates the habituation times for the otters for each of the odours. It is apparent that the otters took the longest time to habituate to the fish odour and that was the one that had the most biological significance for them. They had habituated to the fish odour by day 6 whereas it only took until day 5 to habituate to the rest of the novel odours. This supported the hypothesis that the otters would take the longest time to habituate to the odours that had the most biological significance for them.

Peccaries

Figures 7.11 and 7.12 reveals the levels of exploratory behaviour for the peccaries. It can be seen that the peccaries spent more time exploring the meat, fruit and grass odours, between 3.67 and 5.50 percent, than the control or fish odour, between 0.33 and 0.83. These results support the hypothesis that the animals would spend more time investigating the odours that have biological significance for their species.

Figure 7.13 reveals the habituation times for the peccaries to each of the odours. It is apparent that the peccaries had habituated to the control object by session three and the fish odour by session 4. These were the two odours that had no biological significance for the peccaries. The other novel odours took between sessions 6 and 8. These results support the hypothesis that the animals would take the longest to habituate to the novel odours that were the most significant for their species.

Summary

The data from the three different species supported the hypothesis that the animals would explore more and take longer to habituate to the novel odours that had biological significance for their species.

7.3.3 Hypothesis Three

It is predicted that the:

(a) Peccaries and otters would spend more time exploring the novel odours than the Barbary sheep.

(b) Peccaries and otters would take longer to habituate to the novel odours than the Barbary sheep.

Figure 7.14 shows that the first part of the hypothesis was supported for the first novelty week. During the first week of the novelty phase the otters performed 8.05 percent more exploratory behaviour than the Barbary sheep. The peccaries performed 9.84 percent more exploratory behaviour than the Barbary sheep. These results suggest that the peccaries and otters did perform more exploratory behaviour on the novel odours than the Barbary sheep and supported the hypothesis.

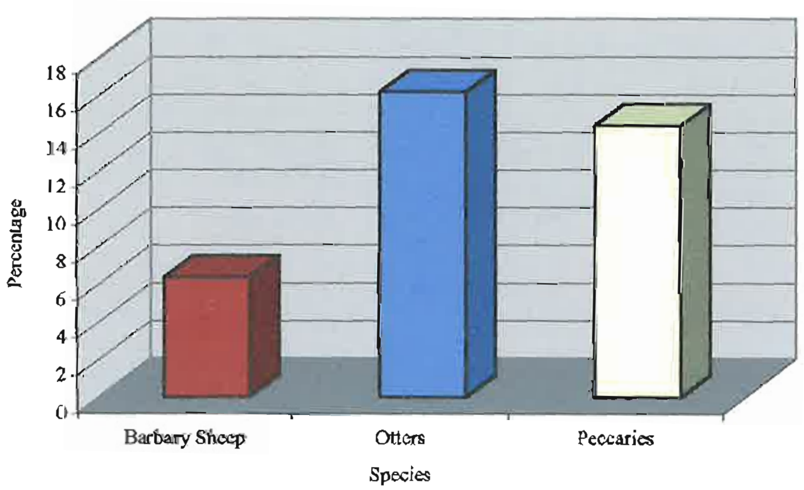

Figure 7.14 - Exploratory behaviour levels for the first week of the study.

The results from the second week are shown in Figure 7.15. It is apparent that the Barbary sheep performed more exploratory behaviour than the peccaries and otters. During this time the Barbary sheep performed 3.19 percent more exploratory behaviour than the otters and 4.23 percent more exploratory behaviour than the peccaries. All of the exploratory behaviour levels can be seen in Table 7.6. These results may suggest that at this time the peccaries and otters had habituated to the objects whereas the Barbary sheep had not. The hypothesis was partially supported in that the results from the first novelty week supported it but not the results from the second novelty week.

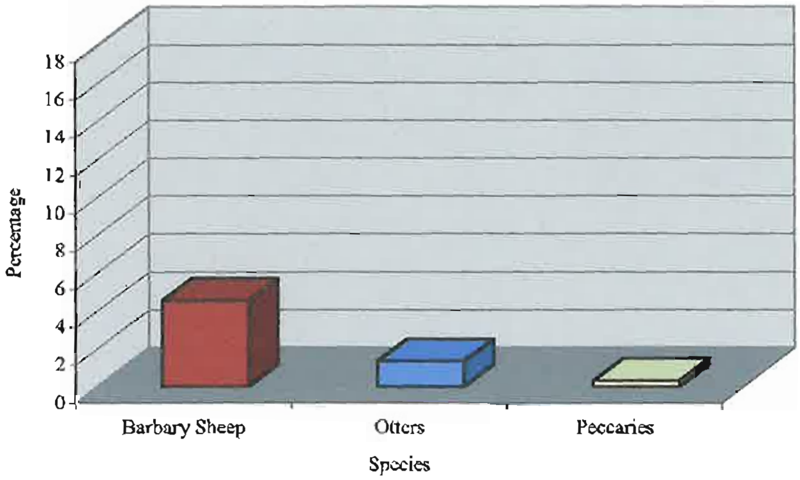

Figure 7.15 - Exploratory behaviour levels for the second week of the study.

Table 7.6 – Exploratory behaviour for each of the species during the two novelty weeks.

Species	**Novelty week 1** **Mean (SD)**	**Novelty week 2** **Mean (SD)**
Barbary sheep	6.33 (0.61)	4.52 (0.82)
Otters	16.17 (0)	1.33 (0)
Peccaries	14.38 (1.00)	0.29 (0.37)

Figure 7.16 indicates the habituation times for each of the species to the novel odours. It is apparent that the Barbary sheep took until session 8 to habituate to the novel odours. They took the longest time of the three species. The otters took until session 6 and the peccaries only performed a small amount of exploratory behaviour after session 6. Although the Barbary sheep took the longest to habituate to the odours they did not explore the novel odours at all until day 3 whereas the other species started on the day they were exposed to them. These results do not support the hypothesis that the peccaries and otters would take longer to habituate to the novel odours than the Barbary sheep.

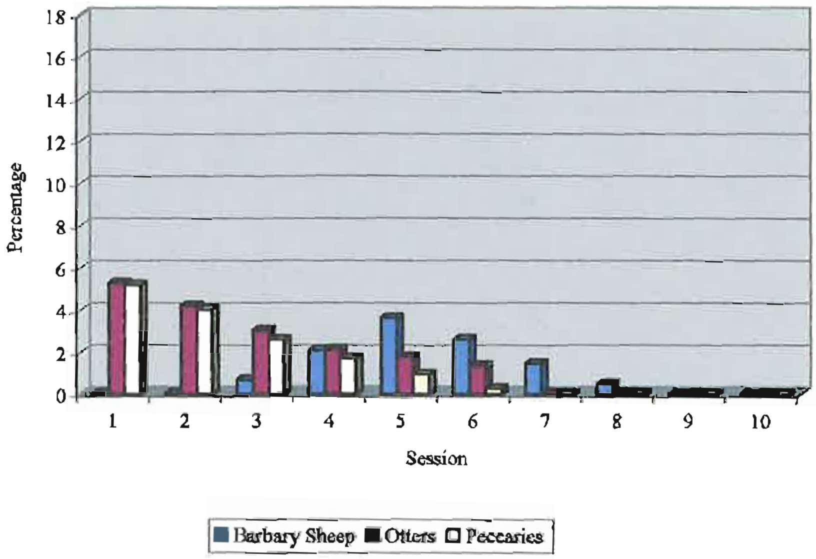

Figure 7 16 - Habituation times for each species to the novel odours.

7.3.4 Hypothesis Four

It was predicted that the presence of the novel odours would stimulate an increase in overall exploratory behaviour.

Barbary sheep

Figures 7.17 and 7.18 indicate the level of exploratory behaviour during each week of the study. It is apparent that all the animals performed more exploratory behaviour during the two novel weeks as opposed to the two weeks when there were no novel odours present. The animals spent between 5.50 and 7.17 percent more time exploring during the first novelty week as opposed to the baseline week. During the second novelty week the animals spent between 3.00 and 5.17 more time exploring than during the baseline week. Even though the increases were small so was overall exploratory behaviour and therefore the differences could only be small. These differences are represented in Table 7.7. This supported the hypothesis that the presence of the novel odours would stimulate an increase in the amount of exploratory behaviour.

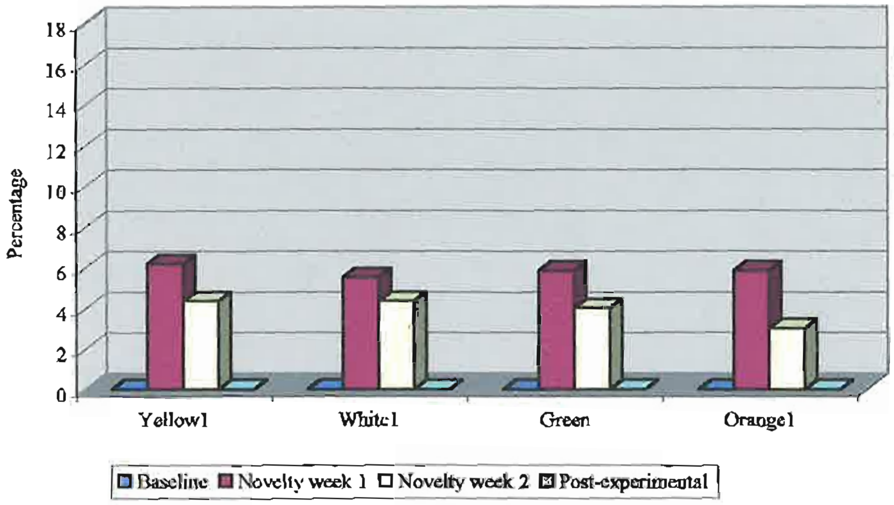

Figure 7.17 - Exploratory behaviour levels for adult Barbary sheep.

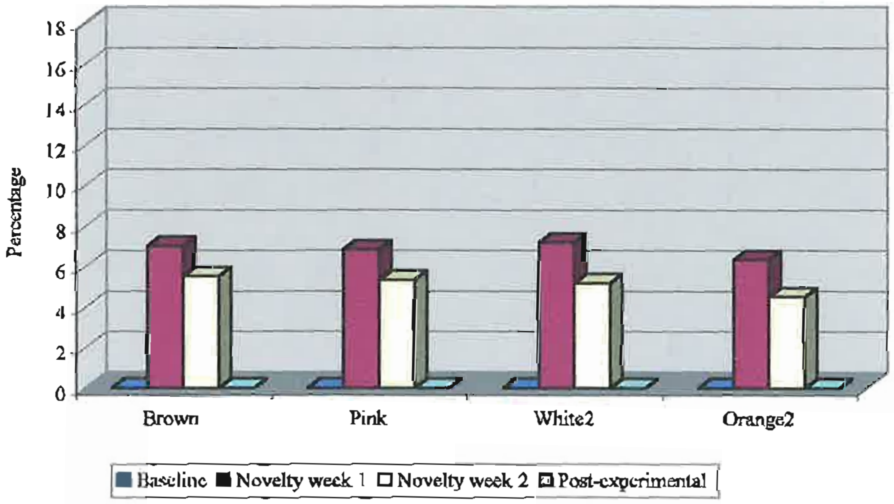

Figure 7.18 - Exploratory behaviour levels for the sub-adult Barbary sheep.

Table 7.7 – Exploratory behaviour during the two novelty weeks for the Barbary sheep.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-experimental Mean (SD)
Yellow1	0 (0)	6.17 (11.21)	4.33 (7.72)	0 (0)
White1	0 (0)	5.50 (10.21)	4.33 (7.49)	0 (0)
Green	0 (0)	5.83 (11.03)	4.00 (7.21)	0 (0)
Orange1	0 (0)	5.83 (11.39)	3.00 (5.41)	0 (0)
Brown	0 (0)	7.00 (9.10)	5.50 (7.30)	0 (0)
Pink	0 (0)	6.83 (8.78)	5.33 (7.33)	0 (0)
White2	0 (0)	7.17 (8.39)	5.17 (6.75)	0 (0)
Orange2	0 (0)	6.33 (7.96)	4.50 (5.64)	0 (0)

Otters

Figure 7.19 indicates the levels of exploratory behaviour during each week of the study. It is apparent that all the animals performed more exploratory behaviour during the first week of novelty than the baseline week. During this time there was an increase of between 16.17 and 16.33 percent in the exploratory behaviour. This difference is defined as a moderate to large difference. These differences can be seen in Table 7.8. The exploratory behaviour levels returned nearly to baseline levels during the second novelty week indicating that the animals no longer found the odours novel. This supported the hypothesis that the presence of novel odours would increase the quantity of exploratory behaviour while the odours were still perceived as novel by the animals.

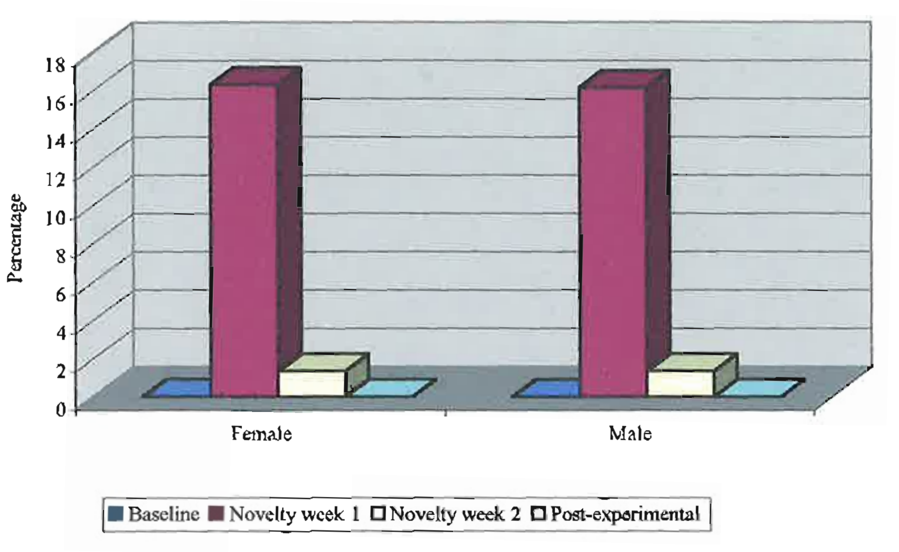

Figure 7.19 - Exploratory behaviour levels for the otters.

Table 7.8 – Exploratory behaviour during the two novelty weeks for the otters.

Animal	**Baseline Mean (SD)**	**Novelty week 1 Mean (SD)**	**Novelty week 2 Mean (SD)**	**Post-experimental Mean (SD)**
Female	0 (0)	16.33 (11.21)	1.33 (3.59)	0 (0)
Male	0 (0)	16.17 (8.15)	1.33 (3.59)	0 (0)

Peccaries

Figures 7.20 and 7.21 indicate the levels of exploratory behaviour with the novel odours during each week of the study. It is apparent that all the animals performed more exploratory behaviour during the first week of the novelty phase. During this time there was an increase of between 12.83 and 15.83 percent, a moderate to large difference. These differences can be seen in Table 7.9. The exploratory behaviour levels returned to very close to baseline levels for all the peccaries during the second week. This indicates that the animals no longer perceived the odours as novel during this time. These results supported the hypothesis that the novel odours would stimulate an increase in exploratory behaviour but only for as long as the odours were perceived as novel by the animals.

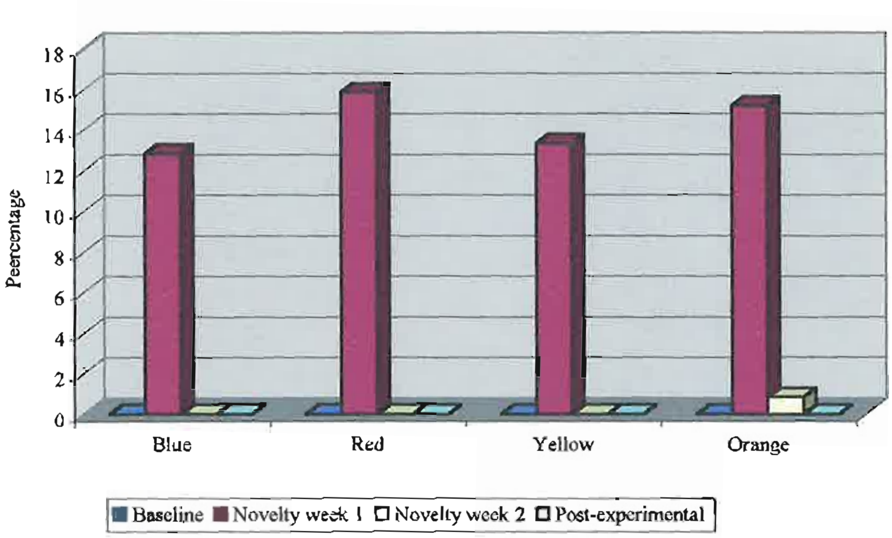

Figure7.20 - Exploratory behaviour levels for the female peccaries.

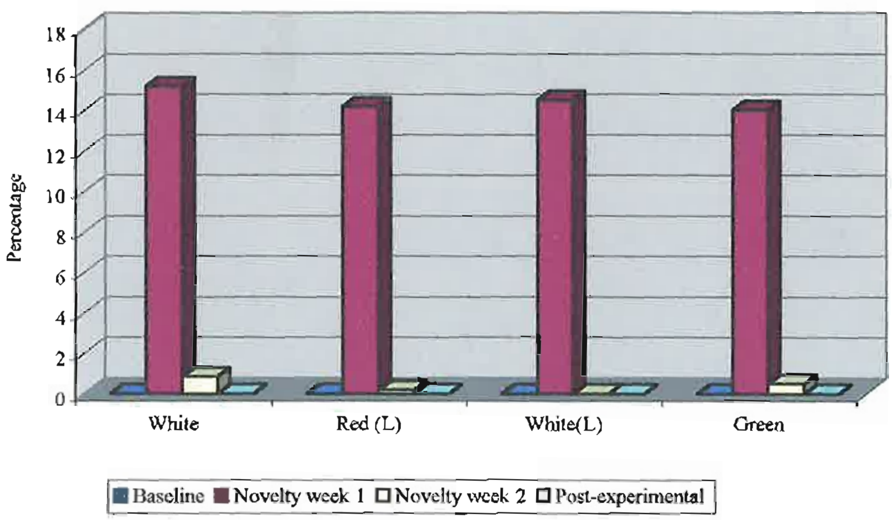

Figure 7.21 - Exploratory behaviour levels for the male peccaries.

Table 7.9 – Exploratory behaviour during the two novelty weeks for the peccaries.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-experimental Mean (SD)
Blue	0 (0)	12.83 (11.44)	0 (0)	0 (0)
Red	0 (0)	15.83 (11.71)	0 (0)	0 (0)
Yellow	0 (0)	13.33 (10.97)	0 (0)	0 (0)
Orange	0 (0)	15.17 (8.84)	0.83 (1.43)	0 (0)
White	0 (0)	15.17 (11.05)	0.83 (2.24)	0 (0)
Red (L)	0 (0)	14.17 (10.49)	0.17 (0.45)	0 (0)
White (L)	0 (0)	14.50 (11.97)	0 (0)	0 (0)
Green	0 (0)	14.00 (14.05)	0.50 (1.35)	0 (0)

Summary

The Barbary sheep performed more exploratory behaviour during both the novelty weeks than the baseline and post-experimental weeks. This supported the hypothesis that the presence of the novel odours would stimulate an increase in exploratory behaviour. The peccaries and otters both preformed more exploratory behaviour in the first novelty week but exploratory behaviour returned to baseline levels during the second novelty week. This suggests that the exploratory behaviour remained high until habituation to the novelty had occurred.

7.3.5 Hypothesis Five

It was predicted that the presence of the novel odours would stimulate an increase in play behaviour.

Barbary sheep

Figures 7.22 and 7.23 indicate the levels of play behaviour for each condition of the study. It is apparent that all the animals performed more play behaviour during the novelty weeks than when there was no novelty present. The Barbary sheep performed between 5.67 and 15.00 percent more play behaviour in the first novelty week than during the baseline week. This was defined as being a small to moderate difference. They also performed between 3.83 and 12.17 percent more play behaviour during the second novelty week than during the baseline week. This was also a small to moderate difference. These differences can be seen in Table 7.10. This supported the hypothesis that the animals would perform more play behaviour when the novel odours were present.

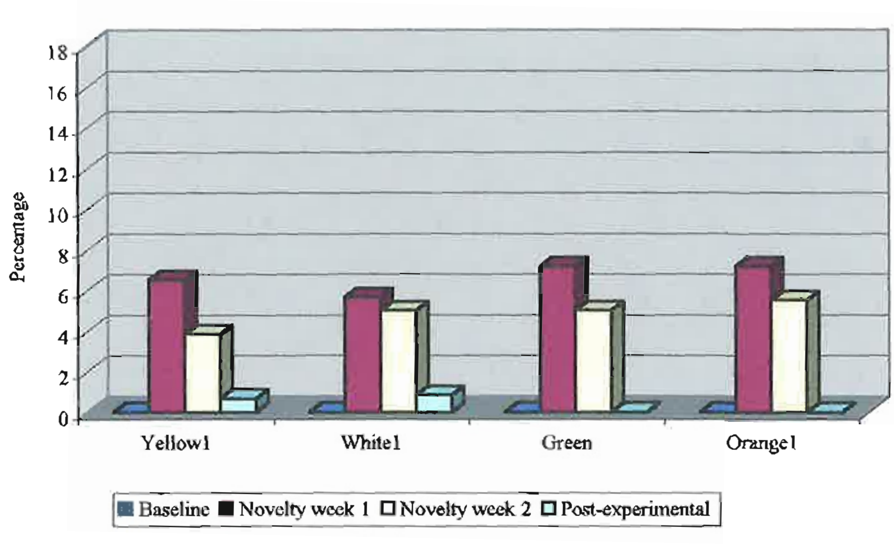

Figure 7.22 - Play behaviour levels for the adult Barbary sheep.

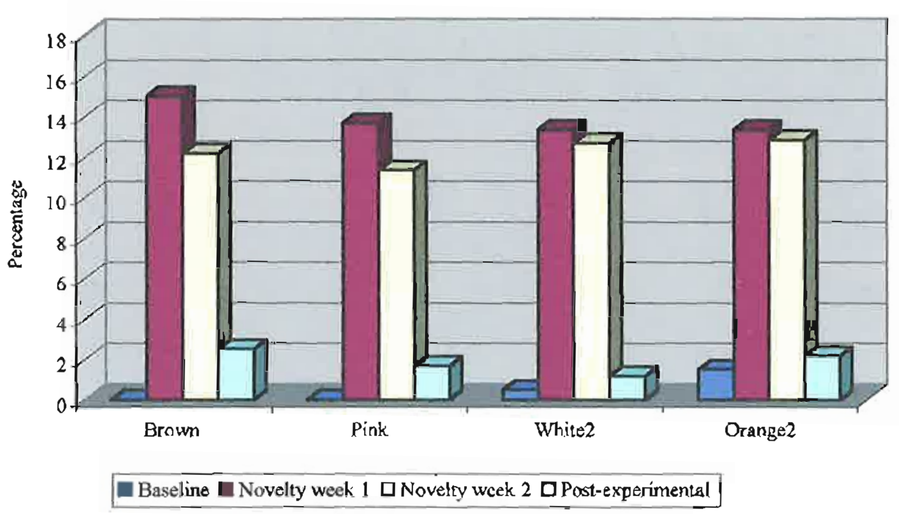

Figure 7.23 - Play behaviour levels for the sub-adult Barbary sheep.

Table 7.10 – Play behaviour during the two novelty weeks for the Barbary sheep.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-experimental Mean (SD)
Yellow1	0 (0)	6.50 (10.78)	3.83 (4.85)	0.67 (1.80)
White1	0 (0)	5.67 (9.6)	5.00 (5.63)	0.83 (2.24)
Green	0 (0)	7.17 (8.15)	5.00 (5.64)	0 (0)
Orange1	0 (0)	7.17 (8.08)	5.50 (4.51)	0 (0)
Brown	0 (0)	15.00 (4.85)	12.17 (6.02)	2.50 (2.19)
Pink	0 (0)	13.67 (7.56)	11.33 (6.73)	1.67 (2.15)
White2	0 (0)	13.33 (22.81)	12.67 (4.66)	1.17 (1.97)
Orange2	0 (0)	13.33 (22.81)	12.83 (4.48)	2.17 (2.65)

Otters

Figure 7.24 indicates the levels of play behaviour for each condition of the study. It is apparent that the animals performed the most play behaviour during the first novelty week followed by the second novelty week. The otters performed more play behaviour during these weeks than during the baseline or post-experimental weeks. The otters performed 12.17 percent more play behaviour during the first novelty week than during the baseline, a moderate difference. During the second novelty week they spent a moderate 8.50 percent more time playing than during the baseline week. These differences can be seen in Table 7.11. These results supported the hypothesis that the presence of novelty would increase the amount of play behaviour that the animals exhibited.

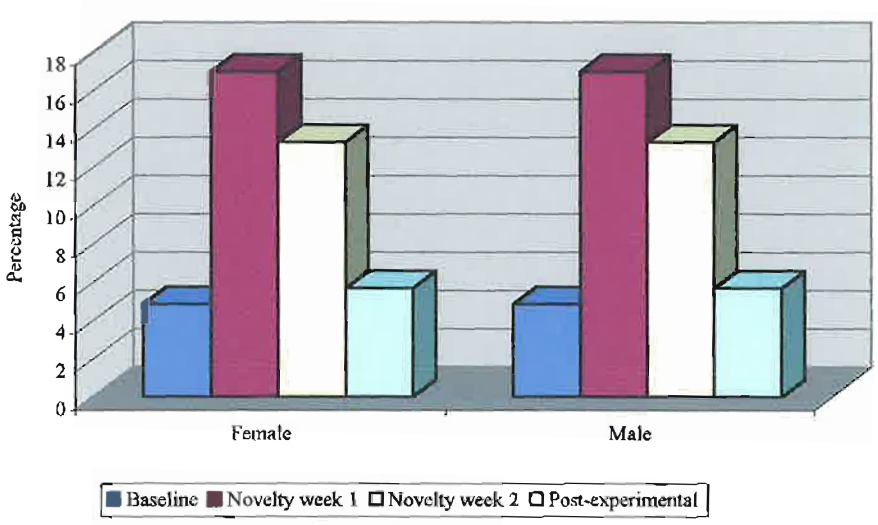

Figure 7.24 - Play behaviour levels for the otters.

Table 7.11 – Play behaviour during the two novelty weeks for the otters.

Animal	**Baseline** **Mean (SD)**	**Novelty week 1** **Mean (SD)**	**Novelty week 2** **Mean (SD)**	**Post-experimental** **Mean (SD)**
Female	4.83 (3.59)	17.00 (5.12)	13.33 (6.40)	5.67 (4.72)
Male	4.83 (3.59)	17.00 (5.12)	13.33 (6.40)	5.67 (4.72)

Peccaries

Figures 7.25 and 7.26 indicate the levels of play behaviour for each condition of the study. It is apparent that the peccaries performed more play behaviour during the first and second novelty weeks than during the baseline or post-experimental weeks. All the peccaries performed more play behaviour during the first novelty week than during the second novelty week. They exhibited a large increase of between 15.50 and 17.50 percent in play behaviour during the first novelty week compared to the baseline week. During the second novelty week they performed between 11.83 and 14.17 more play behaviour than during the baseline week. This was a moderate increase from the baseline to the second novelty week in play behaviour. These differences can be seen in Table 7.12. This supported the hypothesis that the animals would spend more time playing during the novelty weeks than when there was no novelty present.

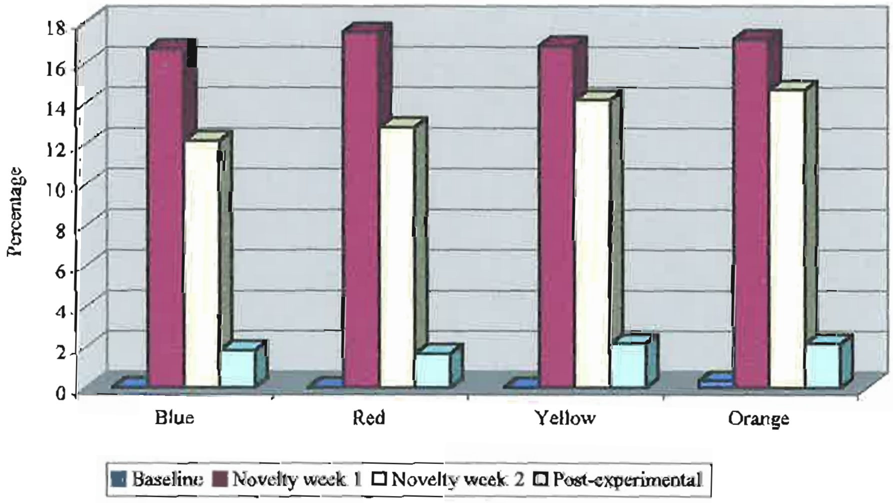

Figure 7.25 - Play behaviour levels for the female peccaries.

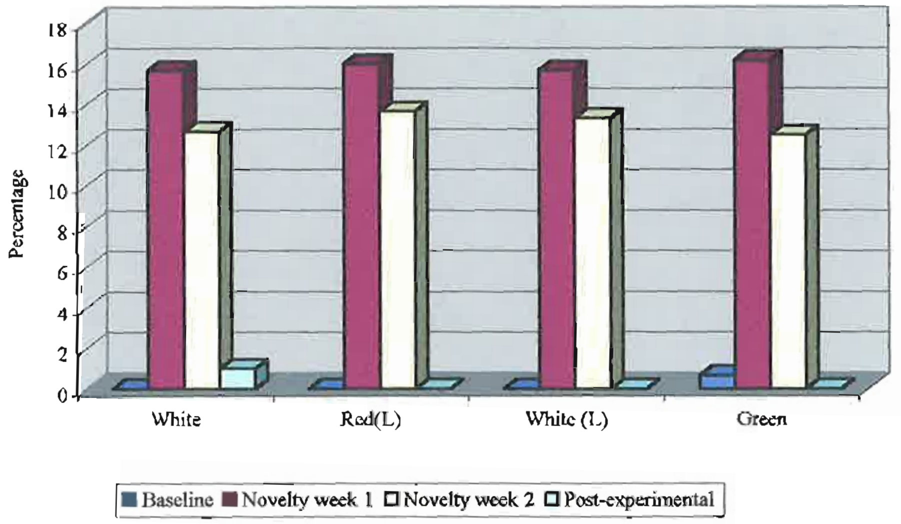

Figure 7.26 - Play behaviour levels for the male peccaries.

Table 7.12 – Play behaviour during the two novelty weeks for the peccaries.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-experimental Mean (SD)
Blue	0 (0)	16.67 (7.10)	12.17 (7.36)	1.83 (3.52)
Red	0 (0)	17.50 (6.27)	12.83 (5.57)	1.67 (2.76)
Yellow	0 (0)	16.83 (7.67)	14.17 (3.81)	2.17 (4.00)
Orange	0.33 (0.55)	17.17 (8.72)	14.67 (5.34)	2.17 (3.75)
White	0 (0)	15.67 (6.63)	12.67 (4.76)	1.00 (2.69)
Red (L)	0 (0)	16.00 (7.00)	13.67 (4.43)	0 (0)
White (L)	0 (0)	15.67 (4.35)	13.33 (4.46)	0 (0)
Green	0.67 (1.80)	16.17 (5.23)	12.50 (4.16)	0 (0)

Summary

The play behaviour was higher during the novelty weeks than the baseline or post-experimental weeks for all three species. This supported the hypothesis that the presence of the novel odours would stimulate an increase in play behaviour.

7.3.6 Hypothesis Six

It was predicted that stereotypical behaviour would be reduced by the presence of the novel odours.

This hypothesis could only be tested for the otters since they were the only species that performed any stereotypical behaviour. Figure 7.27 indicates the levels of stereotypical behaviour for the male and female otters for each condition of the study. It is apparent that the stereotypical behaviour decreased by a moderate amount of between 8.67 and 9.50 percent when the novelty was introduced. The otters performed no stereotypical behaviour when the novel odours were present in the enclosure. When the novel odours were removed the stereotypical behaviour then increased by a small amount of 3.33 percent. These differences can be seen in Table 7.13. This supported the hypothesis that the stereotypical behaviour would decrease with the introduction of the novel odours.

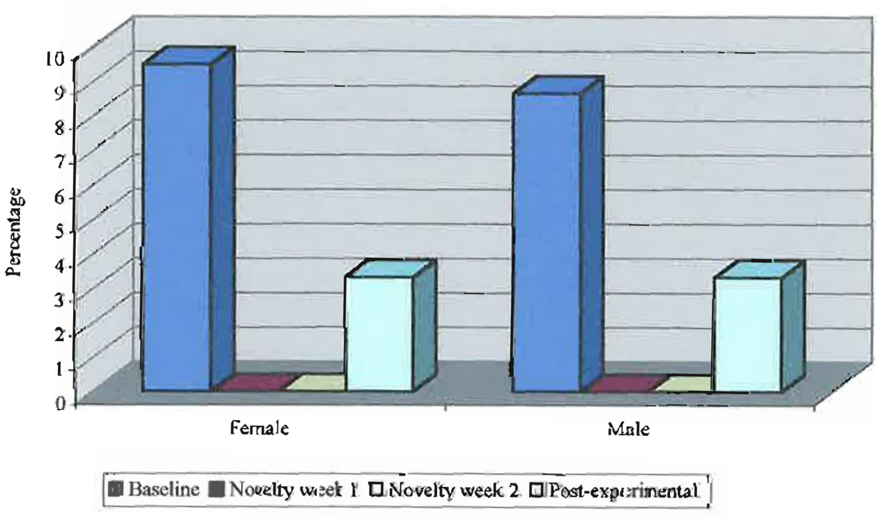

Figure 7.27 - Stereotypical behaviour levels for the otters.

Table 7.13 – Stereotypical behaviour during the two novelty weeks for the otters.

Animal	Baseline Mean (SD)	Novelty week 1 Mean (SD)	Novelty week 2 Mean (SD)	Post-experimental Mean (SD)
Female	8.67 (7.62)	0 (0)	0 (0)	3.33 (3.75)
Male	9.50 (7.60)	0 (0)	0 (0)	3.33 (3.75)

7.4 Discussion

7.4.1 Exploratory behaviour

Contrary to expectations, the three species did not explore the novel objects with odours more than the control novel object. The peccaries and Barbary sheep habituated to the control novel object faster than the odours but the otters habituated to the fruit odour and the control at the same time. These results partially support the findings of Ostrower and Brent (1997), Hall (1998), and Schuett & Frase (2001) that animals explore objects more and take longer to habituate to novel objects if they have a sensory component to them. The results also suggested that each of the species only explored the odours more than the control if the odours had some significance for their species.

In the current studies the biologically significant odours were those that formed part of the species diet as opposed to the odours that did not. The peccaries spent longer exploring and took longer to habituate to the fruit, grass and meat odours than the fish odour or control object (See Figure 7.28). In the wild the peccaries are omnivores and fruit, grass and meat form part of their basic diet making these odours biologically significant for the species (Corn & Warren, 1985). The only odour that was biologically significant for the Barbary sheep was the grass odour since this was the only item that was included in their diet (Nowak, 1999). As predicted they spent longer exploring this odour and also took longer to habituate to it (See Figure 7.29). The most biologically significant odour for the otters was the fish odour, as this forms the bulk of their diet in the wild (MacDonald, 1984). As expected, they took longer to habituate to and spent more time exploring the fish odour than the other odours (See Figure 7.30). In the wild otters also occasionally catch small mammals and birds and as predicted, the meat odour was also explored more than the control but not as much as the fish odour.

Figure 7.28 – A female peccary exploring the grass odour.

Figure 7.29 – A juvenile Barbary sheep exploring the grass odour.

Figure 7.30 – The two otters exploring the meat odour.

These results further support the findings of Heinrich and Smolker (1998) that animals show a preference for novel objects that have biological significance for them by exploring them more and taking longer to habituate to them. In addition, this supports the results of Hall (1998) that the animals will spend more time with and take longer to habituate to objects impregnated with novel odours if the odour has biological significance for the animals. This suggests that the novel enrichment items that will encourage the most exploratory and also take longer to habituate to are those that hold some biological significance for the species.

The otters and peccaries performed more exploratory behaviour than the Barbary sheep during the first week that the novel odours were presented to the animals. This supported the hypothesis that the species that rely more on their olfactory sense would spend more time exploring the novel odours and also supported the statement by Ostrower and Brent (1997) that some species rely more on their olfactory sense than others do. It is also possible that the odours were more biologically significant for the species that relied on olfaction and therefore supported the findings of Heinrich and Smolker (1998) and Hall (1998). Heinrich and Smolker

(1998) and Hall (1998) both found that species would explore objects more that were significant for their species and in the current studies the olfactory stimuli were more relevant for the species that use odour regularly in their daily lives. The peccaries and otters both have advanced olfactory senses that they rely upon to scent mark, delineate territory and to communicate information about identity and sexual state (MacDonald, 1984). In addition to this, peccaries can locate food five to eight centimetres underground before the shoots are visible above the surface (Byers & Bekoff, 1981; Sowls, 1984). The Barbary sheep on the other hand do not have an advanced olfactory sense and do not rely on it on a daily basis. In addition to this these results also support the findings of Glickman and Sroges (1966), Russell and Pierce (1971) and Maple and Perkins (1996) that some animals show a tendency to be more exploratory than others.

During the second week of exposure to novelty the Barbary sheep engaged in more exploratory behaviour than the peccaries or otters. Rather than not supporting this hypothesis these results reflect the fact that the Barbary sheep took longer to habituate to the novel odours and this will be discussed further in the next section. The peccaries and otters spent more time exploring the novel odours while they were still perceived as novel by the two species (i.e. more on the first day than on the second day).

7.4.2 Play behaviour

In a study aimed at investigating the causal mechanisms of object play behaviour in cats, Hall (1998) found that one factor affecting play was the sensory component of the objects. She found that real fur elicited more intensive play behaviour and that the cats took longer to habituate to the object made of real fur than fake fur or feathers. In his study even though each of the objects, be they real fur, fake fur or feathers, had a sensory component the real fur had the most effect on the initial inspection and play behaviour of the cats. She has suggested that this adds variation to the traditional central control mechanism of play. The central control mechanism suggests that the behavioural default is to habituate to a toy after initial interest and play. Once an animal has habituated there will be no more play unless the stimuli are changed. In addition to this, Hall (1998) has suggested that the overall sensory value of the toy will affect the play directed towards the object. A similar line of reasoning can be applied to exploratory behaviour. That is, the traditional view of exploratory behaviour is that there will be initial exploration and then once habituation has occurred the object is ignored unless the object is changed or moved. Once again the overall sensory value of the object appears to influence this sequence in that if the odour is biologically significant for the species then the animal will keep returning and spend more time exploring and take longer to habituate to it. This highlights the importance of investigating the sensory value of objects and their relevance for specific species.

7.4.3 Habituation

The results did not support the hypothesis that the otters and peccaries would take longer to habituate to the odours than the Barbary sheep. The results suggested that the Barbary sheep took the longest time to habituate to the novel odours followed by the peccaries and otters. This suggests that the length of time that an animal takes to habituate to an object may be more complex than whether they belong to a species that relies on their olfactory sense in the wild and how biologically significant the odours are. This contradicts the findings of Hall (1998) and Heinrich and Smolker (1998) that animals take longer to habituate to items that are biologically significant for their species. It appears to depend also on whether they are a neophilic or neophobic species (Cowan, 1983). The peccaries and otters explored the novel odours as soon as they were given access to them. The Barbary sheep, on the other hand, avoided the novel odours for two days for the younger animals and three days for the adults. The exploratory behaviour for the peccaries and otters peaked during session 1 whereas the Barbary sheep exploratory behaviour peaked during session 5. These results suggest that Barbary sheep are a neophilic species, meaning that they avoid novel experiences. In contrast the peccaries and otters are neophobic species meaning that they seek out novel experiences. Russell (1983) has also suggested that species will explore stimuli that fall within the range of complexity normally found within their habitat. The otters and peccaries live in habitats that are more complex than the Barbary sheep and this may further explain why they initially avoided the novel odours. It may also explain why some ungulates have been found to be non-reactive to novel stimuli in the past and other species such as omnivores and carnivores more reactive. Some ungulates, like the Barbary sheep, tend to avoid novel stimuli when they are first presented with them and require a number of days to become accustomed to the novel stimuli before approaching and investigating them. On the other hand species such as peccaries and otters approach novelty immediately and are therefore considered to be more reactive to it. Studies in the past have tended to present the stimulus and then take it away immediately if there was no instantaneous reaction (Glickman & Sroges, 1966; Maple & Perkins, 1996; Russell & Pierce, 1971). The results from this study show that ungulates do react to novelty and can be exploratory if given more time to become accustomed to the novelty. Providing the animals with novel experiences maintains their stimulation levels and helps to reduce anxiety when they encounter something new. If the animals are ever to be reintroduced to the wild it is important that they are not too reactive to novel experiences.

7.4.4 Olfactory enrichment

Hayes et al (1998) have suggested that a starting point for species-appropriate environmental enrichment should be to base it on the sensory modalities that a species use in their daily lives. Since no species has been studied well enough to know everything about each of their senses, this has to be largely experimental and based on what is known about the specific species and others that are closely related. This also highlights the importance of working with zoo keepers and other researchers to determine appropriate enrichment techniques for individual species. Although the primary modalities should be the focus, researchers should not ignore the possibility of enriching animals with sensory stimuli that are not commonly used by the species concerned. Western toads have been taught to identify prey insects by odour rather than the visual stimuli that they normally use (Dole et al, 1981). Thus for this species enrichment through odour is possible. In the current studies although the peccaries and otters reacted more to the odours they still simulated exploratory and play behaviour in the Barbary sheep thus indicating that enrichment through olfaction can be appropriate for them.

7.5 Conclusions

The procedure employed in the present study could be used to promote exploration and play and to decrease stereotypical behaviours in animals in captivity. This in turn helps to promote the healthy social and physical development and well-being of zoo animals. Consistent with previous findings it was found that it is important for environmental enrichment items to include some degree of biological significance to the species for them to be explored and for it to take longer for the animals to habituate to them. It was also found that some novel odours were not explored any more than a control log with no odour, suggesting that these odours had no biological significance for the species concerned. This suggests that finding the appropriate odour for the species involved could be the difference between a successful environmental enrichment program and a complete failure. Once again two species of ungulates were found to be very reactive to novelty, with one of them requiring more time to approach the novel odours than has traditionally been allowed in novelty studies.

Chapter 8: The effects of novel avian and mammalian predator auditory stimuli on animals in captivity.

8.1 Introduction

This chapter is concerned with the results obtained by providing three captive species with access to two different types of novel predator-associated auditory stimuli. It has been proposed that the total removal of animals from predator-associated stimuli may be stressful for them (Beck, 1991; Moodie & Chamove, 1990; Shepherdson, 1992). Lack of predator-associated stimuli is thought to assist the general pattern of lethargy common among individual animals. It is possible that a certain level of predator-associated stimuli could contribute to the well-being of animals rather than detract (Beck, 1991; Moodie & Chamove, 1990; Shepherdson, 1992). This is a general problem for prey animals in captivity since there is almost always a lack of predators and the stimuli associated with them.

Tinbergen (1939) and Lorenz (1939) first studied the effects of presenting predator silhouettes to young geese, turkeys and ducks. They found that some of the silhouettes would elicit anti-predator behaviour from the three species. More recently, methods that have been suggested for providing prey species with predator-associated stimuli include using the faeces or skin of a predator (Ward, MacDonald, & Doncaster, 1997) or through visual or auditory access by placing a predator in an adjacent enclosure (Bayart & Anthouard, 1992). This type of stimulation is essential for species that are to be released into the wild so that the animals retain anti-predator behaviours.

Hayes et al (1998) has suggested that acoustic signals could be used to manipulate the auditory environment of species and influence aspects of their behaviour. Mills (1998) used auditory stimuli to signal the presentation of a stimulus. This could be especially effective for any species that communicates via auditory means. Hayes et al (1998) suggest that predatory species could be enriched using calls of prey species. Indeed Conover (1994) found that by playing distress signals of a prey species to a predator species some of the predators attacked more aggressively.

In the present study predator auditory stimuli were used in an attempt to enrich two prey species (Barbary sheep and peccaries) and a predator species (otters).

8.1.1 Hypotheses and rationale

Hypothesis One: *It was predicted that there would be an increase in flight behaviour associated with the novel predator auditory stimuli for each species.*

Gebo et al (1994) found that red colobus monkeys exhibited rapid fleeing movements and increased vertical leaping and bounding when avian and mammalian predator auditory stimuli were played to them. Chipmunks have also been found to perform more fleeing behaviour when played the alarm calls of conspecifics (Weary & Kramer, 1995). These two species responded to the auditory stimuli as if they were a real threat and therefore exhibited anti-predator behaviours. This suggests that auditory stimulation suggesting the presence of predators may be sufficient to stimulate anti-predator behaviours captive animals. Therefore it was expected that the three species in the present studies would exhibit flight behaviour when the mammalian and avian predator auditory stimuli were played to them.

Hypothesis Two: *It was predicted that there would be an increase in overall exploratory behaviour associated with the novel predator auditory stimuli for each of the species.*

A number of researchers have previously found that a variety of species exhibit an increase in exploratory behaviour when confronted by novelty (Glick-Bauer, 1997; Paquette & Prescott, 1988; Renner et al., 1992; Sandos, 1999; Wilson, 1982; Wood-Gush & Vestergaard, 1991). In the current studies there were no new elements that the animals could explore. Therefore the presence of the novel auditory stimuli was expected to increase the amount of diversive rather than specific exploration (For definitions of these see Section 3.1.2). The more an animal knows about its environment the higher its survival chances (Richardson et al, 1988). With the added stress of the predator-associated stimuli the animals will have more pressure to explore so they can readily escape if the need arises. It was expected that the Barbary sheep, peccaries, and otters would perform more exploratory behaviour when exposed to the novel auditory stimuli.

Hypothesis Three: *It was predicted that*

a. *The Barbary sheep would perform more flight and exploratory behaviour and take longer to habituate to the novel mammalian predator auditory stimuli than the novel avian predator auditory stimuli.*

b. *The otters would perform the same amount of flight and exploratory behaviour and take the same amount of time to habituate to both types of auditory stimuli.*

c. *The peccaries would perform more flight and exploratory behaviour and take longer to habituate to the novel mammalian predator auditory stimuli than the novel avian predator auditory stimuli.*

The two previous hypotheses predicted that there would be an overall increase in both exploratory and flight behaviour in conjunction with the exposure to the novel auditory stimuli. This hypothesis suggests that each species would perform different amounts of exploratory and flight behaviour, depending on which auditory stimuli were being played.

Hanson and Coss (1997) found that Californian mammalian squirrels reacted differently to avian and mammalian predators. When played the mammalian predator auditory stimuli the squirrels spent more time orienting and less time out of view and the opposite occurred with the avian predator auditory stimuli. Gebo et al (1995) found that red colobus monkeys performed more vertical leaping and bounding when played predator auditory stimuli. In addition to this the monkeys increased their movement distances in response to the avian predator auditory stimuli, when compared to the mammalian predator auditory stimuli.

Each species would be expected to react more to the predator auditory stimulus that is more biologically significant for their species. Heirnrich and Smolker (1998) and Hall (1998) both found that animals explore more and take longer to habituate to novel items that have biological relevance for their species. Barbary sheep live in an arid area where there is no vegetation tall enough to hide them. The Barbary sheep's size would suggest that they are more at risk from a land attack than one from the air (MacDonald, 1984). The peccaries are only at risk from mammalian predators and even then the attacks are rarely successful (MacDonald, 1984; Nowak, 1999). There are no reports of oriental small-clawed otters ever being killed by either avian or mammalian predators (MacDonald, 1984). Thus it was expected that the otters would not react more to either predator stimuli, and the Barbary sheep and peccaries would react more to the mammalian predator stimuli rather than the avian predator stimuli.

Hypothesis Four: *It was predicted that the Barbary sheep would perform more exploratory behaviour and take longer to habituate to the novel auditory stimuli than the peccaries and otters.*

It was suggested in Hypothesis Two that all three species would be expected to perform exploratory behaviour in response to the auditory stimuli. In addition it was expected that some species would react to the auditory stimuli more than other species. As discussed above, Barbary sheep are a prey species that live in a habitat where they are open to attack from mammalian predators (MacDonald, 1984). Otters are rarely, if ever, preyed upon in the wild, possibly due to the prevalence of other small animals in their habitat that are easier to catch (Nowak, 1999). When attacked by predators, peccaries will fend them off and are frequently successful in doing so (MacDonald, 1984; Nowak, 1999). Thus the Barbary sheep are the most vulnerable of all the species and the species most likely to need to hide or escape from predators, suggesting that they must have a recent and accurate cognitive map of their environment.

Hypothesis Five: *It was predicted that the otters would perform the least flight behaviour followed by the peccaries and the Barbary sheep would perform the most flight behaviour in response to the novel auditory stimuli.*

Hypothesis One suggested that all three species would perform flight behaviour in response to exposure to the auditory stimuli. It was also expected that some species would react more by performing more flight behaviour. The species that were expected to flee more were those that are more at risk of predation in the wild. As mentioned, the species most at risk would be the Barbary sheep since they are a prey species with no means to fight off a predator (MacDoanld, 1984). The species next at risk would be the peccaries since they are preyed upon but attempts are rarely successful (MacDoanld, 1984; Nowak, 1999). Finally the otters would be least at risk since they are rarely preyed upon in the wild (Nowak, 1999). The Barbary sheep were expected to perform more fleeing behaviour when exposed to the predator stimuli than the other species.

Hypothesis Six: *It was predicted that there would be an overall increase in play behaviour associated with the novel auditory stimuli.*

As discussed previously novelty has been found to stimulate play behaviour in a number of different species (Burghardt et al., 1996; Heinrich & Smolker, 1998; Wood & Wood, 1999; Wood-Gush & Vestergaard, 1991). The novel predator auditory stimuli may induce a moderate level of fear and uncertainty in the animals and, as a consequence, elicit first exploratory and then play behaviour (Aldis, 1975). Once the fear associated with the novelty is reduced through exploratory behaviour then there will be an increase in play behaviour. It has previously been found that the play behaviour may not be with the source of the novelty but rather amongst the animals themselves (Loizos, 1966). In this situation the animals cannot play with the source of the novelty so the increase will have to be in either locomotor or social play behaviour. As with all the species mentioned above it was expected that the Barbary sheep, peccaries, and otters would perform more play behaviour when exposed to the novel auditory stimuli.

Hypothesis Seven: *It was predicted that there would be a decrease in stereotypical behaviour associated with exposure to the novel auditory stimuli.*

As mentioned, a lack of predator-associated stimuli is thought to encourage inactivity in animals in captivity (Beck, 1991; Moodie & Chamove, 1990; Shepherdson, 1992). This can lead to low levels of stimulation in animals and may mean that they perform more stereotypical behaviour (Mason, 1991). A certain level of stimulation may benefit the animals by promoting activity and thereby reducing stereotypical behaviour. Exposure to novelty has been found to reduce the levels of stereotypical behaviour in captive animals (Carlstead et al., 1991; Glick-Bauer, 1997; Mellen et al., 1998; Paquette & Prescott, 1988; Renner et al, 1992; Wilson, 1982). In addition exposure to novelty and specifically novel auditory stimuli has been found to reduce stereotypical behaviour in captive common seals (Grindrod & Cleaver, 2001).

8.2 Methodology

8.2.1 Subjects

The Barbary sheep group was the same as for the study on novel odours and the taxa details for them can be found in Section 7.2.1. The peccary and otter groups were the same as for the study concerning movable and non-movable novel objects and the taxa details can be found in Section 6.2.1.

8.2.2 Diet

The three species diets had not changed since the first study and a description of them can be found in Section 6.2.2.

8.2.3 Enclosure

The enclosures had not changed from the two previous studies and descriptions of them can be found in Section 6.2.3. Figures 8.1, 8.2 and 8.3 show detailed diagrams of the enclosures and the location of the speakers and equipment for each of the species.

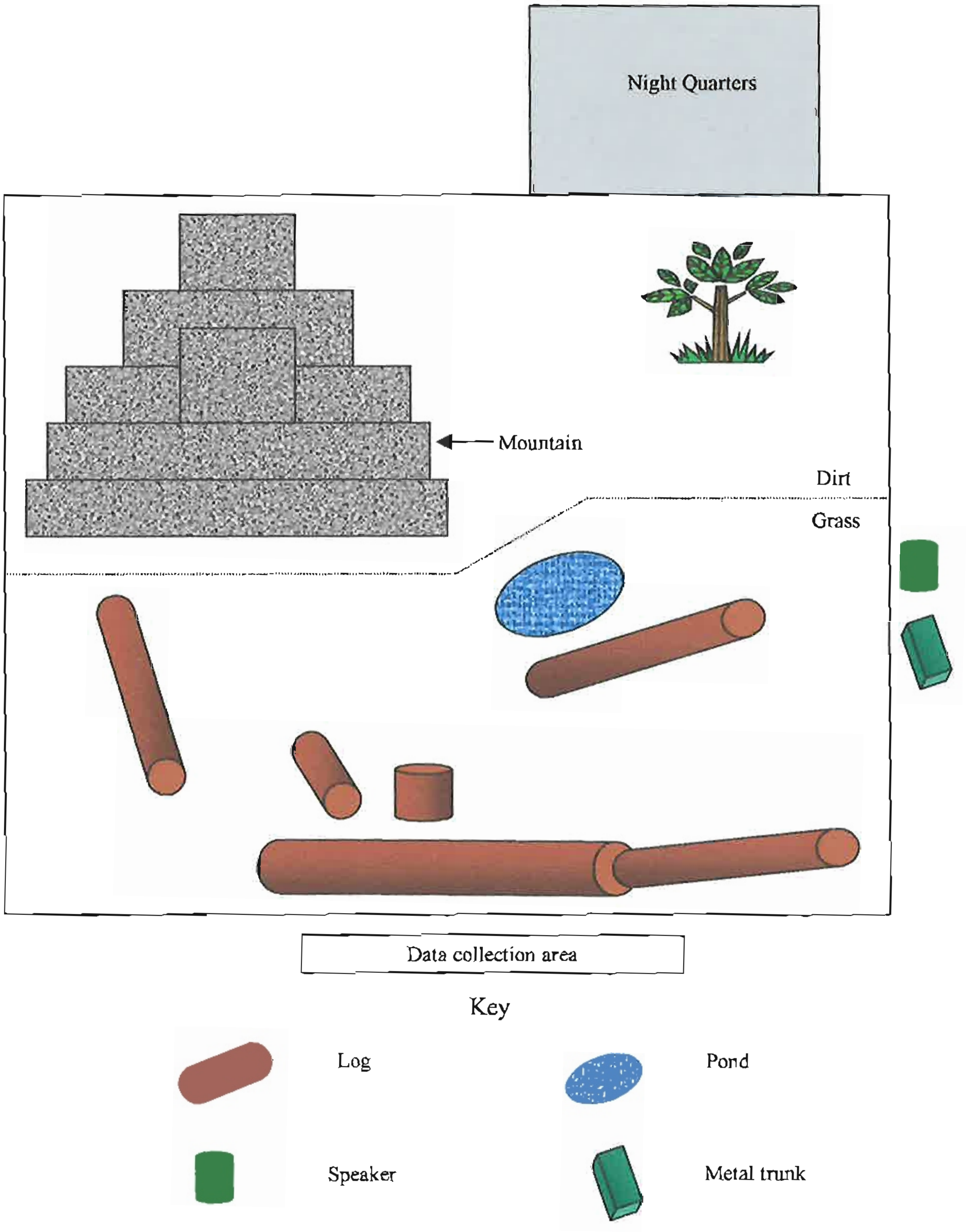

Figure 8.1 – Diagrammatic representation of the Barbary sheep enclosure showing the location of the speaker (not drawn to scale).

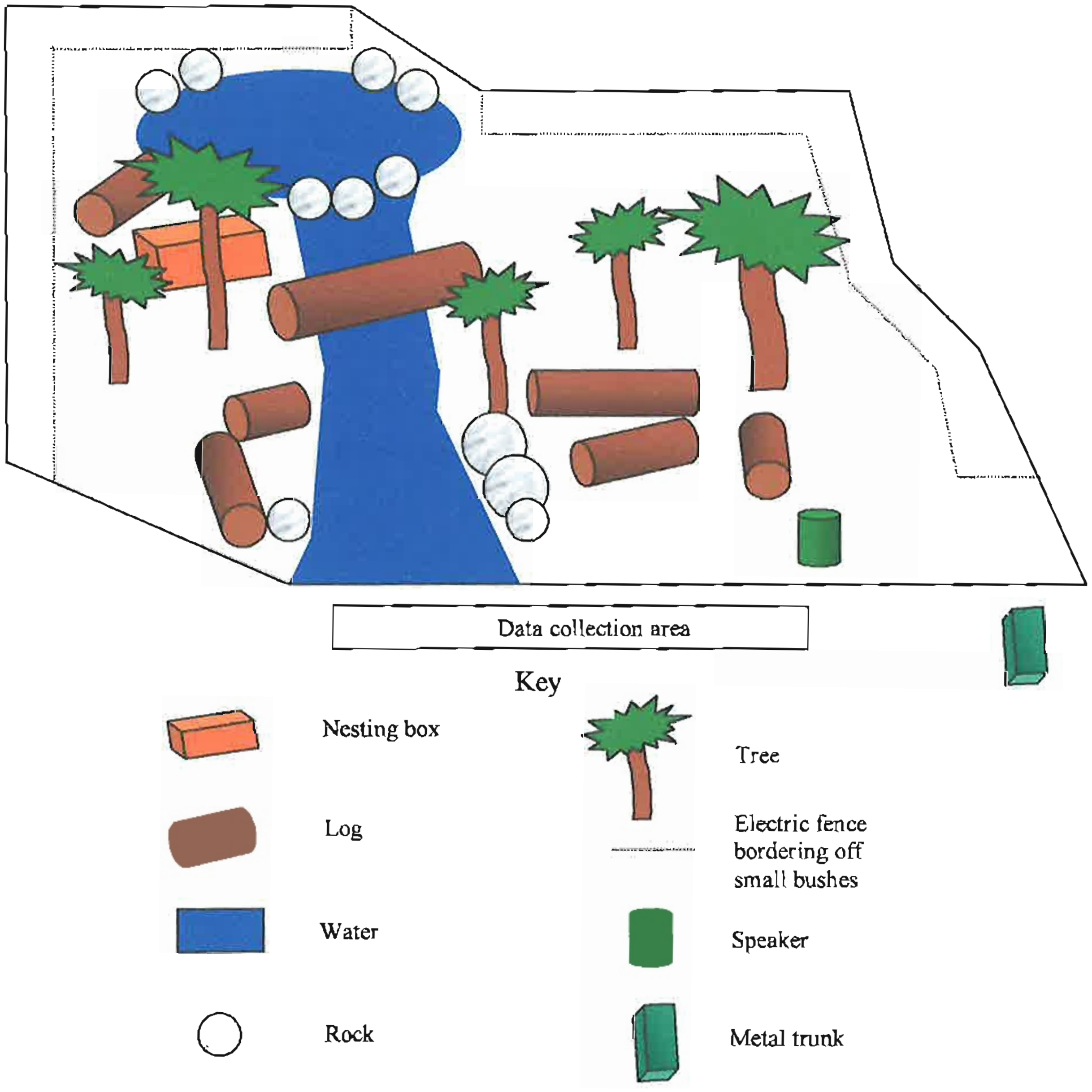

Figure 8.2 – Diagrammatic representation of the otter enclosure showing the speaker (not drawn to scale).

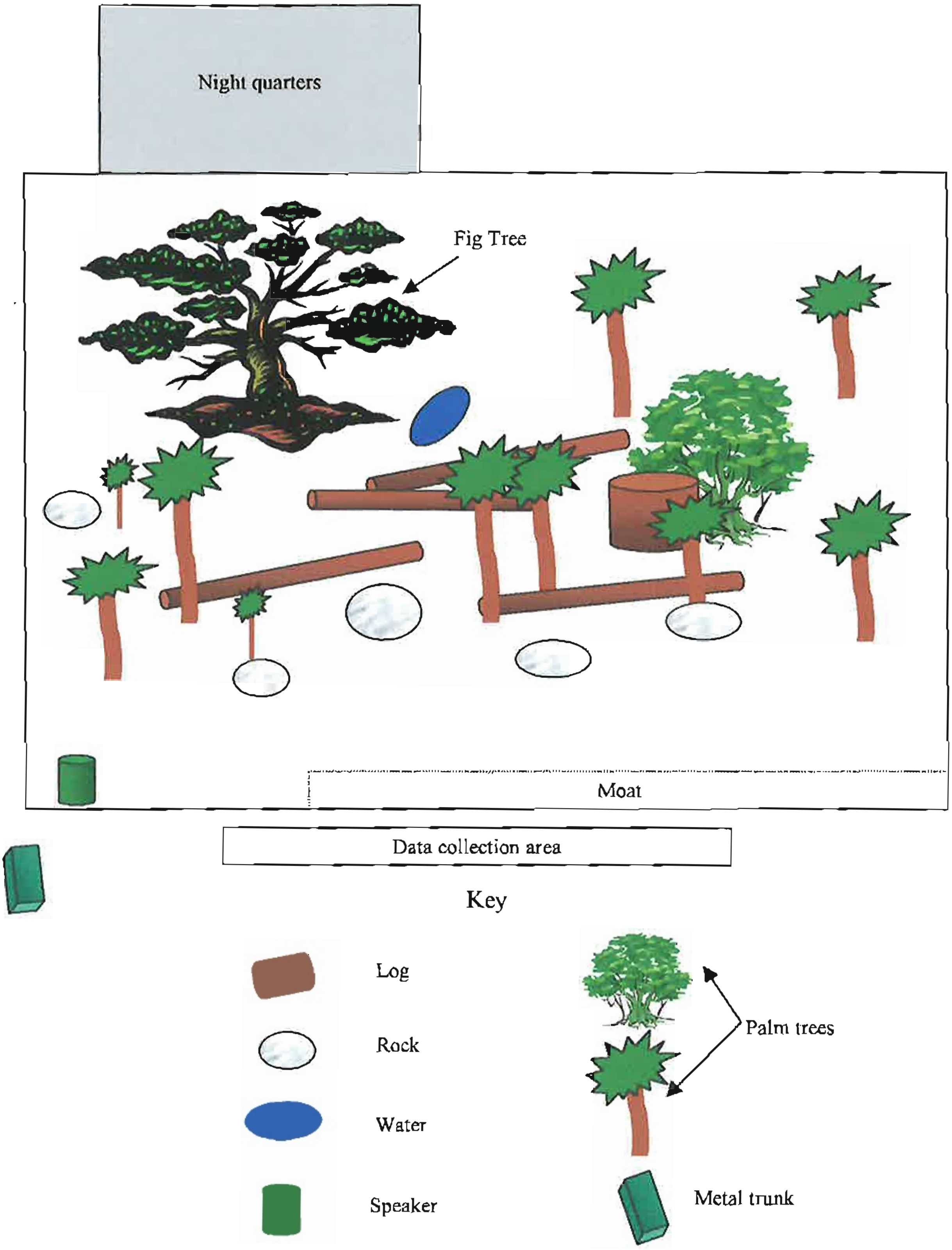

Figure 8.3 – Diagrammatic representation of the peccary enclosure showing the speaker (not drawn to scale).

8.2.4 Apparatus and Equipment

The purpose of this study was to compare different species reactions to two types of novel predator auditory stimuli. Two groups of predator auditory stimuli were chosen for this purpose; one group of mammalian predator auditory stimuli and one group of avian predator auditory stimuli. The mammalian predators that were used in the study were the puma (*Felis concolor*), tiger (*Panthera tigris*), lion (*Panthera leo*), jaguar (*Panthera onca*), bobcat (*Felis rufus*), grey wolf (*Canis lupus*), spotted hyena (*Crocuta crocuta*), dingo (*Canis familiaris*) and red fox (*Vulpes vulpes*). The avian predator auditory stimuli included in the study were the wedge-tailed eagle (*Aquila audax*), brown falcon (*Falco subniger*), peregrine falcon (*Falco peregrinus*), black shouldered kite (*Elanus notatus*), brown goshawk (*Erythrotriorchis radiatus*), grey goshawk (*Acciptiter gentilis*) and the brahmini kite (*Haliastur indus*).

It was decided to play a wide variety of predator auditory stimuli to the animals because the species did not overlap in territory. As a consequence, it was not possible to find a single avian and mammalian predator that was biologically significant for all the species. It was also decided to compare avian predator auditory stimuli with mammalian predator auditory stimuli to determine if the species reacted differently to each of the groups of auditory stimuli.

Speakers were used in this study to deliver the auditory stimuli to each of the species. One speaker was located in each of the enclosures (see Figures 8.1, 8.2 and 8.3 for the location of the speakers and equipment). Each speaker (Figure 8.4) was linked to a Sony MD Walkman portable minidisk recorder (M2-R50) and an Optimus 50Watt High-power stereo amplifier (12-1970) (Figure 8.5). The auditory stimuli were played from the mini-disc player. The sound level for the speakers was set at 82 dba at a distance of 1 metre. A 12V car battery provided the power for the mini-disc player, amplifier, and speaker. The mini disc player and other equipment were kept in lockable metal trunks (Figure 8.6) that were installed close to each of the enclosures. The trunk had been painted green so that it blended in with the surroundings. The otter and peccary enclosures were close enough together so one speaker was installed at each of the enclosures and then they ran off the same mini disc player set-up. The Barbary sheep enclosure ran off a different set-up.

Figure 8.4 – One of the speakers enclosed in a waterproof can.

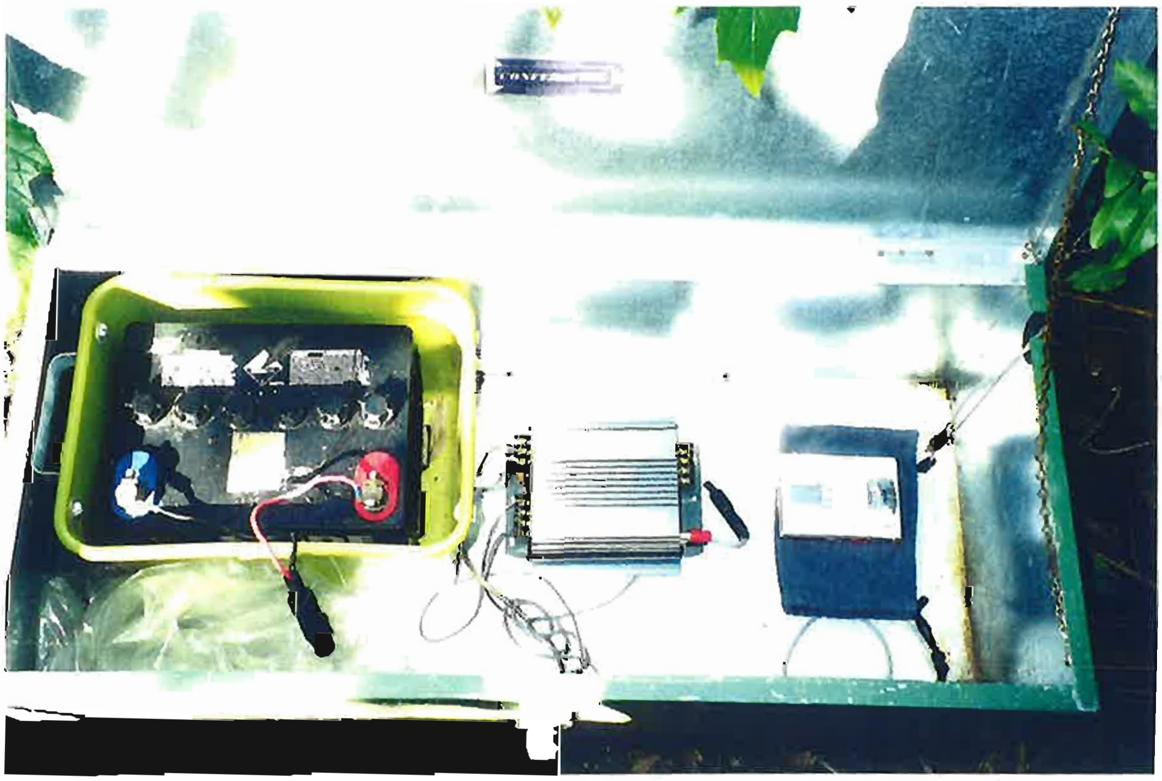

Figure 8.5 – The car battery on the left, the amplifier in the center and the mini-disc player on the right.

Figure 8.6 – Lockable metal trunk.

A sign was placed on the Barbary sheep, peccary and otter enclosures to explain to the public the general nature of the study (See Appendix B). All observation sessions were recorded directly onto check sheets designed during the reconnaissance observation sessions. See Appendix C for examples of the check sheets used in the study. Random sessions were taped to allow inter- and intra-observer reliability assessments to be performed.

Other miscellaneous equipment included:

- Video Camera (NV-M7A)
- 2 x 12 Volt Panasonic batteries
- Recharged using an AC Adaptor (VW-AM7A
- Tripod (SLIK 505QF)
- Blank video tapes
- Pentax camera for still photographs
- Stopwatch

8.2.5 Procedure

8.2.5.1 Reconnaissance observations

Reconnaissance observations were performed for one week prior to the commencement of the study for each of the species. This time allowed the researcher to become familiar with each of the animals and helped with the fast recognition of each of the individuals. It also allowed time to design and refine the check sheets to allow quick recording of the behaviours. Observations were made using the instantaneous sampling method at one-minute intervals for all animals. It was determined that observations could be made at intervals of one minute. Shorter intervals meant that the behaviours could not be recorded properly because of the large number of Barbary sheep and peccaries included in the study.

8.2.5.2 Behavioural categories

The behaviours recorded were the same as for the previous studies and a description of them can be found in Section 6.2.5.2.

8.2.5.3 Experimental design

The otters, peccaries and Barbary sheep were observed for a period of 6 weeks from the 5th June to the 16th July 2000. This makes a total of 30 sessions for each species and adds up to a total of 60 hours per species. A summary of the experimental design can be found in Table 8.1. The predator auditory stimuli were recorded in blocks of 30 seconds every one and a half minutes onto a three-hour mini-disc. The mini-disc was switched on at the beginning of each two hour session and then left running for the whole session. The predator auditory stimuli were then played every one and a half minutes for a 30-second block. Then there was silence for one and a half minutes and then the auditory stimuli would play again and so on. The order that each of the species of predators were played was randomised with several being played each 30-second block. Each of the predator auditory stimuli was played at least once during each of the two-hour sessions.

Table 8.1 – Experimental design for the novel sound study.

Phase	**Baseline 1**	**Baseline 2**	**Mammalian**	**Baseline 3**	**Avian**	**Post-experimental**
Timespan	5/6/00-11/6/00	12/6/00-18/6/00	19/6/00-25/6/00	26/6/00-2/7/00	3/7/00-9/700	10/7/00-16/7/00
Number of sessions	5 each group	5 each group	5 each group	5 each group	5 each group	5 each group
Number of hours	10 each group	10 each group	10 each group	10 each group	10 each group	10 each group
Function	Record data to establish baseline.	Record data to establish baseline with the speakers installed.	Mammalian predator noises played to the animals each session.	Record data to re-establish baseline.	Avian predator noises played to the animals each session.	All noises stopped and animals only observed.

8.2.5.4 Data collection

The data collection was the same as for the previous study and a description of this can be found in Section 6.2.5.4.

8.3 Results

As stated in section 5.5 the definitions of the magnitude of changes to behaviour levels followed the format of Kardos (1999). These are as set out below:

Small changes or effects are: 0.01% to 7.5%

Moderate changes or effects are: 7.51% to 15.0%

Large changes or effects are: 15.01% and higher.

Hypotheses

8.3.1 Hypothesis One

It was predicted that there would be an increase in flight behaviour associated with the novel predator auditory stimuli for each species.

Barbary sheep

Figure 8.7 indicates the levels of flight behaviour for each week of the study for the adult Barbary sheep. It is apparent that the only flight behaviour that the adult Barbary sheep performed during the six week period was when the novel auditory stimuli were being played. There was a moderate increase in flight behaviour of between 8.83 and 11.33 percent from the second baseline week to the week when the novel mammalian predator auditory stimuli were being played. During the avian predator phase there was also a moderate increase of between 7.67 and 9.17 percent from the third baseline week.

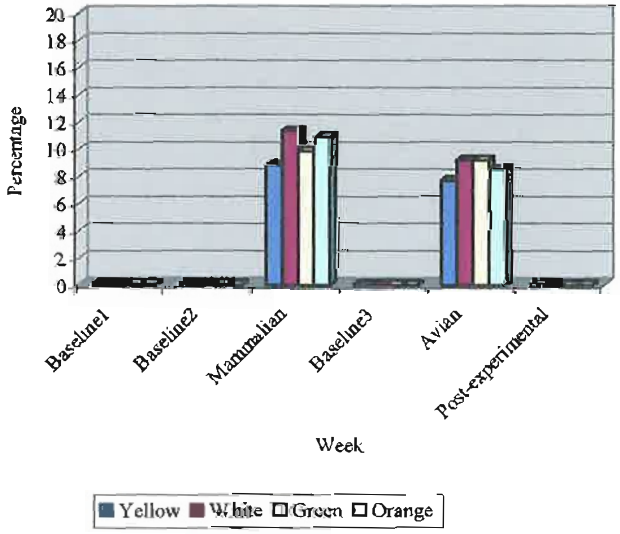

Figure 8.7 - Flight behaviour levels for the adult Barbary sheep.

Figure 8.8 indicates the levels of flight behaviour for the sub-adult and juvenile Barbary sheep. It is apparent that the only flight behaviour was during the novel auditory stimuli periods. There was an increase of between 12.50 and 13.50 percent from the second baseline week to the mammalian predator phase. The flight behaviour also increased by a moderate amount, between 10.83 and 13.50 percent, from the third baseline week to the avian predator phase. These figures can be seen in Table 8.2. The results from the Barbary sheep support the hypothesis that there will be an increase in flight behaviour associated with the novel auditory stimuli.

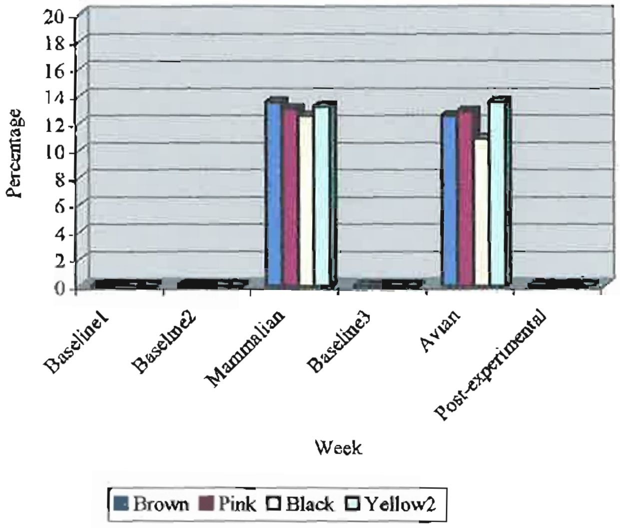

Figure 8.8- Flight behaviour levels for the sub-adult and juvenile Barbary sheep.

Table 8.2 – Flight behaviour for the Barbary sheep for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Yellow1	0 (0)	0 (0)	8.83 (3.64)	0 (0)	7.67 (6.64)	0 (0)
White1	0 (0)	0 (0)	11.33 (5.81)	0 (0)	9.17 (7.36)	0 (0)
Green	0 (0)	0 (0)	9.83 (3.40)	0 (0)	9.17 (4.88)	0 (0)
Orange1	0 (0)	0 (0)	10.83 (7.31)	0 (0)	8.50 (7.06)	0 (0)
Brown	0 (0)	0 (0)	13.50 (4.10)	0 (0)	12.50 (10.31)	0 (0)
Pink	0 (0)	0 (0)	13.00 (4.00)	0 (0)	12.83 (6.41)	0 (0)
White2	0 (0)	0 (0)	12.50 (4.83)	0 (0)	10.83 (11.00)	0 (0)
Orange2	0 (0)	0 (0)	13.17 (4.78)	0 (0)	13.50 (10.24)	0 (0)

Otters

The otters did not perform any flight behaviour during the entire six-week period of the study. This includes the two weeks when the animals were played recordings of novel predatory auditory stimuli. This does not support the hypothesis that the presence of the novel predator auditory stimuli would increase the level of flight behaviour.

Peccaries

Figures 8.9 and 8.10 indicate the flight behaviour levels for the female and male peccaries for each week of the study. It is apparent that the peccaries performed more flight behaviour during the weeks when the novel auditory stimuli were played to the animals than when there was no novel auditory stimulus. The peccaries performed between 14.00 and 19.17 percent more flight behaviour from the second baseline week to the mammalian predator phase. This is defined as a moderate to large increase. The peccaries also increased their flight behaviour by a small amount, between 4.17 and 5.50 percent, from the third baseline week to the avian predator phase. The flight behaviour that the peccaries performed in the baseline and post-experimental weeks were in response to the sprinklers in the enclosure being turned on or the animals being startled by keepers or visitors. The levels of flight behaviour are shown in Table 8.3. These results support the hypothesis that flight behaviour would increase with the presence of the novel auditory stimuli.

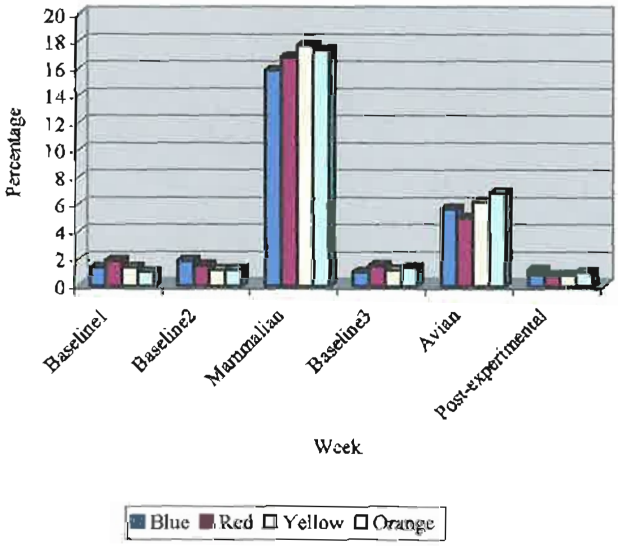

Figure 8.9 - Flight behaviour levels for the female peccaries.

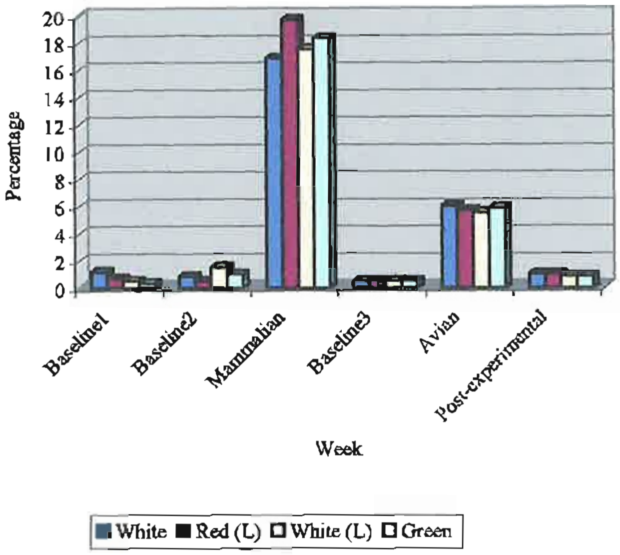

Figure 8.10 - Flight behaviour levels for the male peccaries.

Table 8.3 – Flight behaviour for the peccaries for each week of the study.

Animal	**Baseline 1 Mean (SD)**	**Baseline 2 Mean (SD)**	**Mammalian Mean (SD)**	**Baseline 3 Mean (SD)**	**Avian Mean (SD)**	**Post-experimental Mean (SD)**
Blue	1.33 (2.32)	1 83 (2.52)	15.83 (4.31)	1.00 (1.66)	5.67 (4.16)	1.17 (1.97)
Red	1.83 (3.06)	1.50 (2.70)	16.83 (4.52)	1.50 (1.66)	5.00 (5.07)	0.83 (1.43)
Yellow	1.33 (2.63)	1 17 (1.37)	17.67 (4.56)	1.17 (1.37)	6.17 (8.53)	0.83 (1.43)
Orange	1.00 (1.80)	1.17 (1.97)	17.33 (4.82)	1.33 (2.21)	6.83 (10.1)	1.00 (1.80)
White	1.17 (1.97)	0.83 (1.43)	16.83 (4.17)	0.50 (1.35)	6.00 (6.89)	1.00 (1.66)
Red(L)	0.67 (1.31)	0.50 (1.35)	19.67 (5 44)	0.50 (1.35)	5.67 (4.72)	1.00 (1.80)
White (L)	0.50 (1.35)	1.50 (2.51)	17.50 (4.40)	0.50 (1.35)	5.50 (6.62)	0.83 (1.43)
Green	0.33 (0.90)	1.00 (2.69)	18.33 (7.26)	0 50 (1.35)	5.83 (8.20)	0.83 (1.74)

Summary

There was partial support for the hypothesis that the presence of the novel auditory stimuli would increase the amount of flight behaviour that the animals performed. The peccaries and Barbary sheep performed more flight behaviour during the novel weeks and therefore supported the hypothesis. The otters did not perform any flight behaviour during either the baseline weeks or the novelty weeks and these results did not support the hypothesis.

7.3.2 Hypothesis Two

It was predicted that there would be an increase in overall exploratory behaviour associated with the novel predator auditory stimuli for each of the species.

Barbary Sheep

Figures 8.11 and 8.12 indicate the levels of exploratory behaviour for the adult Barbary sheep and sub-adult and juvenile Barbary sheep. It is apparent that the Barbary sheep performed their only exploratory behaviour during the time when the novel auditory stimuli were present. During the mammalian predator phase the adult Barbary sheep spent between 9.33 and 9.83 percent more time exploring than during the baseline weeks. This was a moderate increase in exploratory behaviour. The sub-adult and juvenile Barbary sheep spent a moderate amount, between 11.33 and 12.83 percent, more time exploring than during the baseline or post-experimental weeks. During the avian predator phase the adult Barbary sheep spent a moderate amount , between 8.17 and 9.50 percent, more time exploring than during the third baseline week. The sub-adult and juvenile Barbary sheep spent between 10.54 and 12.00 percent more time exploring than during the third baseline week. This difference was a moderate increase in exploratory behaviour. These differences can be seen in Table 8.4. The results from all the Barbary sheep support the hypothesis that the novel auditory stimuli would increase exploratory behaviour.

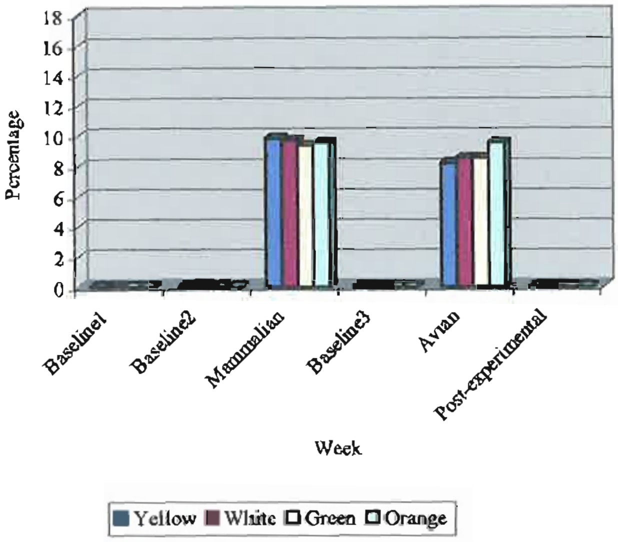

Figure 8.11 - Exploratory behaviour levels for the adult Barbary sheep.

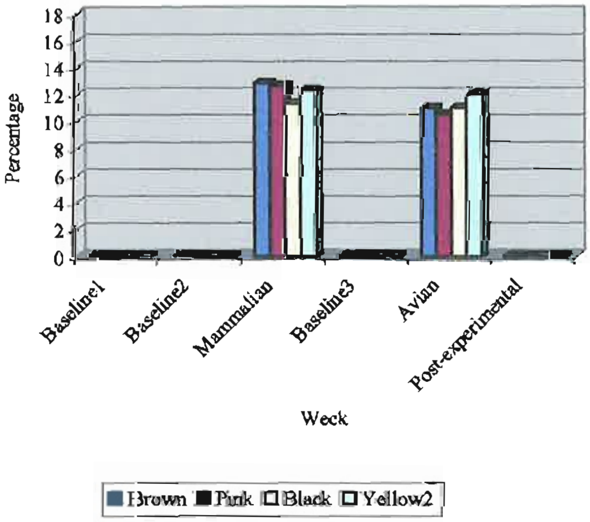

Figure 8.12 - Exploratory behaviour levels for the sub-adult and juvenile Barbary sheep.

Table 8.4 – Exploratory behaviour for the Barbary sheep for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Yellow1	0 (0)	0 (0)	9.83 (3.61)	0 (0)	8.17 (11.96)	0 (0)
White1	0 (0)	0 (0)	9.67 (3.23)	0 (0)	8.50 (4.79)	0 (0)
Green	0 (0)	0 (0)	9.33 (2.39)	0 (0)	8.50 (4.51)	0 (0)
Orange1	0 (0)	0 (0)	9.50 (4.10)	0 (0)	9.50 (6.62)	0 (0)
Brown	0 (0)	0 (0)	12.83 (4.55)	0 (0)	11.00 (8.86)	0 (0)
Pink	0 (0)	0 (0)	12.67 (4.38)	0 (0)	10.50 (4.88)	0 (0)
White2	0 (0)	0 (0)	11.33 (7.33)	0 (0)	11.00 (6.26)	0 (0)
Orange2	0 (0)	0 (0)	12.33 (6.73)	0 (0)	12.00 (3.12)	0 (0)

Otters

Figure 8.13 indicates the levels of exploratory behaviour for each week of the study. It is apparent that the otters performed more exploratory behaviour during the novelty weeks than the other weeks of the study. The otters spent a moderate amount more time exploring during the mammalian predator phase than during the second baseline week. They spent between 14.00 and 14.17 percent more time exploring. They also spent a large amount, between 17.17 and 17.50, more time exploring during the avian predator phase than during the third baseline week. These differences can be seen in Table 8.5. These results support the hypothesis that the presence of the novel auditory stimuli would increase exploratory behaviour.

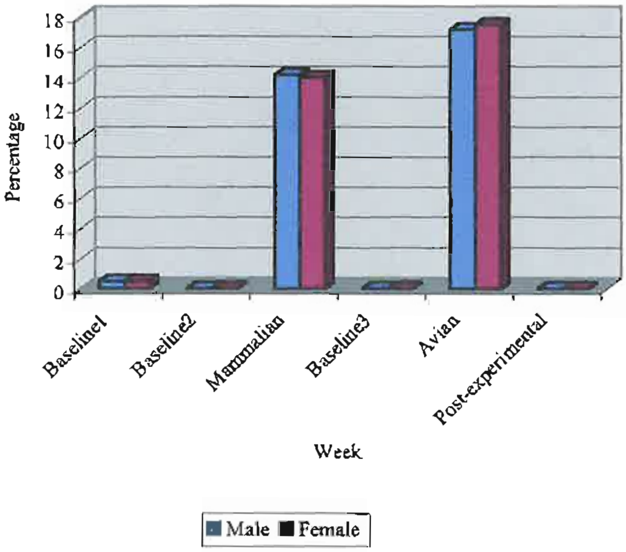

Figure 8.13 - Exploratory behaviour levels for the otters.

Table 8.5 - Exploratory behaviour for the otters for each week of the study.

Animal	**Baseline 1 Mean (SD)**	**Baseline 2 Mean (SD)**	**Mammalian Mean (SD)**	**Baseline 3 Mean (SD)**	**Avian Mean (SD)**	**Post-experimental Mean (SD)**
Male	0.50 (1.35)	0 (0)	14.17 (4.26)	0 (0)	17.17 (6.89)	0 (0)
Female	0.50 (1.35)	0 (0)	14.00 (5.57)	0 (0)	17.50 (6.66)	0 (0)

Peccaries

Figures 8.14 and 8.15 indicate the levels of exploratory behaviour for the female and male peccaries for each week of the study. It is apparent that the animals all spent more time exploring during the novelty weeks of the study than during the baseline and post-experimental weeks. The peccaries spent between 10.16 and 12.00 percent more time exploring during the mammalian predator phase than during the second baseline week. This represented a moderate increase in exploratory behaviour. During the avian predator week the peccaries spent slightly (between 4.50 and 5.33 percent) more time exploring than during the third baseline week. These differences can be seen in Table 8.6. These results supported the hypothesis that the presence of the novel auditory stimuli would increase the levels of exploratory behaviour.

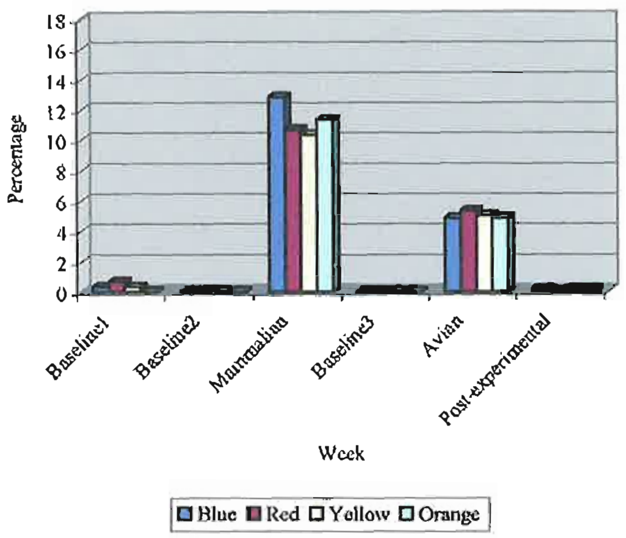

Figure 8.14 - Exploratory behaviour levels for the female peccaries.

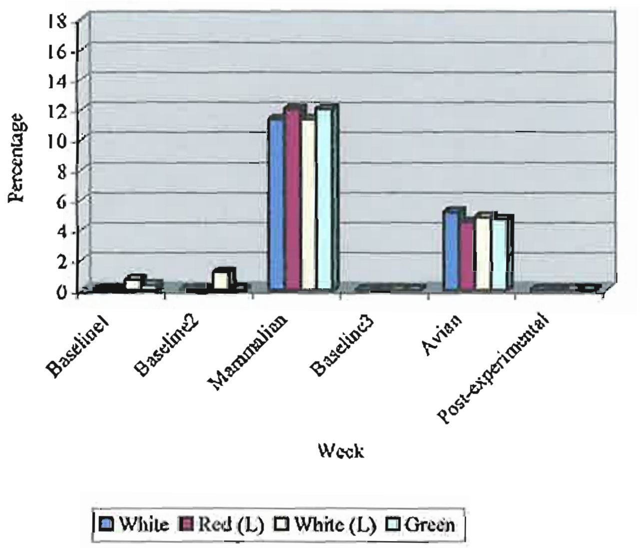

Figure 8.15 - Exploratory behaviour levels for the male peccaries.

Table 8.6 Exploratory behaviour for the peccaries for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Blue	0.33 (0.90)	0 (0)	12.83 (3.25)	0 (0)	4.83 (6.03)	0.17 (0.45)
Red	0.67 (1.10)	0 (0)	10.67 (4.60)	0 (0)	5.33 (5.81)	0 (0)
Yellow	0.33 (0.90)	0 (0)	10.33 (2.58)	0 (0)	5.00 (6.54)	0.17 (0.45)
Orange	0 (0)	0 (0)	11.33 (2.78)	0 (0)	4.83 (5.37)	0.17 (0.45)
White	0 (0)	0 (0)	11.33 (2.69)	0 (0)	5.17 (6.17)	0 (0)
Red(L)	0 (0)	0 (0)	12.00 (3.24)	0 (0)	4.50 (6.27)	0 (0)
White (L)	0.67 (1.80)	1.17 (1.97)	11.33 (3.43)	0 (0)	4.83 (4.62)	0 (0)
Green	0.33 (0.90)	0 (0)	12.00 (3.24)	0 (0)	4.67 (7.44)	0 (0)

Summary

The data from each of the three species supported the hypothesis that there would be an increase in exploratory behaviour associated with the presence of the novel auditory stimuli.

7.3.3 Hypothesis Three

It was predicted that:

a. *The Barbary sheep would perform more flight and exploratory behaviour and take longer to habituate to the novel mammalian predator auditory stimuli than to the novel avian predator auditory stimuli.*
b. *The otters would perform the same amount of flight and exploratory behaviour and take the same amount of time to habituate to the novel mammalian and avian predator auditory stimuli.*
c. *The peccaries would perform more flight and exploratory behaviour and take longer to habituate to the novel mammalian predator auditory stimuli than the novel avian predator auditory stimuli.*

Barbary Sheep

Figure 8.16 indicates that the Barbary sheep spent only slightly more time exploring during the mammalian predator phase than the avian predator phase. There was either no difference or only a small difference of less than 1.83 percent between the amount of exploratory behaviour during the mammalian and avian auditory phases.

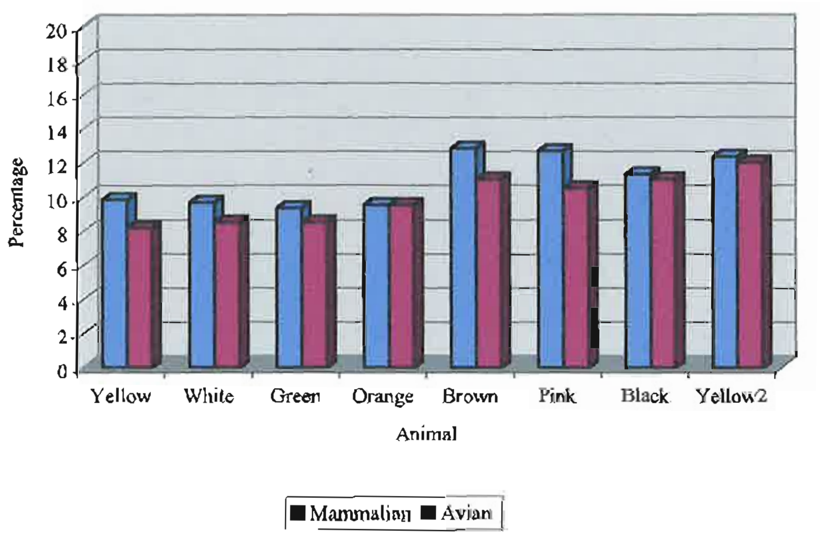

Figure 8.16 - Exploratory behaviour for the mammalian and aavian predator phases for the Barbary sheep.

Figure 8.17 indicates the levels of flight behaviour for the Barbary sheep during the avian and mammalian predator phases. It is apparent that they spent slightly more time performing flight behaviour during the mammalian than the avian predator phases. There was slightly more (between 0.17 and 2.70 percent) flight behaviour during the mammalian predator phase than during the avian predator phase. Yellow 2 was the only exception to this among the Barbary sheep. Yellow 2 spent slightly more time performing flight behaviour during the avian predator phase than the mammalian predator phase, a small difference of 0.33 percent. Table 8.7 shows the levels of exploratory and flight behaviour for the mammalian and avian phases of the study. These results only partially support the hypothesis that the Barbary sheep would perform more exploratory and flight behaviour during the mammalian, than during the avian, novel predator phase.

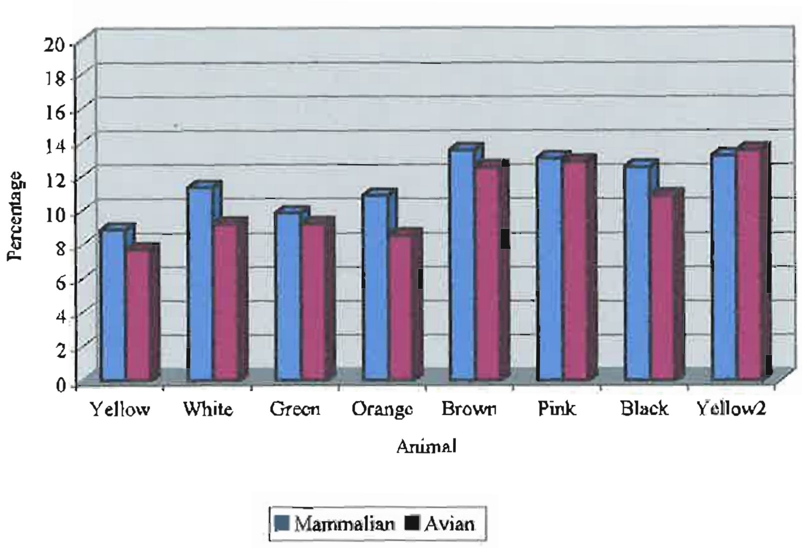

Figure 8.17 - Flight behaviour for the avian and mammalian predator phases for the Barbary sheep.

Table 8.7 – Exploratory and flight behaviour for both the mammalian and avian predator phases for the Barbary sheep.

Animal	Exploratory behaviour		Flight behaviour	
	Mammalian Mean (SD)	Avian Mean (SD)	Mammalian Mean (SD)	Avian Mean (SD)
Yellow1	9.83 (3.61)	8.17 (11.96)	8.83 (3.64)	7.67 (6.64)
White1	9.67 (3.23)	8.50 (4.79)	11.33 (5.81)	9.17 (7.36)
Green	9.33 (2.39)	8.50 (4.51)	9.83 (3.40)	9.17 (4.88)
Orange1	9.50 (4.1)	9.50 (6.62)	10.83 (7.31)	8.50 (7.06)
Brown	12.83 (4.55)	11.00 (8.86)	13.50 (4.10)	12.50 (10.31)
Pink	12.67 (4.38)	10.50 (4.88)	13.00 (4.00)	12.83 (6.41)
White2	11.33 (7.33)	11.00 (6.26)	12.50 (4.83)	10.83 (11.00)
Orange2	12.33 (6.73)	12.00 (3.12)	13.17 (4.78)	13.50 (10.24)

The Barbary sheep flight and exploratory behaviour had not habituated to either of the novel predator auditory stimuli by the end of the five sessions. There was a slight decrease over the week for both the flight behaviour and the exploratory behaviour but there was no habituation to either of the novel predator auditory stimuli. This can be seen in Figures 8.18, 8.19, 8.20 and 8.21. These results neither confirm nor disconfirm the hypothesis that the Barbary sheep would take longer to habituate to the mammalian, than to the avian, predator auditory stimuli. Since they had not habituated to either of the novel auditory stimuli it cannot be determined which predator auditory stimuli they would have habituated to first.

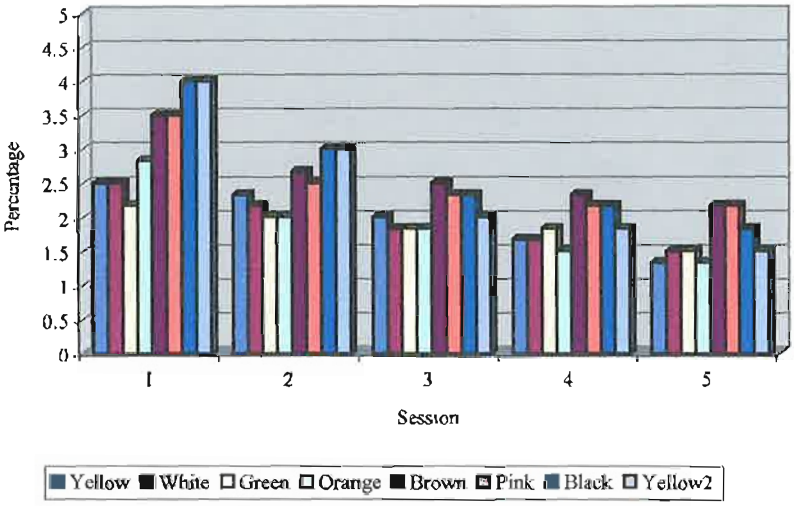

Figure 8.18 - Habituation times for exploratory behaviour for the Barbary sheep for the mammalian predator phase.

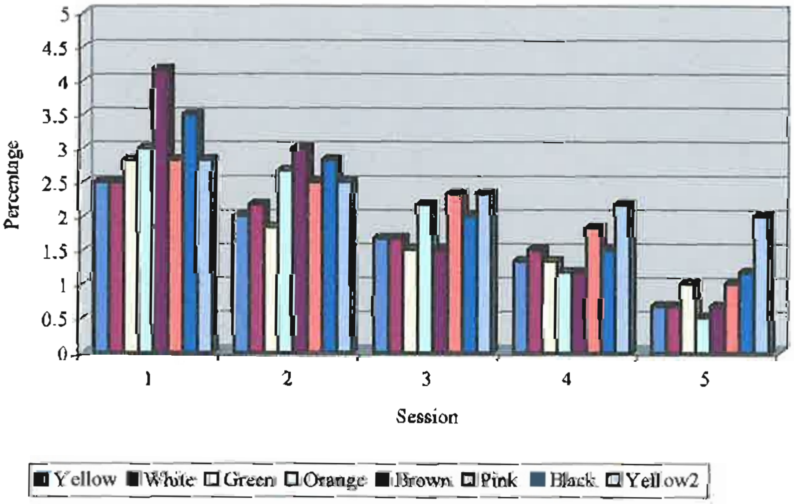

Figure 8.19 - Habituation times for exploratory behaviour for the Barbary sheep for the avian predator phase.

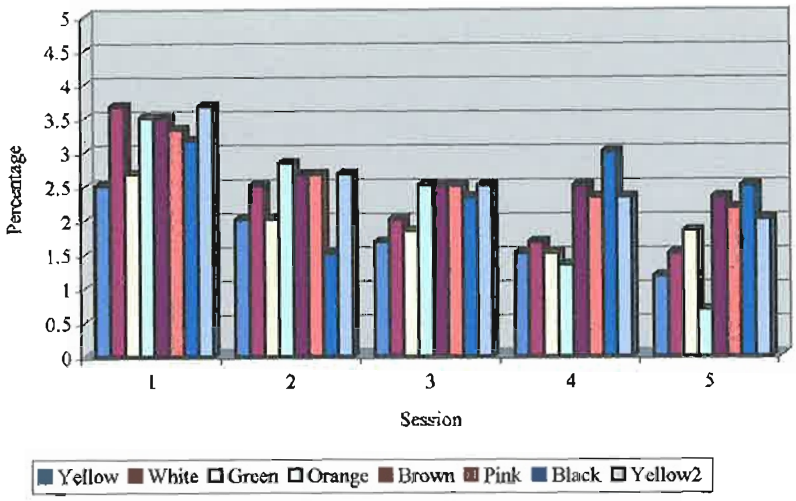

Figure 8.20 - Habituation times for flight behaviour for the Barbary sheep for the mammalian predator phase.

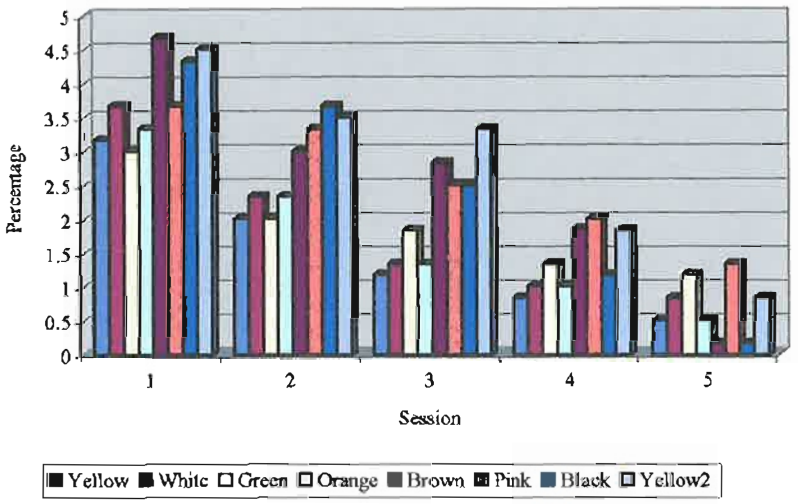

Figure 8.21 - Habituation times for flight behaviour for the avian predator phase for the Barbary sheep

Otters

Figure 8.22 indicates that the otters spent more time exploring during the novel avian predator phase than during the mammalian predator phase. It is apparent that the otters spent slightly more time, between 3.00 and 3.50 percent, exploring during the avian predator phase than during the mammalian predator phase. This does not support the hypothesis that the otters would perform the same amount of exploratory behaviour during the avian and mammalian phases.

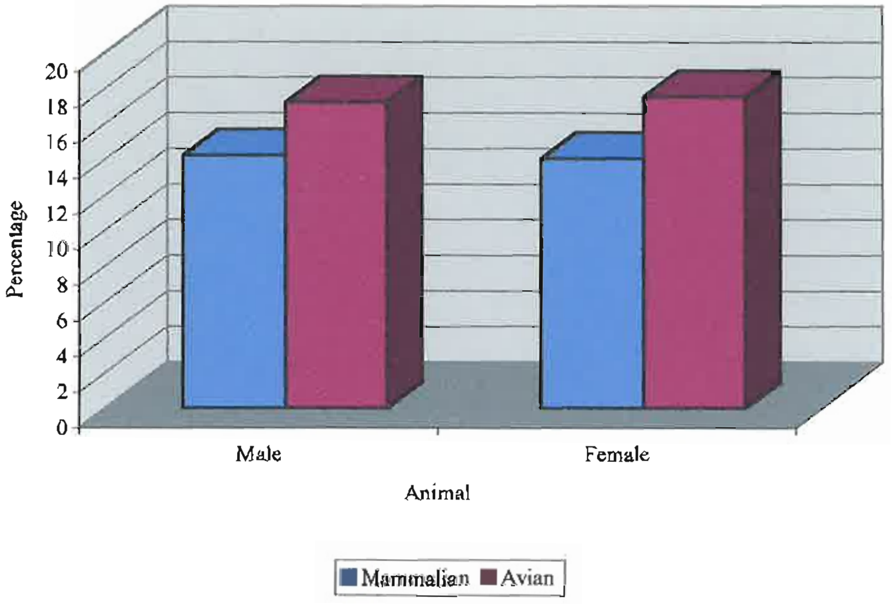

Figure 8.22 - Exploratory behaviour for the avian and mammalian phases for the otters.

The otters performed no flight behaviour during either of the novel predator auditory stimuli phases. These results do support the hypothesis that the otters would perform the same amount of flight behaviour during the avian and mammalian predator phases. The levels of exploratory and flight behaviour can be seen in Table 8.8.

The otters had not habituated to either of the novel predator auditory stimuli by the end of the week for exploratory behaviour. This can be seen in Figure 8.23 and 8.24. Consequently it cannot be determined the rate that they were going to habituate to the auditory stimuli. This does not either support or not support the hypothesis that the otters would habituate to the mammalian and avian predator sounds at the same rate.

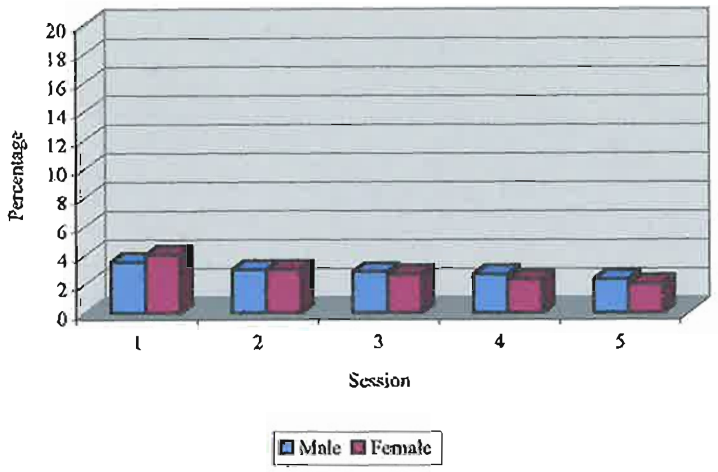

Figure 8.23 - Habituation times for exploratory behaviour for the mammalian predator phase for the otters.

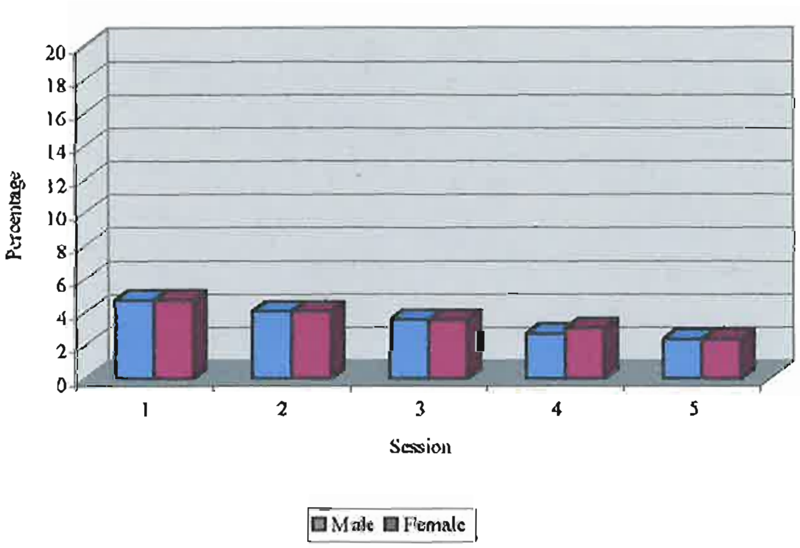

Figure 8.24 - Habituation times for the exploratory behaviour for the avian predator phase for the otters.

Table 8.8 – Exploratory and flight behaviour for both the mammalian and avian predator phases for the otters.

Animal	**Exploratory behaviour**		**Flight behaviour**	
	Mammalian Mean (SD)	**Avian Mean (SD)**	**Mammalian Mean (SD)**	**Avian Mean (SD)**
Male	14.17 (4.26)	17.17 (6.89)	0 (0)	0 (0)
Female	14.00 (5.57)	17.50 (6.66)	0 (0)	0 (0)

Peccaries

Figure 8.25 indicates the levels of exploratory behaviour for the two novel auditory stimuli for the peccaries. These levels can also be seen in Table 8.9. It is apparent that the peccaries spent more time exploring during the mammalian predator phase than the avian predator phase. The peccaries spent a small to moderate amount more time, between 5.33 and 8.00 percent, exploring during the mammalian predator phase than during the avian predator phase. These results supported hypothesis three.

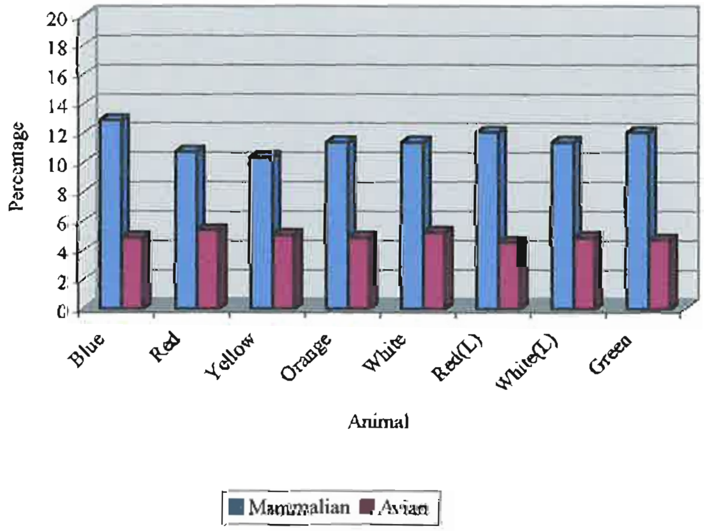

Figure 8.25 - Exploratory behaviour for the mammalian and avian predator phases for the peccaries.

Figure 8.26 indicates that a similar result was obtained for the flight behaviour during the two novel periods. The peccaries performed more flight behaviour in response to the mammalian predator auditory stimuli than the avian predator auditory stimuli. The peccaries spent between 10.16 and 14.00 percent more time in flight behaviour during the mammalian predator phase than the avian predator phase. This was defined as a moderate increase in flight behaviour from the avian to mammalian predator auditory stimuli. This supports the hypothesis that the peccaries would perform more flight behaviour in response to the mammalian predator than avian predator auditory stimuli.

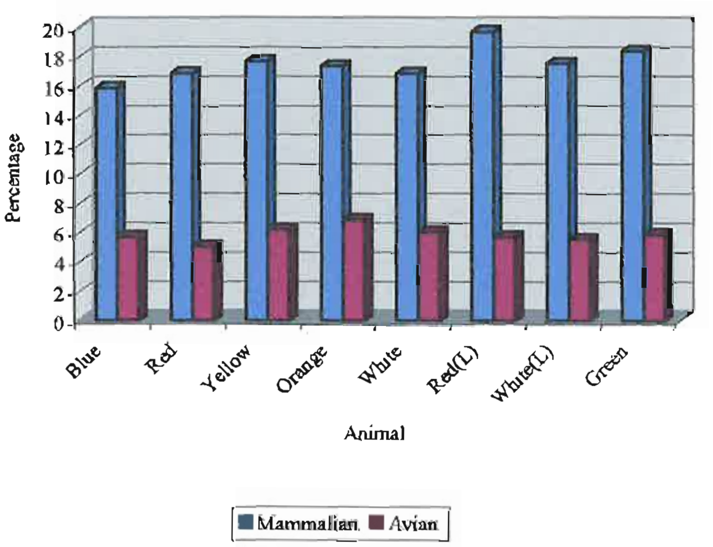

Figure 8.26 - Flight behaviour for the novel aerial and ground predator phases for the peccaries.

Table 8.9 – Exploratory and flight behaviour for both the mammalian and avian predator phases for the peccaries.

Animal	**Exploratory behaviour**		**Flight behaviour**	
	Mammalian Mean (SD)	**Avian Mean (SD)**	**Mammalian Mean (SD)**	**Avian Mean (SD)**
Blue	12.83 (3.25)	4.83 (6.03)	15.83 (4.31)	5.67 (4.16)
Red	10.67 (4.6)	5.33 (5.81)	16.83 (4.52)	5.00 (5.07)
Yellow	10.33 (2.58)	5.00 (6.54)	17.67 (4.56)	6.17 (8.53)
Orange	11.33 (2.78)	4.83 (5.37)	17.33 (4.82)	6.83 (10.10)
White	11.33 (2.69)	5.17 (6.17)	16.83 (4.17)	6.00 (6.89)
Red (L)	12.00 (3.24)	4.50 (6.27)	19.67 (5.44)	5.67 (4.72)
White (L)	11.33 (3.43)	4.83 (4.62)	17.50 (4.40)	5.50 (6.62)
Green	12.00 (3.24)	4.67 (7.44)	18.33 (7.26)	5.83 (8.20)

The habituation times to the mammalian predator and avian predator auditory stimuli can be seen in Figures 8.27 and 8.28 respectively. It is apparent that the peccaries showed no habituation to the mammalian predator auditory stimuli whereas they had habituated to the avian predator auditory stimuli by session five.

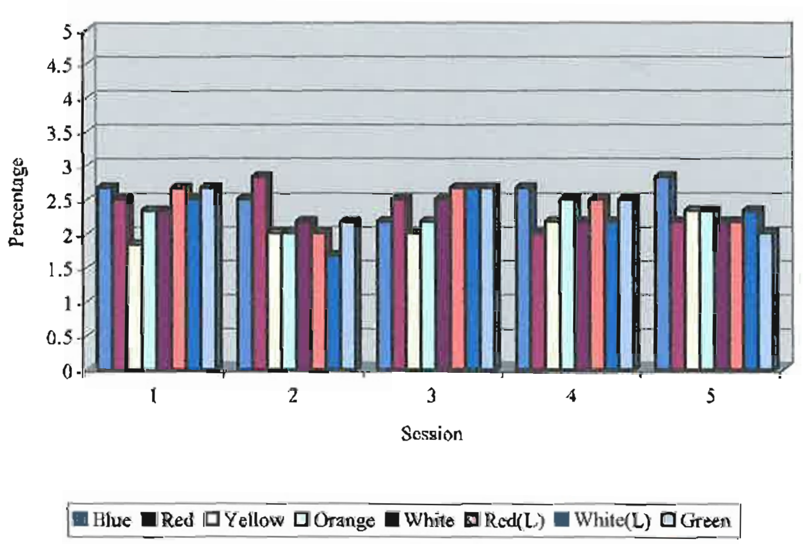

Figure 8.27 - Habituation times for exploratory behaviour for the mammlian predator phase for the peccaries.

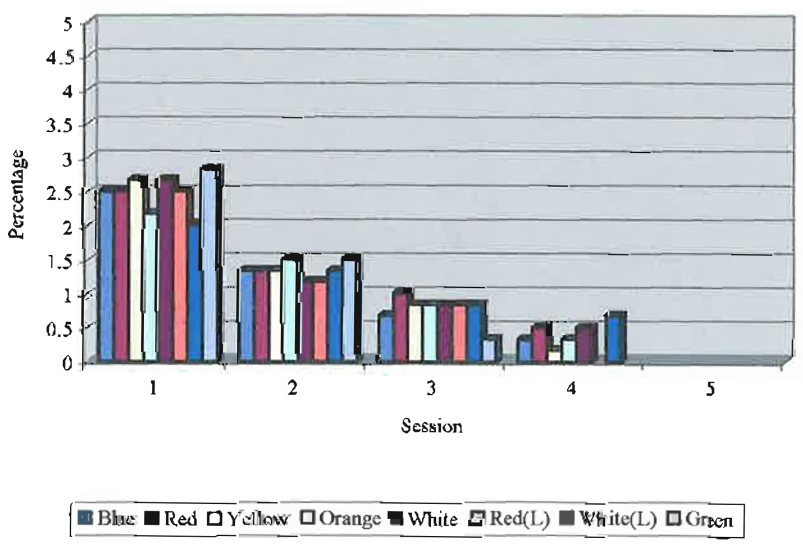

Figure 8.28 - Habituation times for exploratory behaviour for the avian predator phase for the peccariesi.

A similar pattern could be seen in they way that the peccaries habituated for flight behaviour to the two different novel auditory stimuli. There was no habituation for flight behaviour to the mammalian predator auditory stimuli (Figure 8.29) whereas flight behaviour levels were very low on days four and five for the avian predator auditory stimuli (Figure 8.30). These results support the hypothesis that the peccaries would take longer to habituate to the mammalian than to the avian predator auditory stimuli.

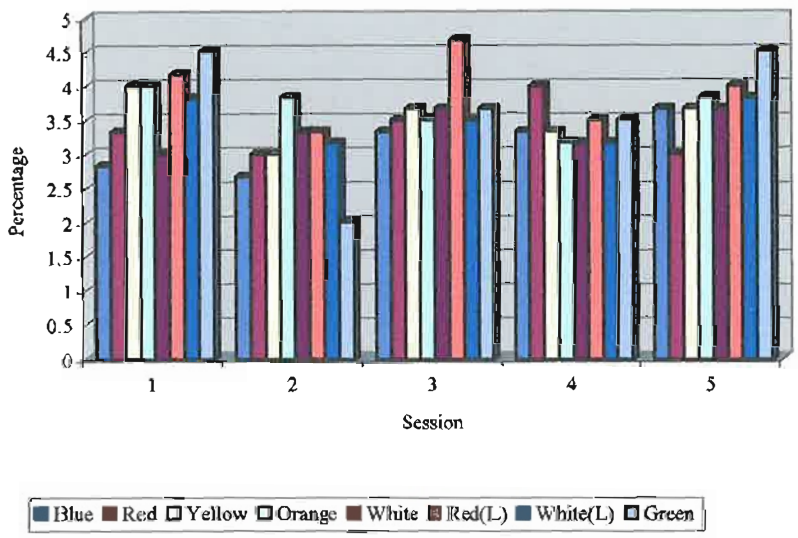

Figure 8.29 - Habituation times for flight behaviour for the avian predator phase for the peccaries.

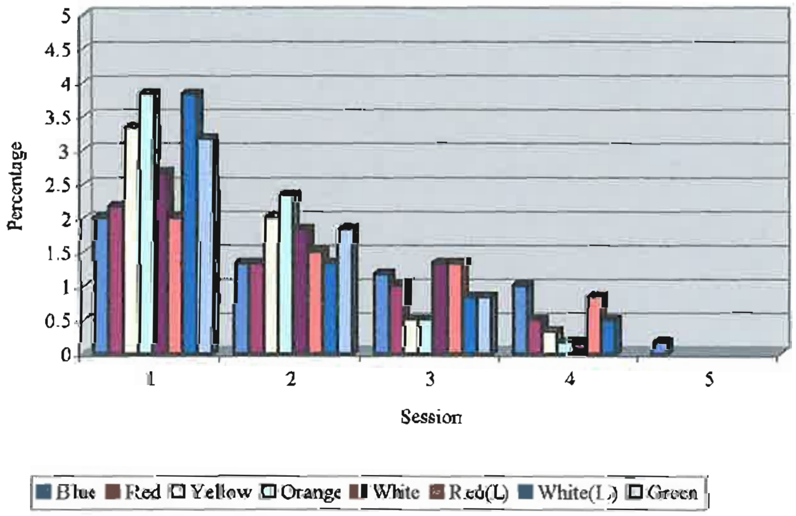

Figure 8.30 - Habituation times for flight behaviour for the avian predator phase for the peccaries.

Summary

Support was found for some of Hypothesis three and no conclusive results were found with other parts of the hypothesis as summarised below. The majority of the Barbary sheep performed slightly more exploratory and flight behaviour for the mammalian than the avian novel auditory stimuli, partially supporting the hypothesis. The Barbary sheep had not habituated to either of the novel auditory stimuli by the end of the five sessions and therefore neither supported nor did not support the hypothesis.

The otters were found to perform more exploratory behaviour in response to the avian predator novel auditory stimuli, not supporting the hypothesis. They did not perform any flight behaviour, even during the novel weeks thereby not supporting the hypothesis. The otters had not habituated to either of the novel auditory stimuli by the end of the week and therefore neither supported nor did not support the hypothesis.

The peccaries were found to perform more exploratory and flight behaviour in response to the novel mammalian predator auditory stimuli as opposed to the avian predator auditory stimuli thus supporting the hypothesis. The peccaries habituated to the avian predator auditory stimuli whereas they did not habituate to the mammalian predator auditory stimuli, also supporting the hypothesis.

7.3.4 Hypothesis Four

It was predicted that the Barbary sheep would perform more exploratory behaviour and take longer to habituate to the novel auditory stimuli than the peccaries and otters.

Figure 8.31 indicates the levels of exploratory behaviour for each of the species during the mammalian predator auditory phase. It is apparent that the peccaries only performed a very small amount, 0.54 percent, more exploratory behaviour than the Barbary sheep. The otters performed more exploratory behaviour than both of these species. They performed 3.15 percent more than the Barbary sheep and 2.61 percent more than the peccaries. Both of these are small increases in exploratory behaviour. This does not support the hypothesis that the Barbary sheep would perform more exploratory behaviour than the peccaries and otters.

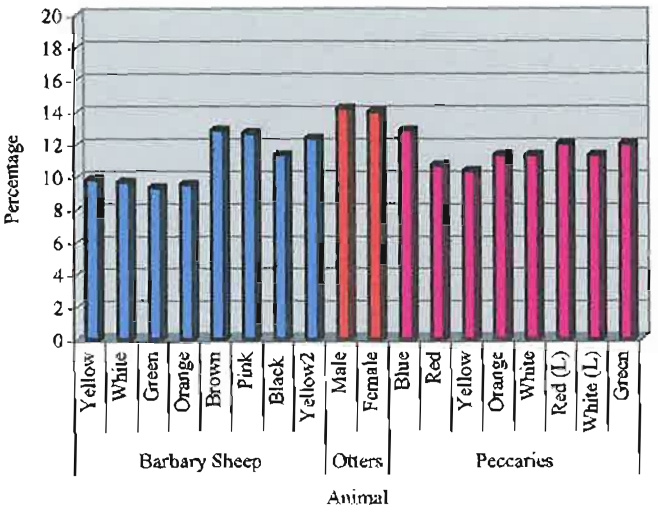

Figure 8.31 - Exploratory behaviour during the mammalian predator phase.

Figure 8.32 indicates the levels of exploratory behaviour during the avian predator phase. It is apparent that the otters spent the most time exploring, followed by the Barbary sheep and then finally the peccaries spent the least amount of time exploring. During the avian predator novel auditory phase the otters performed 17.34 percent exploratory behaviour followed by the Barbary sheep with 9.91 percent and then the peccaries with 4.90 percent. The levels of exploratory behaviour for each of the species can be seen in Table 8.10. These results do not support the hypothesis that the species that would spend the most time in exploratory behaviour was the Barbary sheep.

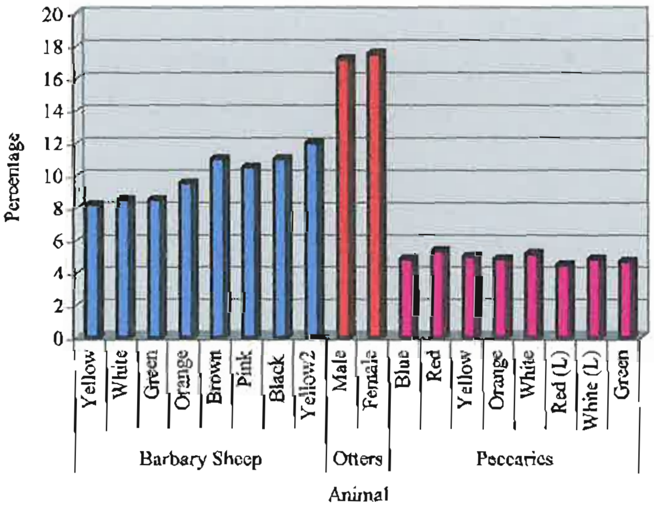

Figure 8.32 - Exploratory behaviour during the avian predator phase.

Table 8.10 – Indicates the levels of exploratory behaviour for each species for the two novel phases of the study.

Species	Mammalian	Avian
Barbary Sheep	10.94 (1.52)	9.91 (4.15)
Otters	14.09 (0.12)	17.34 (0.24)
Peccaries	11.48 (0.79)	4.90 (0.26)

7.3.5 Hypothesis Five

It was predicted that the otters would perform the least flight behaviour followed by the peccaries and then the Barbary sheep would perform the most flight behaviour in response to the novel auditory stimuli.

Figure 8.33 indicates the levels of flight behaviour for the three species for the mammalian predator phase of the study. The otters performed no flight behaviour and the peccaries performed the most flight behaviour, 17.50 percent, with the Barbary sheep in between at 11.62 percent. These results partially support the hypothesis in that the otters performed the least exploratory behaviour. However the Barbary sheep performed less than the peccaries and this did not support the hypothesis.

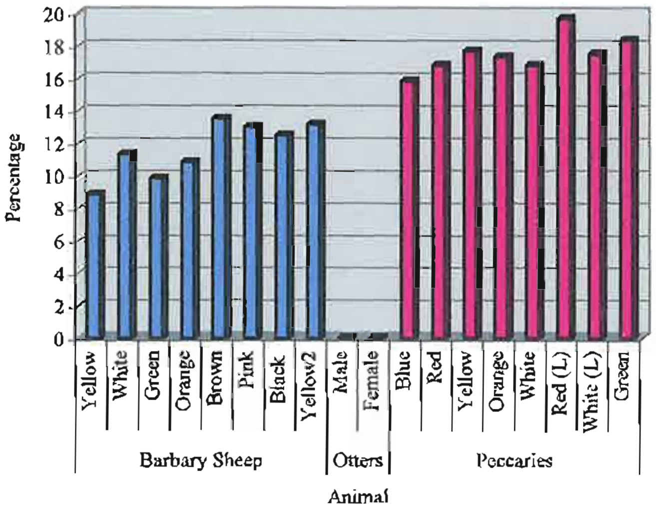

Figure 8.33 - Flight behaviour during the mammalian predator phase.

Figure 8.34 indicates the levels of flight behaviour during the avian predator phase. It is apparent that the otters once again performed no flight behaviour, followed by the peccaries, with 5.83 percent and finally the Barbary sheep with 10.52 percent. The levels of flight behaviour for each species can be seen in Table 8.11. These results supported the hypothesis that the otters would perform less than the peccaries and Barbary sheep.

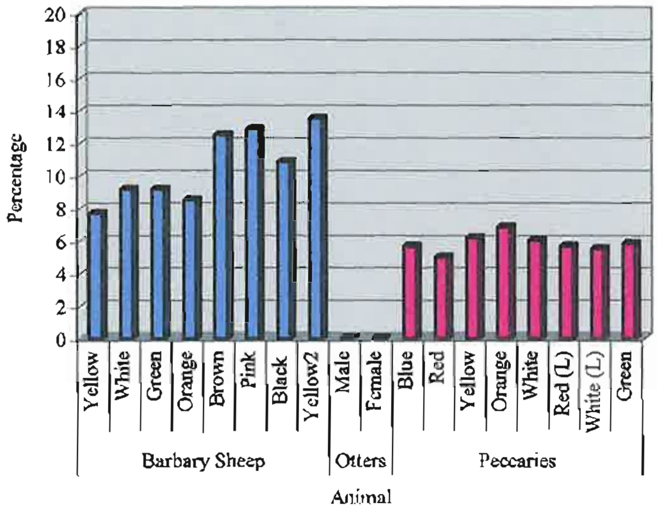

Figure 8.34 - Flight behaviour during the avian predator phase.

Table 8.11 – Indicates the levels of flight behaviour for each species for the two novel phases of the study.

Species	Mammalian Mean (SD)	Avian Mean (SD)
Barbary sheep	11.62 (1.70)	10.52 (2.21)
Otters	0 (0)	0 (0)
Peccaries	17.50 (1.14)	5.83 (0.54)

7.3.6 Hypothesis Six

It was predicted that there would be an increase in play behaviour associated with the novel auditory stimuli.

Barbary Sheep

Figure 8.35 indicates the levels of play behaviour for the adult Barbary sheep for each week of the study. It is apparent that the Barbary sheep performed more play behaviour during the novelty weeks than any other week of the study. The adult Barbary sheep spent between 7.50 and 9.00 percent more time playing during the mammalian predator phase than during the second baseline week. They also spent between 8.83 and 10.17 percent more time playing during the avian predator phase than during the third baseline week. All these differences represent moderate increases in play behaviour during the novelty weeks compared to the baseline weeks.

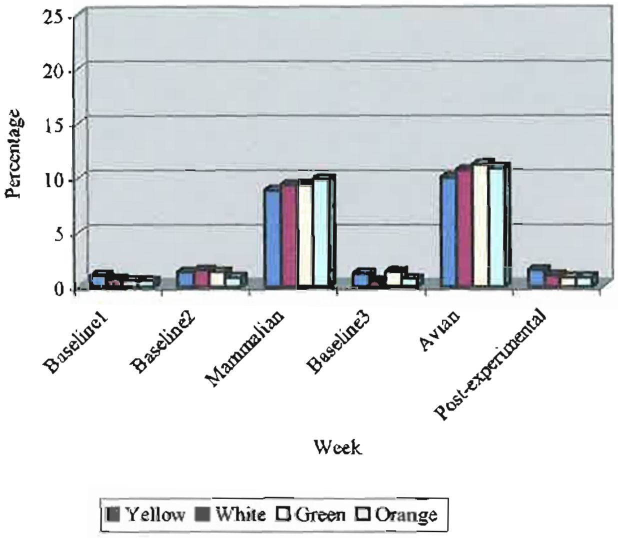

Figure 8.35 - Play behaviour levels for the adult Barbary sheep.

Figure 8.36 indicates the play behaviour for the sub-adult and juvenile Barbary sheep and once again it is apparent that the level of play behaviour was higher during the novelty weeks than the other weeks of the study. During the mammalian predator phase they spent between 12.83 and 14.17 percent more time playing than during the second baseline week. The sub-adult and juvenile Barbary sheep spent between 16.17 and 18.00 percent more time playing during the avian predator phase than during the third baseline week. Table 8.12 shows the play behaviour levels for each of the Barbary sheep. These results all support the hypothesis that the Barbary sheep would spend more time playing during the novelty weeks than when the novelty was absent.

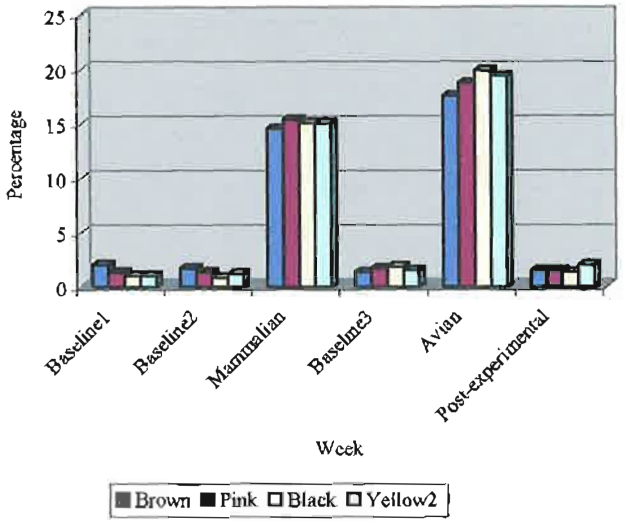

Figure 8.36 - Play behaviour levels for the sub-adult and juvenile Barbary sheep.

Table 8.12 – Play behaviour for the Barbary sheep for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Yellow1	1.00 (2.69)	1.33 (2.21)	8.83 (7.26)	1.17 (1.97)	10.00 (3.61)	1.50 (3.98)
White1	0.67 (1.80)	1.50 (2.51)	9.33 (7.23)	0.50 (1.35)	10.67 (3.37)	1.00 (1.66)
Green	0.50 (1.35)	1.33 (2.32)	9.33 (6.71)	1.33 (1.55)	11.17 (3.61)	0.83 (1.43)
Orange1	0.50 (1.35)	0.83 (2.24)	9.83 (7.97)	0.67 (1.31)	10.83 (4.40)	0.83 (1.43)
Brown	2.00 (3.32)	1.67 (3.10)	14.5 (13.58)	1.33 (3.60)	17.50 (5.37)	1.50 (4.04)
Pink	1.33 (3.60)	1.33 (2.32)	15.33 (5.16)	1.67 (2.76)	18.67 (5.36)	1.50 (4.04)
White2	1.00 (2.69)	0.83 (2.24)	15.00 (8.65)	1.83 (4.94)	19.83 (4.99)	1.33 (3.60)
Orange2	1.00 (2.69)	1.17 (3.14)	15.00 (12.38)	1.50 (3.05)	19.33 (5.99)	2.00 (3.39)

Otters

Figure 8.37 indicates the levels of play behaviour for the otters for each week of the study. It is apparent that the otters spent more time in play behaviour during the novelty weeks of the study than the other weeks. During the mammalian predator phase the otters spent between 14.16 and 16.66 percent more time playing than during the second baseline week. The otters also spent between 14.83 and 16.50 percent more time playing during the avian predator phase than during the third baseline week. Table 8.13 indicates the levels of play behaviour for the otters. These results support the hypothesis that the otters would spend more time playing during the novelty weeks than when the novelty was not present.

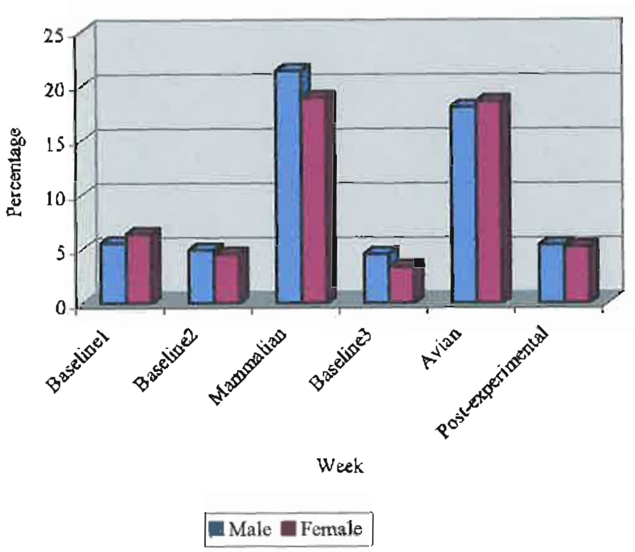

Figure 8.37 - Play behaviour levels for the otters.

Table 8.13 – Play behaviour for the otters for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Male	6.83 (3.52)	6.00 (4.59)	22.66 (10.52)	4.50 (3.84)	19.33 (11.04)	5.83 (4.31)
Female	7.66 (5.29)	6.17 (3.99)	20.33 (9.22)	3.33 (2.84)	19.83 (11.42)	6.17 (4.43)

Peccaries

Figures 8.38 and 8.39 indicate the levels of play behaviour for the female and male peccaries respectively. It is apparent that all the peccaries spent more time playing during the weeks when the auditory stimuli were in place than during the other weeks of the study. The peccaries spent between 14.34 and 16.67 percent more time playing during the mammalian predator phase than during the second baseline week. They also spent between 15.66 and 18.50 percent more time playing during the avian predator phase than during the weeks when the novelty was not present. These differences are all moderate to large increases in play behaviour from the baseline weeks to the novelty weeks. The play behaviour levels can be seen in Table 8.14.

These results support the hypothesis that the peccaries would spend more time playing during the novelty weeks than when the novelty was absent.

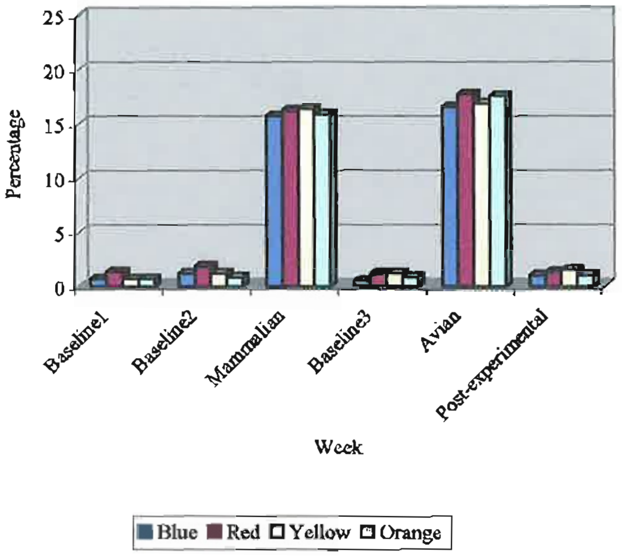

Figure 8.38 - Play behaviour levels for the female peccaries.

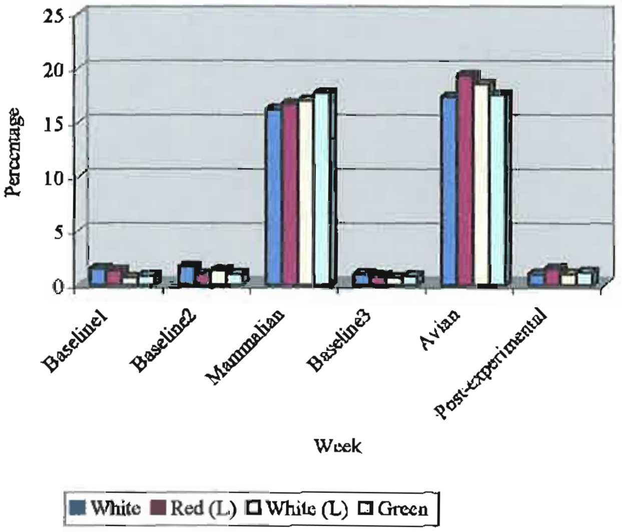

Figure 8.39 - Play behaviour levels for the male peccaries.

Table 8.14 Play behaviour for the peccaries for each week of the study.

Animal	**Baseline 1 Mean (SD)**	**Baseline 2 Mean (SD)**	**Mammalian Mean (SD)**	**Baseline 3 Mean (SD)**	**Avian Mean (SD)**	**Post-experimental Mean (SD)**
Blue	0.67 (1.80)	1.17 (1.97)	15.67 (8.18)	0.50 (1.35)	16.50 (5.51)	1.00 (1.66)
Red	1.33 (2.32)	1.83 (2.32)	16.17 (6.92)	1.17 (1.97)	17.67 (7.16)	1.33 (2.21)
Yellow	0.67 (1.80)	1.17 (1.97)	16.33 (6.53)	1.17 (2.21)	16.83 (4.84)	1.50 (2.51)
Orange	0.67 (1.80)	0.83 (2.24)	15.83 (4.59)	0.83 (2.24)	17.50 (4.67)	1.00 (1.66)
White	1.50 (1.82)	1.67 (3.10)	16.17 (4.10)	1.00 (1.66)	17.33 (4.98)	1.00 (1.66)
Red(L)	1.33 (1.84)	1.00 (1.66)	16.67 (6.19)	0.83 (1.43)	19.33 (5.38)	1.50 (2.51)
White (L)	0.67 (1.80)	1.33 (2.63)	17.00 (4.33)	0.67 (1.80)	18.50 (6.23)	1.00 (1.80)
Green	0.83 (2.24)	1.00 (1.66)	17.67 (6.10)	0.83 (1.43)	17.50 (4.67)	1.17 (1.97)

Summary

Play behaviour levels were higher during the novelty weeks than during the baseline or post-experimental weeks for all three species. This supports the hypothesis that the presence of the novel auditory stimuli would stimulate an increase in play behaviour.

7.3.7 Hypothesis Seven

It was predicted that there would be a decrease in stereotypical behaviour associated with exposure to the novel auditory stimuli.

The otters were the only species to perform any stereotypical behaviour throughout the study and so were the only species for which this hypothesis could be tested. Figure 8.40 indicates the levels of stereotypical behaviour for the otters for each week of the study. It is apparent that stereotypical behaviour was reduced during both the weeks of the novel auditory stimuli. The otters spent moderately less time, between 9.33 and 9.50 percent, exhibiting stereotypical behaviour during the mammalian predator phase than during the second baseline week. They also spent moderately less time, between 8.67 and 10.00 percent, performing stereotypical behaviour during the avian predator phase than during the third baseline week. The stereotypical behaviour levels can be seen in Table 8.15. These results support the hypothesis that the presence of novelty would decrease stereotypical behaviour.

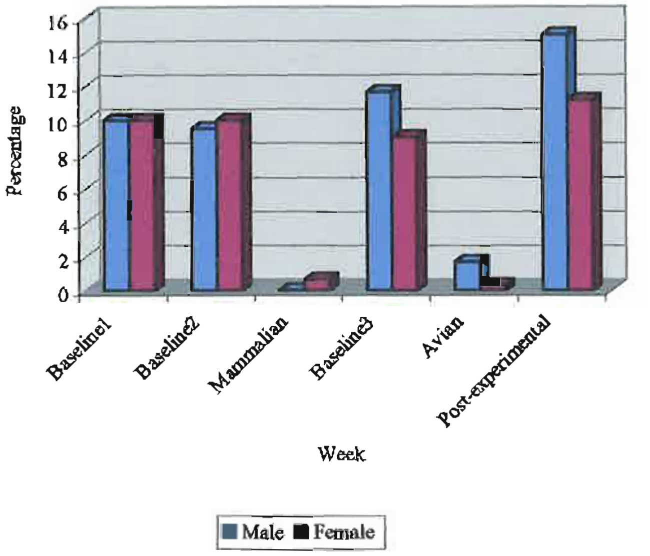

Figure 8.40 - Stereotypical behaviour levels for the otters.

Table 8.15 – Stereotypical behaviour for the otters for each week of the study.

Animal	Baseline 1 Mean (SD)	Baseline 2 Mean (SD)	Mammalian Mean (SD)	Baseline 3 Mean (SD)	Avian Mean (SD)	Post-experimental Mean (SD)
Male	10.00 (9.03)	9.50 (5.23)	0 (0)	11.67 (6.58)	1.67 (2.80)	15.00 (10.74)
Female	10.00 (9.03)	10.00 (4.42)	0.67 (1.80)	9.00 (7.26)	0.33 (0.9)	11.17 (8.43)

8.4 Discussion

8.4.1 Flight behaviour

The Barbary sheep and peccaries both performed more flight behaviour in response to the novel predator auditory stimuli. These results were expected and support the findings of Gebo et al (1994) and Weary and Kramer (1995) that predatory stimuli delivered via auditory means can stimulate flight behaviour. It is suggested that the fleeing behaviour occurs as a result of the expected attack from a predator. The otters did not perform any flight behaviour during the study, not even in response to the predator auditory stimuli. This may have been because the otters did not perceive the auditory stimuli as 'real' and therefore did not flee. Another possibility is that oriental small-clawed otters have no predators in the wild and therefore do not have any anti-predator behaviour to exhibit (Nowak, 1999).

A result that was not expected was that the peccaries performed more flight behaviour than the Barbary sheep during the mammalian phase. This result may indicate why attempts at preying on the peccaries are rarely successful. In the wild herds of peccaries are often threatened by attack from mammalian predators such as jaguars, bobcats, coyotes, mountain lions and jaguars (MacDonald, 1984; Nowak, 1999). The peccaries are always alert to this danger and generally flee when faced with the threat of attack. The fact that peccaries bred in captivity for several generations still exhibit this behaviour may indicate that this anti-predator behaviour is an important survival technique. This high degree of vigilance to the mammalian predator auditory stimuli may also suggest why predators in the wild are rarely successful in killing peccaries.

The Barbary sheep and peccaries exhibited flight behaviour that was quite similar to what has been described for their wild counterparts. In these studies the Barbary sheep were observed performing two types of anti-predator behaviours. One was to freeze and remain completely motionless when the auditory stimuli were played and the other was to flee immediately and then congregate at the rear of their enclosure. These two types of anti-predator behaviour occurred in response to both of the types of auditory stimuli. These are the types of anti-predator behaviours that have been reported for Barbary sheep in the wild. The freezing behaviour is thought to occur because of an adaptation to the Barbary sheep's habitat where there are no trees and bushes tall enough to hide them. In response to this the Barbary sheep attempt to blend in with their background by remaining motionless (Burton, 1980; Nowak, 1999). The peccaries also fled in response to the auditory stimuli with all members of the group spreading out across the enclosure and then collecting as a herd at the very back of the enclosure (See Figure 8.41). This resembles the anti-predator behaviour that has been observed when a predator in the wild is not detected by a peccary herd until it is very close. This type of behaviour is thought to confuse the predator so it cannot focus on one individual (Sowls, 1984). The peccaries also exhibited another type of unusual anti-predator behaviour that is more often observed when there are young present and they are in a dense habitat. In this situation, the peccaries will also flee but one individual will confront the predator and fight viciously with its sharp teeth. The peccaries performed the fleeing behaviour in response to the avian auditory stimuli whereas they exhibited both types of behaviour in response to the mammalian auditory stimuli. Whenever this behaviour was observed it was the neutered male Red (L) that stood up to the "predator" (See Figure 8.42). It was interesting to note that even though in the wild the peccary that confronts the predator is often killed, in these studies it was always the same peccary that assumed this role.

Figure 8.41 – Peccaries gathered together at the back of the enclosure after having fled the predator auditory stimuli.

Figure 8.42 – Red(L) confronting the predator auditory stimuli.

8.4.2 Exploratory behaviour

The Barbary sheep, peccaries, and otters all performed more exploratory behaviour when the novel predator auditory stimuli were present than in the weeks when there was no novelty. These results support Wood-Gush & Vestergaard (1991), Glick-Bauer (1997), Renner et al. (1992), Wilson (1982), Paquette and Prescott (1988), and Sandos (1999). In this series of studies the increase in exploratory behaviour was observed for both diversive and specific exploratory behaviour. Each of the three species was observed orienting and approaching the source of the auditory stimuli (the speakers) (See Figure 8.43 for Barbary sheep and Figure 8.44 for the otters orienting to the auditory stimulus) and also performing diversive exploratory behaviour. This contrasts with the previous studies that have only found an increase in specific exploratory behaviour to a source of novelty. This suggests that the animals may have been exploring to increase their survival chances by investigating escape routes and also hiding places. These results support the views of Dewsbury (1978) and Weisler and McCall (1976) that exploratory behaviour is highly adaptive and important for survival and reproduction. Animals must explore new elements in their environments in order to find food resources, potential mates and shelter from predators and the more an animal knows about its environment the higher its survival chances. The otters on the other hand did not perceive the threat as "real" and thus it is suggested that the observed increase in the exploratory behaviour occurred purely due to the presence of a source of novelty. The otters performed the most exploratory behaviour during both the predator phases and a reason for this could be that they were not limited by having to hide and flee from predators whereas the other species did. The animals that explore while directly threatened by attack from predators would be more at risk from predation. Thus the peccaries and Barbary sheep did not perform as much exploratory behaviour because the risks outweighed the benefits. This supports the results of Glickman and Morrison (1969) that animals that are more exploratory are more likely to be preyed upon. Ambrose (1972) suggests that animals that reside in an area can explore when there is no threat. In this situation, the peccaries and Barbary sheep could explore when the predator auditory stimuli were not present.

Figure 8.43 – Adult male Barbary sheep orienting towards the predator auditory stimuli.

Figure 8.44 – The two otters orienting and approaching the predator auditory stimuli.

8.4.3 Comparisons between the avian and mammalian predators

The Barbary sheep performed about the same amount of exploratory and flight behaviour in response to the two novel predator auditory stimuli. This contradicts the hypothesis that they would respond more to the mammalian predator as opposed to the avian predator. These results could be explained by the possibility that birds are a threat to young Barbary sheep in the wild or that the animals were reacting to the novelty and not the threat of the auditory stimuli. The otters did not perform any flight behaviour in response to either of the novel stimuli and this was expected because they are not preyed upon in the wild and therefore do not exhibit anti-predator behaviours. However, the otters did perform more exploratory behaviour during the avian predator phase than during the mammalian predator phase. A reason for this could be that the otters found the avian predator sounds more significant because they prey on birds in the wild and were therefore more interested in them. The peccaries performed more flight and exploratory behaviour in response to the novel mammalian predator auditory stimuli as opposed to the novel avian predator auditory stimuli. In the wild peccaries are at greater risk from mammalian predators as opposed to avian predators and would therefore be expected to react more to the mammalian predator sounds. The peccaries habituated to the avian predator sounds by the end of the five sessions and were the only species to habituate to the sounds during the studies. A point for further consideration in future research is that there may have been a generalised response to auditory stimuli rather than the animals responding to the stimuli because it was predator-associated. Further research could include an auditory stimulus that is non-threatening and determine if this is the case. The majority of the species not habituating to the sounds, even though they were being exposed to them for two hours everyday, was a positive outcome as will be discussed later in this section.

The results mentioned above support the results of Gebo et al. (1995) and Hanson and Coss (1997) that a species will react differently to avian and mammalian predators according to what, if anything, poses the greatest threat in the wild. The results discussed above also support the view that a species will react more to a type of novelty that is biologically significant for their species and supports the results of Hall (1998) and Heinrich and Smolker (1998). This suggests that the novel enrichment programs that will encourage the most exploratory and also take the longest to habituate to are those that hold some biological significance for the species and for the individual animals.

8.4.4 Play behaviour

An interesting result in these studies was that even in the presence of a potentially threatening event the animals still performed more play behaviour. It has been observed in the wild that play behaviour is the first behaviour to cease when animals are threatened by a predator (Dolhinow & Bishop, 1972). Biben et al. (1989) also found that animals are more at risk of predation due to their reduced vigilance when playing. This result could be potentially negative for these animals if they were released to the wild and continued playing in the presence of a predator. If these animals are never to be released into the wild then this behaviour may not be negative due to the benefits of play behaviour that have been discussed previously. At the very least this result would have to be investigated to determine if this was because of the regularity and consistency of the auditory stimuli. A better result in terms of anti-predator behaviours may be obtained if the stimuli were delivered via a variety of means including a combination of olfactory, auditory and visual stimuli.

8.4.5 Benefits of threatening events for captive animals

As mentioned previously it is now thought that brief threatening events may be beneficial for animals in captivity. Reasons for this that have been suggested include the proposal that animals in captivity should be maintained so that they can survive in the wild if they are ever released (Snowdon, 1989) and that animals should be provided with stimuli so that they can perform the full range of their normal behaviours (Chamove & Anderson, 1989). Moodie and Chamove (1990) have suggested that the natural progression of these two suggestions is that the presence of natural levels of stimulation is essential to prepare the individual for future challenges and to produce normal behaviours by providing natural stimuli. Arousal due to threat of predation is common to all animals in the wild but is almost never present in captivity. If the duration of the "frightening" event is short they evidently do not lead to abnormal behaviours like other stressors, such as zoo visitors (Moodie & Chamove, 1990). This was supported by the results from the current studies where the predator stimuli led to a decrease in abnormal behaviours. Another positive outcome was the increased exercise that the animals got through the fleeing behaviour. This could help counter the inactivity and obesity that can be associated with animals in captivity. The fact that only one species habituated to one type of auditory stimuli was also positive since this could possible be a negative consequence if the animals are ever to be released into the wild. If the animals are exposed to the predator stimuli too frequently then habituation will occur and they will learn that the stimuli have no consequences and predation will not result then they will stop fleeing from the stimuli. Thus a potentially negative type of stimulus was found to be positive form of enrichment for three species of animals in captivity.

8.5 Conclusions

The procedure employed in the present study was found to be an effective method for encouraging activity in three species of animals in captivity. The healthy social and physical development and well-being of the animals was ensured by promoting flight, exploratory, and play behaviour. Furthermore, stereotypical behaviours were decreased thus allowing the public to have a more natural view of the behaviour of specific species. In addition this method was not invasive to the animals enclosures and meant that there was no danger for the animals and nothing unnatural for the public to see. This was also an effective method of providing animals in captivity with access to predator-associated stimuli and this is thought to be essential for the well-being of animals in captivity. It was also found that the three species reacted differently to each of the types of novel auditory stimuli. This suggests that the type of novelty used could affect how successful an enrichment program is. As previously found with novel objects and novel odours, the novel auditory stimuli that were more biologically significant for the species were found to affect the species the most.

Chapter 9: General Discussion

9.1 General conclusions

The studies reported in Chapters 6, 7 and 8 have clearly demonstrated the importance of novelty for animals in captivity. In all four species levels of exploratory and play behaviour increased in the presence of novelty. Just as importantly, stereotypical behaviour decreased in the presence of the novelty. When the novel stimuli were removed levels of exploratory and play behaviour decreased, often back to baseline levels. Moreover, consistent with these reversions to pre-experimental activities, the levels of stereotypical behaviour increased. It is clear from these outcomes that the provision of novel stimuli to these animals was highly successful in stimulating exploratory and play behaviour and reducing stereotypical behaviour.

In addition, these studies have highlighted the importance of sensory stimulation for species in captivity. Thus, the present set of experiments has extended past studies into the effects of novelty which have tended to concentrate only on the general reactions of animals to novelty, rather than which features of the novel objects elicit changes in behaviours. The present experiments have clearly demonstrated that olfactory and auditory stimulation, often overlooked in earlier research, are important methods for stimulating exploratory and play behaviour and for reducing stereotypical behaviour. A third significant finding from the research reported in this thesis has been that it is important to consider the implications that different types of novelty have for different species and even for the different animals concerned. This matter will be discussed further in Section 9.4.3.

As discussed in Chapter 1, the central thesis underpinning this dissertation was that the environments of multiple species in captivity could be enriched by providing them with access to several types of novelty. It was proposed that exposure to novelty would lead to more exploratory and play behaviour and less abnormal behaviour in the presence of the novelty. It was argued that this form of enrichment is important because captivity reduces opportunities for exploratory and play behaviour that form part of natural activities in the wild, which are essential for the physiological and psychological health of animals. Novelty was provided by giving the animals' access to objects, olfactory and auditory stimuli. Following a careful analysis of difference between these species in the wild, it was also suggested that each species would react differently to each type of novelty. Consistent results in a number of different areas were obtained throughout the three studies. Novelty, in the form of objects, odours and auditory stimuli, was found to increase exploratory and play behaviour and decrease stereotypical behaviour. The subject species reacted differently and in some cases did not react at all to all of the different types of novelty. These results supported the thesis that provision of novelty is a reliable method for increasing activity and decreasing abnormal behaviours and therefore enriching the lives of animals in captivity.

The two main aims of environmental enrichment programs have been discussed previously in Chapter 1. These aims are the maintenance of the welfare of animals in captivity; and to prepare captive animals for release into the wild. As an enrichment program the three studies reported here have contributed towards meeting both aims. Thus, the maintenance of the animals' welfare was achieved, at least in the short-term, by increasing the exploratory and play behaviour that the animals engaged in and by decreasing their stereotypical behaviour. This outcome was immediately beneficial because exploratory and play behaviour are considered to be important for countering obesity and general inactivity in captive animals (Baer, 1998). There can be no doubt that the introduction of these programs resulted in marked changes in the behaviours of the animals involved. Levels of exploratory and play behaviour were low to nonexistent prior to the introduction of the novelty, indicating that the enclosures were lacking in novel stimulation prior to these studies. Thus, the improved levels of exploratory and play behaviours observed in these animals dropped back to low to nonexistent levels as soon as the novel materials were removed at the conclusion of this series of studies.

Koebner (1994) has reported that the best exhibits of animals in captivity are those that include key elements of the wild and a very important element is that of novelty. Animals that have been deprived of novelty when young show very little interest in novel items as adults and this can be dangerous to their survival if they are subsequently released into the wild (Bradshaw & Polling, 1991). Thus exposure to novelty in captivity is essential to help animals become accustomed to the novelty that they will face if ever released into the wild. Play and exploratory behaviour are also good methods for animals to learn and practise the skills that they do not need in captivity but are essential for survival in the wild. As Box (1991) has reported, many of these behaviours are not innate and therefore need to be learnt. Play behaviour resembles real world activities and as a result can be used to maintain these behaviours.

The relevance of the present studies to the preparation of animals for the wild was less immediate because none of the animals involved would ever be released; but relevant nonetheless. This is because the types of novelty that were presented were shown to result in species appropriate behaviours. The movable and non-movable objects appeared to either represent prey or predatory stimuli to each of the species and they reacted by approaching or withdrawing from the stimuli as was appropriate. In future research this approach could be further enhanced by associating the movable stimuli with other factors such as the odour or auditory stimuli associated with the predator or prey species. Furthermore, the olfactory stimuli simulated foraging behaviour and, as in the wild, this did not necessarily lead to food. The provision of food-related odours in the enclosure encouraged the animals to search for food as they would in the wild, thus encouraging natural behaviours. Foraging could be stimulated more naturally by dragging food around the enclosure and leaving an odour trail that sometimes culminates in food and sometimes does not. The auditory stimuli encouraged species-typical predator avoidance strategies in the animals. This is an essential skill for animals to learn if they are ever to be released to the wild. It is also very important that the predator stimuli are given intermittently so that the animals do not habituate to predators and endanger them when released. Thus, although the enrichment strategies employed in the current studies would not have been sufficient on their own to prepare animals for release to the wild, they clearly demonstrated the direction that future research aiming should take to maintain species-typical behaviours.

Provision of novelty is also a good method for environmental enrichment because it can be very simple and cheap to develop and does not require numerous extra keeper hours to maintain this kind of program. Provision of novelty does not have to be as involved or expensive as either the Hagenbeck or Markowitz approaches. The Hagenbeck approach to environmental enrichment often involves the complete remodelling of the enclosures; and this approach has in any case been criticized as being focussed on what looks good for the visitor without serving any practical purpose for the animals (Tudge, 1991). The Markowitz approach requires the development of expensive apparatus and in addition requires the commitment of numerous keeper hours to train animals to respond to such materials. This can mean that these environmental enrichment programs are not successful because of money or time constraints. On the other hand, the argument developed here has been that novelty can be provided, simply by dragging a piece of meat around the enclosure, or by providing the faeces of one animal to another, or by providing cheaply made 'toys', or by recording one species and playing it to another. The only requirement of this approach is that these forms of enrichment have to be varied from time to time, so that the animals do not habituate to these stimuli.

Despite the finding that the current enrichment techniques were successful in increasing exploratory and play behaviour and decreasing stereotypical behaviour they have not been continued, with these species, by the zoo involved. The ultimate explanation for this is probably insufficient funds. As mentioned above, in addition to being highly effective, these methods of enrichment were relatively inexpensive and required only limited keeper hours. Nonetheless, many zoos operate with under resourced conditions, keepers are often over-worked and even small amounts of extra time can be hard to find. So, too, money in zoos can be a hard commodity to find, even relatively small amounts. Thus, zoos are often forced to disregard enrichment programs in favour of feeding the animals and the general maintenance of the exhibits. It is the case, too, that zoos are heavily reliant on gate takings and sponsorships; and members of the public can sometimes react negatively to materials in an exhibit that do not appear to be consistent with widely held expectations about what kinds of things should be seen in exhibit. Thus for example, a zoo may be disinclined to persevere with sound speakers in a tree, even when camouflaged, if sufficient members of the public raise objections. It was stated in Chapter 1 that many zoos have the potential to play an essential role in the conservation of many species. However, even though the potential is there, many zoos do not fulfil this role because of time and monetary constraints. Certainly, a more positive effort could be made if fewer animals were kept at each zoo, with a focus within locations on fewer species. A problem with this approach, however would then be that each zoo would not have the "key" animals in their collections, such as lions and elephants, that draw paying customers. Thus the zoos would have the extra time and space to devote to enrichment and conservation but not the money. Clearly, there may be a fundamental contradiction between policies that advocate conservation but also demand that zoos be significantly self-funding.

9.2 Reactions to novelty

The three species reacted differently to each type of novel stimulus. Reactions to novelty were determined by the stimulus characteristics and the species involved, supporting the results of Joseph and Gallagher (1980). The Barbary sheep typically tended first to avoid the novel material for a few days but then explored these materials for longer than the other species. The zebras, peccaries and otters all explored the novel element as soon as it was placed in their enclosure. This species difference indicates that Barbary sheep are a neophobic species whereas the other three species are neophilic. Neophobic species tend to avoid novelty whereas neophilic species seek it out. This could be the reason why ungulates in general have been found to be non-reactive to novelty enrichment programs. The most comprehensive comparative study into the effects of novelty by Glickman and Sroges (1966) provided the novel stimuli for only a short period of time. Thus, the novelty may have been removed before the ungulates had a chance to investigate them. The Barbary sheep in the current situation would also have been found to be non-reactive had the time frame here been as followed by Glickman and Sroges, whereas, with extra time they were found to display exploratory behaviour.

The levels of stimulation were also different for each species. The Barbary sheep and zebras reacted to the presence of the less complex objects but appeared to find the more complex objects too novel and tended to avoid them. This supported the view that omnivores and carnivores require a higher level of stimulation than ungulates. Nonetheless, the ungulates were also found to spend some time exploring the objects, and odours and they reacted to the auditory stimuli, suggesting that they benefited from the enrichment program.

Importantly, this study has also shown that the nature and hence salience of novel stimulation can vary across species. Thus it is important to determine the appropriate form of novel materials, to encourage the optimum reaction from each species. Previously, movable novel objects have been thought to be best for all species, having been found appropriate for orang-utans (Wilson, 1982), monkeys (Sambrook & Buchanan-Smith, 1996), the greater galago and the slow loris (Jaenicke & Ehrlich, 1982) and chimpanzees (Paquette & Prescott, 1988). However, zebras showed a slight preference for the movable rather than the non-movable objects and Barbary sheep were found to prefer the non-movable objects. The inferences drawn here was that this was related to the biological significance of the movability of the novel objects. Movable stimuli to the zebra and Barbary sheep would indicate predators and that they were at risk, whereas for the peccaries and otters, the movable stimuli would indicate a possible food source. Each species also investigated the olfactory stimuli that were more relevant for their species. The olfactory stimuli that were biologically significant for their species were the food items that the particular species included in their diet. Animals only explored the irrelevant stimuli for long enough to discover that they were not important for them. So too with the auditory stimuli, the animals reacted more to the predator sounds that were threatening for their species. This observation suggests that, for enrichment programs to be effective, it is important that they hold some biological significance for the species.

9.3 Limitations of the current studies

As discussed previously in Chapter 4, there are a number of unavoidable limitations associated with performing research in a zoo environment. These are all associated with the reduced extent of control that the researcher has when compared to the laboratory. Limitations include unpredictable subject numbers, time restraints and the need to make all equipment safe and as natural looking as possible. The number of animals available at the zoo determines the number of subjects that any study can include. In the current situation this meant that only two zebras and two otters were used initially. Moreover, the male zebra died following (but not as a result of) the first study and could not be replaced, so that the decision was made not to include the remaining zebra for the later studies.

The limited subject numbers also determined the way in which the data were analysed. Visual inspection was used rather than the usual statistical analysis. This was considered appropriate because the behaviour of each individual animal can be investigated, rather than focussing on average overall effects. In the end this may not be a significant shortcoming because whether an enrichment program will be considered a success or not is not if statistical significance is obtained. If statistical significance is obtained but a number of the animals have not benefited from the program, then that outcome is unlikely to be viewed as worth the effort required. The need to look at each animal individually will be discussed further later.

A further limitation of the studies was due to currently inadequate knowledge about the behaviour of some species in the wild. In many instances it is impossible to determine what types or quantities of behaviour are abnormal. In this series of studies the otters would quite often bounce repetitively in one spot, and this behaviour increased any time there was a person in sight. The behaviour of otters in the wild has been reported in enough detail so that researchers can be relatively sure that this behaviour is abnormal. However, the Barbary sheep spent large periods of time asleep or lying down during the day. Their activity cycle has not been reported in enough detail to determine if this is an appropriate amount of time for this species to be inactive. Observation of inactivity provides a good example of a behaviour that was once generally considered to be abnormal in captivity; but that was then found to be normal for some animals. Thus, lions in the wild are inactive for long periods of time (Stevenson, 1983). Stimulating activity in these species in captivity would be creating an abnormal level of behaviour.

9.4 Implications for captivity

When dealing with species that have not been studied extensively in the wild, care must be taken not to cause abnormal behaviours or levels of behaviour. Some field researchers, such as Wrangham (1992), have focussed their research on the aspects of the wild habitat that elicit natural behaviours. Once these have been identified it is then possible to design exhibits with the elements that are necessary to elicit natural behaviours. Wrangham (1992) researched the elements that were necessary for chimpanzees to perform species-typical behaviours and it is essential that this type of research be performed for other species. A priority should be those species that are endangered and close to extinction in the wild, because otherwise the types of behaviours that must be preserved will never be known. Zoo researchers should seek out the information made available to them by the field researchers and design enclosures and enrichment programs that will elicit natural behaviours.

9.5 Individual differences

Not only must species-specific behaviours be taken into account when designing enrichment programs but also the histories of the individual animals must be considered as well. Many animals in captivity have lived very different lives to each other. Some have been caught in the wild and then kept in captivity, while others have been born in captivity. Bacon, Ripsky, Hawk and Battershill (2000) designed enrichment programs for two giant pandas. The male panda was injured in the wild and could not be released from captivity, whereas the female was captive born and mother raised. As a result, the two animals varied greatly in their behaviour. The male interacted only with the food in his enclosure, exhibited stereotypical behaviour and reacted badly to any changes in routine. The female showed a lot of interest in everything in her enclosure especially new elements and did not exhibit any stereotypical behaviour. Bacon et al. (2000) aimed to stop the male from stereotyping and increase the time that it took both animals to eat their daily food rations. The female needed no encouragement to use the enrichment devices, whereas some of them had to be modified, to make them easier for the male to use. Even with the modifications the male showed no interest in some of the enrichment devices. However, as the enrichment program progressed he began to show more interest in some of the novelty items and also displayed less stereotypical behaviour. This research showed that one enrichment program may work effectively for one animal but may require revision for another. The keepers involved in these enrichment programs were more interested in the fact that the procedures adopted worked well for these two pandas, and were not concerned to extend the research so as to gain statistical significance with more animals. In addition, the low subject numbers meant that the keepers could persevere with the program for the male and were ultimately successful in enriching his environment and therefore his behaviour.

In the current studies the Barbary sheep came from different backgrounds. Most significantly, the female called Green had been born and raised at Monarto Zoological Park. Monarto is an open-range plains zoo where there is little close contact between either keepers or visitors and the animals. Possibly as a consequence of this, Green would keep her distance from the keepers and was initially very wary of the novel item that was presented to the animals. The other animals approached the novel item sooner and appeared less stressed when the keepers were in the enclosure. However, with time Green approached and explored the novel items. These were only minor differences because the animal had lived in a different zoo environment but the strategies necessary to ensure success of the enrichment program may have been very different if the animal had been born in the wild and captured. In addition the treatment that the animals have experienced and conditions in which they have lived can be very different and some animals stereotype badly before they arrive at the zoo. All of these factors must be taken into account when designing an enrichment program. In the above examples with the Barbary sheep, Green, and the male panda, persistence was necessary to ensure the success of the enrichment program. Therefore, it is important to take into account the background of each of the animals.

9.6 Applications of the current studies

A primary aim of the current studies was to enrich the lives of these animals in captivity. Encouraging exploration and play is essential for the healthy social and physical development of animals in captivity. Exploration and play can also help to maintain health in older animals. Furthermore, because of the increase in activity, it is easier for keepers to observe if animals are sick. Exploration and play are also important because they can have an engineering role in the evolution of new behaviours (Brown, 1998). In addition, animals prevented from playing when young may suffer impairments as adults (Markus & Croft, 1995). Animals prevented from exploring can also perform increased amounts of stereotypical behaviour. As mentioned, play can be used as a way of maintaining behaviours not necessary in captivity. This is because play resembles real world behaviours. This was evidenced by the play activities seen in the current studies. The social play encounters of the Barbary sheep, zebras and peccaries included a high degree of social running or chasey play behaviour. In addition, they performed some play-fighting behaviour. This resembles the flight behaviour and intraspecies aggression that occur in the wild. The play behaviour of the otters included a large amount of play-fighting and object play behaviour. This resembles the intraspecies aggression and handling of prey of the otters. Play and exploration are also important because they can be the way new behaviours are integrated into the group. Therefore, exploration and play are very important for animals, especially those in captivity.

9.6.1 Exploratory behaviour theories

The reaction of the animals to the novelty was consistent with the environmental modelling and discrepancy theory, discussed in Chapter 3. The animals appeared to have recognised that there was a discrepancy between what was previously available in their enclosure and the presence of the new elements. This recognition then led to either approach or withdrawal, depending on the species or individual involved. The drive theories of exploratory behaviour discussed in Chapter 3 were also supported, in that the levels of exploratory behaviour were very low prior to exposure to the novelty but higher when the animals were exposed to novelty. The drive theories state that sustained exposure to an unchanging environment will motivate behaviour directed away from familiar sources and towards new sources. This outcome observed, with most of the animals immediately exploring a novel item when they were exposed to it. The animals were seen approaching and withdrawing from the novelty periodically during the time that they were exposed to it. This was consistent with optimal stimulation and arousal theories that suggest animals use novelty as a method for keeping their stimulation at an optimal level. However, evidence was found to support the fear and exploration theories. These theories suggest that animals explore to reduce fear induced by exposure to novelty. In contrast to this suggestion, many of the animals did not display signs of fear and explored the novelty as soon as they were exposed to it. The information primacy theory was supported because the animals explored all the objects, even if they were not relevant to their survival, but they paid more attention to the biologically relevant stimuli.

9.6.2 Play behaviour theories

The Surplus Energy Theory for play behaviour was not supported by the results of these studies. When exposed to the novelty, the animals displayed more play behaviour, despite the fact that they were expending more energy by exploring. According to this theory, play behaviour should have been highest when the animals were at their least active or prior to exposure to novelty. No support was found for the Optimal Arousal Theory since it could not be determined what the arousal states of the animals were. A theory that incorporates both of these theories, the Surplus Resource Theory may be more beneficial for accounting for play, since it incorporates more factors and can account for play behaviour in captivity. Support was found for a version of the Surplus Resource Theory, as suggested by Burghardt (1988), in that species in captivity that are not in nutritional stress and not constantly active near their physiological limits would be expected to play and they did in the current studies. He furthermore suggested that animals will play more in captivity than in the wild because the animals have time to spare, have no survival concerns and the need to burn up excess energy. The levels of play behaviour observed for the animals in captivity in these studies were high, in contrast to what is known about play activities for these same species in the wild. In fact, play is barely mentioned for animals of these species in the wild, suggesting that it does not occupy a substantial amount of their time. The Surplus Resource Theory also negates the need to consider the functions of play behaviour in terms of theory since it explains play in terms of the animal's response to the resources available to the animal to play. Thus predictions about levels of play behaviour can be made for individual animals and for species.

The fact that play behaviour in these species resembles real world activities is evidence for the practice theory. Byers (1977) studied the play behaviour preferences of Siberian ibex kids in their natural habitat. He found that they revealed a preference for social play-fighting on flat surfaces and social play-chasing and locomotor play on sloped surfaces. The Barbary sheep also showed these same preferences. They only performed play-fighting on the flat surfaces and play-chasing behaviour on the mountain in their enclosure. This behaviour would have to be strongly selected for because of the increased risks associated with performing play-chasing behaviour on uneven ground. The animals could quite easily fall and injure themselves with the likely result being death. There was nothing to be gained by play-fighting in the hilly areas so this was performed on level ground where fewer risks would have to be taken.

9.6.3 Enrichment strategies

A further application of the current work is to devise enrichment strategies for the species studied. Table 9.1 summarises the enrichment strategies that were found to be the most effective for each species involved; (zebras are not included in this Table because they were only involved in one study and were found not to prefer either movable or non-movable novel objects). This kind of information is vital when implementing future enrichment programs for these species. These results also clearly demonstrate that it is important for any enrichment program to include elements that are biologically significant for the species involved.

Table 9.1 – Summary of the most effective enrichment strategies for each species.

Species	**Novel objects**		**Odours**				**Predator sounds**	
	Movable	**Non-movable**	**Meat**	**Fish**	**Fruit**	**Grass**	**Mammalian**	**Avian**
Barbary sheep	✗	✓	✗	✗	✗	✓	✓	✗
Otter	✓	✗	✗	✓	✗	✗	✓	✓
Peccary	✓	✗	✓	✗	✓	✓	✓	✗

As demonstrated in Table 9.1 each of the species reacted very differently from each other for each of the types of novelty. The only type of novel stimulation that was effective for each of the three species was the novel mammalian predator auditory stimuli. Apart from this common element, no other type of novel stimuli was effective for all three species. These results support the suggestion of Timberlake (1998) that everything that is placed in an animal's enclosure should be evaluated from the animals' "point of view" or using a theromorphic technique. As discussed in Chapter 2, Timberlake (1998) has stated that the sensory and motor capacities of humans are vastly different from those of other species. It should also be remembered that, not only are other species different from humans but many are also vastly different from each other. Therefore, each species may require different forms of novel stimuli to elicit species-typical behaviours. From the information in Table 9.1 we can predict that Barbary sheep would benefit the most from non-movable novel objects, grass novel olfactory stimuli and mammalian novel auditory stimuli. In contrast to this configuration, otters would benefit from movable novel stimuli, fish novel olfactory stimuli and mammalian or avian novel auditory stimuli. Differing again, peccaries would benefit from meat, fruit or grass novel olfactory stimuli and mammalian novel auditory stimuli. Thus, the novel stimuli mentioned above are those that stimulate the most exploratory and play behaviour from each of the three species. Timberlake (1998) has suggested that these should be predictable as the most suitable elements of the animals' environment to elicit these behaviours, by using the theromorphic technique. Important elements to consider when predicting what novel elements will elicit a reaction from a species are the relevance of the stimuli for the species, how the animal will perceive the stimuli and the senses the novel element will stimulate.

9.7 Future research

One of the most important areas for future research must involve comprehensive study of the behaviour of more species in the wild. The behaviours of animals in captivity can then be compared with those in the wild, to determine what behaviours or levels of behaviour are normal or abnormal in wild populations. Future enrichment strategies can then aim towards ensuring that animals in captivity perform the correct behaviours and behaviour levels. With many species in the wild becoming extinct this may also be the only way to know what behaviours must be preserved before animals raised in conservation programs can be released as their habitats become more stable. Until then care must be taken not to encourage abnormal behaviours in captive animals. The study of animals in their natural habitats may also suggest future enrichment ideas for other species. One of the most well recognised enrichment ideas came about in this way. Chimpanzees were observed to modify branches to 'fish' for termites in their mounds (Goodall, 1986). These termite mounds now exist in many zoos for chimpanzees and even for some gorillas and orang-utans. Observations of other species may suggest other appropriate enrichment ideas. Furthermore, this helps to educate the public about the natural behaviours only previously seen in wild populations.

Further investigation into the sensory systems of different species is also necessary. This would enable better predictions to be made about the effects of auditory, visual and olfactory stimuli on various species. As suggested by Timberlake (1998), such effects have to be studied from a theromorphic viewpoint. This means attempting to determine what enrichment properties are required from the animal's viewpoint, rather than the person assuming how the animal perceives the stimuli. For this to be feasible as much as possible needs to be known about the sensory capabilities of the species. Once again this points to the need for more field research to be performed, like the work performed by Wrangham (1992) that was aimed at finding what elements are necessary to stimulate species-specific behaviours.

Another important area for future research is to concentrate on those species or taxonomic groups that have been largely ignored up until now. King (1993) reports that there has been a lack of research on environmental enrichment for birds. There has also been a lack of enrichment ideas for ungulates and non-mammalian species and researchers have tended to focus on primates and carnivores. Wemmer, Rodden and Pickett (1997) analysed the publication trends of *Zoo Biology*, an American journal specialising in zoo-related issues. They found that the taxonomic representation in publicised research was heavily skewed towards mammals. Mammal-related articles made up 73% of research articles whereas only 10% dealt with birds, 7% with reptiles and 7% focussed on invertebrates. It is possible that the percentages reported by Wemmer et al. (1997) might not actually reflect the levels of research that arte being performed in different areas but rather the articles accepted for publication by *Zoo Biology*. This seems unlikely, however. Wemmer et al. (1997) suggested that the lack of research on these latter groups reflects the small numbers of research-oriented staff working in these areas. It could also be because these species do not show obvious signs of stress or abnormal behaviours in captivity. Some researchers are now focussing on species that have not generally been associated with enrichment research. Thus, for example Burghardt et al. (1996) have recently published research with a Nile soft-shelled turtle, Sandos (1999) with birds and Wood and Wood (1999) with octopuses.

The attitudes of people who work in or visit zoos to environmental enrichment programs is another factor that should be considered. Enrichment programs can involve elements that people may be uncomfortable with. For example, as was done in the third study reported here, these programs can include potentially frightening events, like exposing the animals to predator-associated stimuli. The keepers or the zoo visitors may find it difficult to accept that this is beneficial for the animals; and if a decision to establish or continue an enrichment program depends on support from these groups, then the program will probably fail. Education programs to emphasize the importance of these stimuli to normal development are necessary if such enrichment programs are not to offend people.

It is, above all, critically important to determine how supportive the zoo staff in general will be of any type of enrichment program, since enrichment programs will fail without the full support of the zoo personnel. The experience of this author while completing the research reported here was while many zoo personnel in theory supported enrichment programs, they did not regard such work as a high priority. Thus many fail because of a lack of practical support. The type of support that is necessary includes extra keepers to cover the additional time that is necessary to support the program, while still having sufficient time for other housekeeping issues. It is equally important also that the management level support enrichment in their zoos and promote the benefits of it because if they do not, then enrichment will not become a priority within the zoo. Unfortunately, earlier statements that zoos are not active in conservation issues and that many of the animals in zoos stereotype badly and do not possess the skills necessary for survival in the wild (McKenna, 1987), still have an element of truth today. Even though many zoos will state that enrichment is important this does not carry through in practice. However, solving this problem probably requires that the public be educated and convinced to support only zoos that make the well-being of their animals a priority. If this is achieved, the much needed public funds will only go to those zoos that are making enrichment and conservation a priority. Areas in zoos that need to be addressed include feeding regimes, enclosure design and enrichment strategies. Litchfield (2000) has reported that even relatively new multi-million dollar exhibits still do not have the necessary elements to elicit species-typical behaviours and thus give the public an inappropriate perception of a species' behavioural repertoire.

Specifically, research into the biological significance of novelty and how this affects habituation times is important. One of the main factors that limit enrichment programs involving novelty is rapid habituation of the animals to the new circumstances. Research could look at how habituation time is affected by combining more than one sensory element. For example, combining predator auditory stimuli with the faeces of a predator or combining a visual stimulus by flying predator silhouettes and playing an auditory stimulus may extend habituation times. Kardos (1999) investigated the effects of predator silhouettes on meerkats and dwarf mongoose. An extension of her study would be to associate the silhouette with odours in the form of predator faeces or predator auditory stimuli. Many of the studies to date have focussed on one single novel stimulus rather than combining several to determine whether the animals react differently to these situations.

Another area that could extend this research would be to investigate the reactions of the animals to novel odours on familiar objects and novel odours on unfamiliar objects. If the animals reacted as much (or more) to the odours on familiar objects, then this could be a better way of presenting the odours to the animals. This would mean that this type of enrichment program would be less intrusive.

9.8 Conclusion

The current research has supported the thesis that the lives of animals in captivity can be enriched by introducing novelty into their environments. Evidence of enrichment was an increase in the level of play and exploratory behaviour and a decrease in stereotypical behaviour. The novelty was provided in the form of objects, olfactory and auditory stimuli. The manner in which different species reacted differently to different novel items was consistent with a theory that animals will respond more to stimuli that have biological significance for those animals in the wild. When the novel stimuli were first established as biologically significant for a species, by choosing items consistent with known salient behaviours in the wild, the animals spent more time exploring and playing with those items and took longer to habituate to them. Finally, this research has demonstrated that the use of novelty can be a simple, cheap and effective form of environmental enrichment. A gulf exists, however, between the success of such a demonstration and the effective implementation of larger scale, longer-term enrichment programs. To achieve this may require a major change of attitudes towards community-based zoos and levels of funding required to sustain such programs.

Appendix A – The Behaviour and Ecology of the Subject Species.

Plains, common or Burchell's zebra

Species Classification

The horses, asses and zebras are the only widespread and well-known members of the Perissodactyla, or odd-toed ungulates. This group also includes the tapirs and rhinos. In total the Perissodactyla includes 16 species in six genera and three families (MacDonald, 1984). Together, asses, horses and zebra form the family Equidae and all seven species in this family are included under a single genus *Equus*. The seven species are the African ass (*Equus africanus*), Asiatic ass (*Equus hemionus*), domestic horse (*Equus caballus*), Grevy's zebra (*Equus grevyi*), mountain zebra (*Equus zebra*), plains or common zebra (*Equus burchelli*), and Przewalski's horse (*Equus przewalski*) (MacDonald, 1984). The Grevy's zebra is the only representative of the subgenus Dolichohippus. The mountain zebra and the plains zebra (*Equus burchelli*) form the subgenus Hippotigris. The plains zebra also has three subspecies (MacDonald, 1984). One of the subspecies is Chapman's zebra (*Equus burchelli chapmani*)

Morphological/ Physical Characteristics

Zebras are medium-sized herbivores with long heads and slender necks. They have a mane that stands erect on the neck. The eyes are set far back in the skull, thus giving them a wide field of view, with only a blind spot at the top of their heads. They are short-legged, generally fat looking and bear their weight on only the middle digit of each hoofed foot (MacDonald, 1984). Each species of zebra is distinguishable from the others by their stripe patterns, ear size and shape and body size.

Table 1 indicates the physical dimensions for the male plains or common zebra. The females are slightly smaller than the males (Nowak, 1999).

Table 1 – Physical dimensions for the common zebra (Nowak, 1999).

Head and body length	**Tail length**	**Shoulder height**	**Weight**
217-46cms	47-56cms	110-45cms	175-385 kgs

The most notable feature of the zebra is their prominent black and white stripes. Each of the three species is distinguished by a different stripe patterns. The plains zebra, for instance, has a sleek coat with vertical black and white stripes on the body that become horizontal on the haunches (MacDonald, 1984). Much like fingerprints, no two zebra's stripes are the same, thus making it easy to identify individuals (Timms, 1998). Zebras can have aberrations in their coat colour, such as an almost completely dark coat or the pattern reversed so that the ground colour is dark and the stripes are white (Nowak, 1999). Zebras with unusual stripe patterns are usually not allowed to join a herd and they therefore die (Timms, 1998). This is probably why the stripes have remained a dominant characteristic of the zebra.

There have been a number of suggestions as to the function of the zebra's stripes. Suggested functions include helping the animals to regulate their body temperature, deterring harmful insects, confusing predators, and the recognition of other zebras (MacDonald, 1984). Grzimek (1990) has suggested that the stripes probably serve a recognition function foremost and then assist with camouflage and protection. Zebras from birth are attracted to objects with stripes and thus the stripes may help to keep the herd together (Timms, 1998). The individual stripe patterns may also help the members of each family group recognise each other when they congregate together in large herds. The effectiveness of the stripes as camouflage is most evident at high temperatures and at a distance of a few hundred yards (Grzimek, 1990). The zebra then blends into the "waviness" of the air and is less visible than an animal with a solid coat. The other suggestion is that the striped coat serves as protection from the tsetse flies that suck the blood of animals and transmit disease (Grzimek, 1990). It has been shown that the flies were attracted to black or white dummies rather than striped dummies. It is believed that the fly cannot identify the zebra as a body at a certain distance because of the fly's eye structure.

Distribution and Habitat

Plains zebra herds occur in east Africa, ranging from Kenya to the Cape (MacDonald, 1984). They occupy various habitats including savannah, light woodland, open scrub and grassland. They have sometimes been found in broken, hilly country and on mountain slopes up to 4,400 metres (Nowak, 1999). They are limited in their habitat because of a daily requirement for fresh water. Zebras can cover as much as 13 km in a day as they move from the higher, more open areas, where they sleep, to the lower, lush areas where they graze (Nowak, 1999).

Sedentary and migratory populations have resulted because of differing habitats and the need to forage and find water. Home range size varies according to the quality of the habitat. Each herd defends a home range that overlaps with their neighbours (MacDonald, 1984). The herds in the Serengeti, Tanzania can migrate a distance of 100-150 kilometres between the wet and the dry seasons. When the habitat starts to deteriorate, in the dry season, the herds combine and migrate as a mass group. In the Serengeti, the zebras defend a home range of 300-400 sq km in the rainy season and 400-600 sq km in the dry season. There are both sedentary and migratory herds of zebra in the Kruger National Park in South Africa and they have a home range of 49-566 sq km. There are only sedentary herds in the Ngorongoro Crater in Tanzania where the home ranges are 80-250 sq km (Nowak, 1999).

Diet

Zebras are entirely vegetarian and their diet includes 90% grass and 10% browse. The browse includes bark, leaves, buds, fruits and roots (Nowak & Paradiso, 1983; Timms, 1998). In addition zebras will eat dirt for the mineral content and young foals sometimes eat their mother's droppings for the intestinal flora and bacilli (Haltenorth & Diller, 1980). Zebras spend most of the day and night foraging and this can occupy between 60 and 80% of their time (Timms, 1998). In addition to this, zebras require a daily supply of fresh water and, at the most, can go no longer than three days without water (Haltenorth & Diller, 1980).

Zebras have upper and lower incisors that are used to clip vegetation. They also have high-crowned rigid cheek-teeth that are used to grind the vegetation (MacDonald, 1984). They utilise a hindgut fermentation system, so plant cell walls are only incompletely digested and the processing is rapid (Nowak, 1999). This means that they have to ingest large quantities of food, but the quality of the food does not affect the process. Therefore, zebras can exist on diets of lower quality than ruminants, although they do prefer high quality low fibre food.

Activity Cycle

The plains zebra is generally active throughout the day (Nowak & Paradiso, 1983; Grzimek, 1990). At sunrise they leave the sleeping area and travel in single file to the grazing areas, where they spend the day eating, drinking and resting in an alternating cycle. In the late afternoon they return to the sleeping area and at night they have three distinct rest periods with grazing in between. Zebras can rest in both a standing and lying position (Grzimek, 1990).

Predators, Defence and Sensory abilities

The main predators of zebras are lions, hyenas, leopards, and cheetahs (Timms, 1998). The leopards and cheetahs tend only to attack foals. As mentioned, one of the zebras forms of defence is possibly to confuse a predator with its stripes. Timms (1998) has reported that the main form of protection is to remain with the herd. Zebras prefer to graze in the open and do not attempt to conceal themselves or freeze when attacked. They have the best vision during the day but their night vision ranks with dogs and owls (MacDonald, 1984). The zebra's large ears can rotate to locate sounds and they can detect sounds at great distances (Haltenorth & Diller, 1980). Zebras have a moderate sense of smell (Haltenorth & Diller, 1980). At least one member of the herd stays alert to danger at all times especially at the sleeping area. If hyenas or lions attack them, they will retaliate by turning away from the predator and kicking out with their hind legs. Eventually, when threatened, the family closes up and will take flight with the lead mare at the front and the stallion at the rear (Haltenorth & Diller, 1980). When fleeing, the zebra, can reach speeds of up to 65 kms per hour (Timms, 1998).

Reproduction and Development

Zebras are capable of reproducing throughout the whole year, however mating and foaling usually occurs during the wet season when the conditions are the most favourable (Nowak, 1999). In Tanzania the foaling time is October to March, Zambia is June to September, Rhodesia, July to August, northwestern Botswana December to February, and East Transvaal, September to March (Haltenorth & Diller, 1980). Females generally come on heat within seven to ten days after giving birth, so birth and mating can occur in the same season (MacDonald, 1984). However, there is often a period of between one and three years between births for each female due to the stress of rasing a foal.

Males assess the sexual state of a female using the flehman or lip-curl response and their well-developed vomeronasal or Jacobson's organ helps with this

(Haltenorth & Diller, 1980). Rival males fight over females by neck wrestling in a standing position and biting the rival's legs. The losing zebra will usually take flight and the wounds are rarely serious (Haltenorth & Diller, 1980). The female in oestrus allows the victorious male to follow her closely and smell, lick and groom her. Mating only lasts a few seconds and takes place repeatedly at intervals of between one and two hours for one to two days (Haltenorth & Diller, 1980). The gestation period lasts for between 360 and 396 days and there is usually a single foal. The single foal weighs around 32 kilograms at birth and can put on as much as half a kilogram per day until it is two months old (Timms, 1998). Foals can stand soon after birth, run within an hour, and are eating grass by the end of the first week (Nowak, 1999). The female licks the foal after birth and this is thought to assist in teaching it to recognize her. The mother does not eat the foetal sac or afterbirth and foals in the home range with the family stallion watching her (Haltenorth & Diller, 1980). For the first few days after foaling, the mother keeps the other mares away and the foal recognizes its mother after three to four days. She will protect her foal from small to medium sized predators (Haltenorth & Diller, 1980).

Weaning occurs between seven and 11 months and the young zebra is independent after one year. Young females are sexually mature between 16 and 22 months and males generally start to compete for mares around the age of four years (Nowak, 1999). Young zebras tend to leave the family group between one and three years. There are varying reports as to the longevity of the plains zebra with some researchers reporting nine years (Nowak, 1999) while others have suggested around 20 years (Timms, 1998; Haltenorth & Diller, 1980). Zebras in captivity have been known to live up to 40 years (Haltenorth & Diller, 1980; Nowak, 1999).

Social Organisation and Behaviour

The social organisation of the plains zebra is restricted to small family groups and stallion groups (Nowak, 1999). Vast numbers are known to congregate during migratory periods or near favourable resources, but these large herds are made up of small family groups. The family groups in large herds recognise each other by stripe patterns, voice and scent. Herds of plains zebra can be associated with herds of mountain zebra, Grevy's zebra, oryx, eland, wildebeest, and giraffe (Haltenorth & Diller, 1980).

The family units include an older stallion, and between one and six females, and their offspring of several years (Nowak, 1999). The group usually includes between four and eight individuals but can be up to 15. The group is usually stable with only the younger members leaving, and the mares remain in the group for their lifetime even when old and sick (Nowak, 1999). The stallion is dominant over all other members of the group and the mares have a rank hierarchy with the oldest female dominant. The highest rank means first access to water and good vegetation. Mares cement relationships by mutually grooming each other (MacDonald, 1984). Dominant males will greet each other with a ritualised ceremony (Nowak, 1999). The foals in the group often play together, engaging in play-fighting behaviour and playfully mounting each other (Grzimek, 1990). The dominant males are very defensive of their family group and will take up a position at the rear if they have to flee from a predator. The stallions dominate the group until they are about 16 to 18 years of age and are then replaced peacefully by a younger stallion between the ages of six and eight. If a stallion that has a family dies, another family will take them in or they are taken over by a young stallion that has not yet formed a family (Haltenorth & Diller, 1980). Young females reach their first oestrus by the age of one and a quarter. years and at this age they are either abducted by a stallion to join his family or by a young stallion to form a new family. Males fight fiercely to obtain and/or retain mares (Nowak, 1999). The young males in the group leave between about one and four years of age to join a stallion group. The relationship between the young males and the dominant stallion in the group is good, they do not drive them away (Nowak, 1999).

The stallion groups can include as many as 16 members but more usually between two and three (Nowak, 1999). The young males spend a few years in these bachelor groups, after they have left their family groups, before they attempt to form their own family groups. These groups are generally less stable than family groups and include young males and older males that have lost control of their family groups (Nowak, 1999).

Communication

Plains zebras communicate via gestures, facial expressions and a variety of sounds (Nowak, 1999). They communicate their moods by changes in ear, mouth and tail position (MacDonald, 1984). The also use odour to keep a track of animals from neighbouring herds through urine and faeces (MacDonald, 1984). The majority of their communication is through sounds, including an "explosive braying bark" that identifies stallions and maintains group cohesion (Nowak, 1999). Mothers "whinney" to their foals when they are separated from them and also to warn them of danger. Stallions "nicker" to declare their interest in mares and "squeal" to warn competitors that they will continue fighting (MacDonald, 1984). The warning call of the plains zebra is an "ee-aa" sound and a long snort indicates contentment (Haltenorth & Diller, 1980).

Status

The plains zebra is the only zebra that is not endangered. Populations of plains zebra have declined in recent years because of hunting for their skins and competition for habitat with domestic livestock (Nowak, 1999).

Oriental small-clawed otter

Species Classification

Otters belong to the Mustelidae or weasel family and they are known to occur on every continent except Antarctica. They have even been introduced into Australasia (Chanin, 1985). Otters belong to the subfamily Lutrinae, which includes 12 species of otters in six genera. Six species of otter are included in the genus *Lutra,* including the North American river otter (*Lutra canadensis*), European river otter (*Lutra lutra*), marine otter (*Lutra felina*), southern river otter (*Lutra provocax*), neotropical river otter (*Lutra longicaudis*), and hairy-nosed otter (*Lutra sumatrana*). The spot-necked otter (*Hydrictis maculicollis*), Indian smooth-coated otter (*Lutrogale perspicillata*), giant otter (*Pteronura brasiliensis*), and sea otter (*Enhydra lutris*) are all the only representatives of their respective genera. The genera *Aonyx* includes the cape clawless otter (*Aonyx capensis*) and the oriental small-clawed otter (*Aonyx cinerea*) (MacDonald, 1984).

Morphological/ Physical Characteristics

Oriental small-clawed otters are the smallest of all otters, and are usually no longer than 90 centimetres in length. Males and females are usually about the same size. Table 2 shows the physical dimensions of the oriental small-clawed otters.

Table 2 – Physical dimensions for the oriental small-clawed otter (Nowak, 1999).

Head and body length	Tail length	Weight
45-55 cm	25-35 cm	3-6 kg

The oriental small-clawed otter coat colour ranges from greyish brown to dark brown, the underside of the body and throat are a whitish grey colour (Grzimek, 1990). The body is elongated, lithe and built for swimming. The otters limbs are short, with the forefeet shorter than the hind feet. The tail is fully covered in fur and is wider at the base and tapers to a point at the tip (Grzimek, 1990). The oriental small-clawed otter differs from most other otters in that it only has small claws that do not project past the ends of the pads. They have no swimming membranes between their fingers but do have small membranes between their toes. Another distinguishing feature is that their forepaws are very sensitive and they have considerable digital movement

(Nowak, 1999). Otters have tightly packed underfur and long guard hairs so their coat is water repellent. They also have numerous vibrissae (stiff whiskers) around their nose and snout and these are thought to assist in the detection of prey. Otters can also close their ears and nostrils under water (MacDonald, 1984).

Distribution and Habitat

Oriental small-clawed otters are found in northwestern India to southeastern China and the Malay Peninsula, southern India, Hainan, Sumatra, Java, Borneo, Riau Archipelago and Palawan (Nowak, 1999). They inhabit rivers, creeks, estuaries, coastal waters, and rice paddies and seldom venture into deep water (MacDonald, 1984). Chanin (1985) has reported that oriental small-clawed otters have a home range of between four and five and a half kilometres along the coast and the edges of their home ranges overlap with other otters of the same and other species.

Diet

The diet of the oriental small-clawed otter includes fish, frogs, snails, birds, small mammals, snakes, molluscs, clams, crayfish, crabs, and other crustaceans (MacDonald, 1984; Nowak, 1999; Grzimek, 1990). Oriental small-clawed otters also include some fish in their diet, particularly slow moving fish such as eels (Grzimek, 1990; Timms, 1998). However, they are capable of catching faster fish and have been trained quite successfully to catch fish by Malay fishermen. They are also popular with the rice farmers because they kill the crayfish that damage their rice paddies (Grzimek, 1990). Like most predators otters prey on what is readily available and easy to catch.

Oriental small-clawed otters are hand-oriented rather than mouth-oriented and so they seize their prey with their forepaws. They catch fish in their forepaws and then pass them to their mouth to bite their heads and kill them. Fish are then eaten headfirst. Oriental small-clawed otters have relatively large, broad cheek teeth, probably for the purpose of crushing the shells of crabs and molluscs (Nowak, 1999). These teeth also allow them to eat all but the largest fish head. They also use their delicate forepaws to locate prey in mud or under stones and their manual dexterity means that they can eat their prey immediately in the water (Chanin, 1985). Grzimek (1990) has reported that oriental small-clawed otters have developed a special technique for catching clams. They dig through the shallow waters with their highly sensitive forepaws, find a clam, bring it ashore and leave it on the bank. They then go back straight away and search for another and bring it ashore. They keep searching for the clams and then eat them all once they have opened in the heat of the sun (Grzimek, 1990).

Otters have a very fast metabolism and their meals pass through the digestive tract in a few hours. This means that they have a lot of energy but also that they have to eat frequently. Otters need to eat 15-20% of their body weight on a daily basis (Chanin, 1985).

Activity cycle

Oriental small-clawed otters are active during the day. They have several hunting sessions during the day, and will feed and swim for an hour and then come onto land to rest, and then repeat the cycle (MacDonald, 1984)

Predators, Defence and Sensory abilities

Grzimek (1990) has reported that the predators of the oriental-small-clawed otters are not known. They rarely fall prey to predators, possibly due to the prevalence of other, easier to catch, small mammals that occupy the same habitat (Nowak, 1999). Otters are often referred to as "top carnivores" as they are at the end of their food chains. Large carnivores sometimes prey on smaller carnivores but not generally, because other small mammals are more common and easier to catch (Chanin, 1985).

Otters have small ears but their hearing is still very good. Hearing, however, does not help the otters to locate prey under water, as they have not developed the specialisations necessary to judge direction under water (Chanin, 1985). Sense of smell is acute and very important for communication but they cannot rely on this sense underwater. Therefore, otters must rely on vision and their sense of touch to help them locate prey underwater. In bright light otters can see as well underwater as in air, but in dim light their vision is poorer in water than in air (Chanin, 1985).

Reproduction and Development

The oestrous cycle in the otter averages about 24 to 28 days with the oestrus lasting three days. Successful copulations last for somewhere between 10 and 30 minutes and mating occurs several times while the female is receptive (Chanin, 1985). Otters are capable of producing two litters annually and they have a gestation period of 60-64 days. The mother will find a secluded part of her home range and give birth in a hollow log or a burrow left by another animal (Chanin, 1985). Otters have as few as one and as many as six pups but more often two. The young are born helpless and the male assists by bringing food to the mother and her young. The babies are born blind and do not open their eyes until they are 40 days old and do not take solid food until they are around 80 days old. Otters emerge from the burrow around nine weeks of age and have their first swim (Nowak, 1999). Captive oriental small-clawed otters have been known to live for 16 years in captivity (Nowak, 1999).

Social Organisation and Behaviour

Oriental small-clawed otters live in extended family groups of about 12 individuals. The group consists of a breeding pair and their offspring. There is strong pair-bonding between the male and female and the female is the dominant member of the group. The male helps the female to raise the young (MacDonald, 1984).

Communication

The two main forms of otter communication are via sound and odour. The vocabulary includes 12 or more basic calls and they use a variety of chirps, chuckles, screams, and squeals to communicate with other otters (Nowak, 1999). The warning growl and "inquiring huh" are common to all species of otter (MacDonald, 1984).

Communication via odour is very important for most species of otter, including the oriental small-clawed otter. Otters have two pairs of glands in the anal region, the anal glands and the proctodeal glands, and these discharge inside and outside the anus respectively. Otter faeces are referred to as "spraints" and otters will spend a great deal of time investigating both their own spraint and that of other otters. After detailed investigation of spraint, otters will often turn around and deposit more onto the pile. This can be quite a small amount and only consist of a few small-undigested bones and mucus (Chanin, 1985). Fresh spraint has a characteristic smell and can be recognised by humans as otter in origin and is still detectable by humans when it is weeks old. Otters also use urine to leave scent marks and will trample vegetation while dribbling urine and cover themselves in the scent as well as the vegetation. While resting together they rub themselves on the ground and on other otters until there is a composite scent for the whole group (MacDonald, 1984).

The chemical composition of spraint appears to be unique to each individual otter. Chanin (1985) has reported that the chemicals vary between otters but remain constant for each otter over time. Thus, it has been suggested that spraint may serve to identify individual otters much the same way as fingerprints identify humans. Suggested functions of spraint have been to communicate the individual identity of the otter, age, sex, breeding condition, status and the time since they last visited the area (Chanin, 1985; MacDonald, 1984).

Status

All otters have been hunted extensively for their fur (Timms, 1998). Oriental small-clawed otters have also suffered because of habitat loss and pollution and is rare in much of its mainland range (Nowak, 1999). They have been designated as near threatened by the IUCN and are on Appendix II of CITES (Nowak, 1999).

Collared peccary

Species Classification

The collared peccary is a member of the order Artiodactyla, or even-toed ungulates, and this group forms the most spectacular and diverse range of large land-dwelling mammals alive today (MacDonald, 1984). Members of the Artiodactyla are found on all continents, apart from Australasia and Antarctica, and includes 187 species classified in 76 genera and 10 families (MacDonald, 1984). Peccaries belong to the superfamily Suidoea and are included in the family Tayassuidae. The superfamily Suidoea also includes the family Suidae (pigs) and the family Hippopotamidae (hippos and pygmy hippos). Peccaries are classified into two genera; *Catagonus,* which includes only a single species, the chacoan peccary (*Catagonus wagneri*) and Tayassu, which includes the white-lipped peccary (*Tayassu peccari*) and the collared peccary (*Tayassu tajacu*) (MacDonald, 1984).

Morphological/ Physical Characteristics

The collared peccary is similar to pigs in body shape, form and the presence of a distinctive snout, but the peccary's legs are longer and slimmer and the hooves smaller than those of pigs (Nowak, 1999). There are four digits on the forefoot and two functional digits on the hindfoot. The snout is elongate, mobile and cartilaginous with a nearly naked terminal surface where the nostrils are located (Nowak, 1999). The upper canines grow downward and form tusks that are kept sharp by rubbing on the lower canines (Nowak, 1999). Males and females are generally about the same size and the physical dimensions are shown in Table 3.

Table 3 – Physical dimensions for the collared peccary (Nowak, 1999).

Head and body length	Tail length	Shoulder height	Weight
75-100 cm	1.5-5.5 cm	44-50 cm	14-40 kg

The three species are identifiable from each other because of size and colour. The collared peccary is grizzled grey in colour with a dark grey back and blackish limbs. The collar, for which they get their name, is a whitish band extending from the middle of their back to their chest (Nowak, 1999). Young peccaries are reddish brown and have a blackish stripe on their backs (Nowak, 1999). The black tips of the bristles are used to store heat in winter and then break off in summer so that the lighter coat can reflect the sun's rays (Grzimek, 1990). This ability helps the peccaries to regulate their temperature. A distinctive feature of the collared peccary is a dorsal scent gland located at the midline of the back in front of the tail. The gland is about 75 mm in diameter and 125 mm thick (Nowak, 1999).

Distribution and Habitat

The collared peccary inhabits a wide area including northern South America, central America and southwestern North America (Corn & Warren, 1985; Sowls, 1984). Recently, they have been introduced into in northern Texas and southern Oklahoma (Nowak, 1999). The collared peccary lives in a diversive range of habitats, including rainforest, arid woodland and desert scrub (Nowak, 1999). They have been found from the coastline up to an elevation of 2,400 metres. Collared peccaries frequent water holes and in the tropics tend to stay near running streams.

Collared peccaries are sedentary and depending on food supply and group size, each collared peccary group has a home range of between 0.5 and 8.0 sq km (Nowak, 1999). The central part of the home range is exclusive territory whereas the peripheral parts are shared with neighbouring groups. The peripheral section of the territory often includes a watering hole and a wallow (Grzimek, 1990). The central part of the territory is characterised by the group's odour from the males marking rocks and tree trunks with their dorsal glands (Nowak, 1999). The resting sites and the perimeter of the territory are marked with up to 20 defecation sites, and these are visited by all the group members together. These dung piles are an important part of the forest ecology since they contain undigested seeds that germinate to replenish the forest (Nowak, 1999).

Diet

The collared peccary is an omnivorous species. They feed on cactus fruit, berries, tubers, bulbs, rhizomes, roots, seeds, fruit, grubs and other insects, small reptiles and snakes and other small vertebrates (Corn & Warren, 1985; Grzimek, 1990; MacDonald, 1984; Nowak, 1999). It has also been reported that they eat bird and turtle eggs, fungi, nuts, carrion, leaves, frogs and fish (Grzimek, 1990). Collared peccaries will also feed on cultivated foods such as corn, melons, sweet potatoes, cassava (root tubers), bananas, sugarcane, and sorghum. In Venezuala, they have been known to follow capuchin monkeys and eat the fruit residue that falls as the monkeys feed (Grzimek, 1990). The majority of the collared peccary diet, over 80% depending on the season, consists of the agave and prickly pear. The peccary holds the prickly pear down with one of its forefeet and peels the skin and sharp spines off and then eat the fleshy insides. The prickly pears have a high water content and therefore peccaries can go for up to two weeks without water (Grzimek, 1990). Peccaries have also been observed to lick and eat soil, presumably for the mineral content (MacDonald, 1984).

The collared peccary uses its snout to forage for food in the dirt and cuts through roots with its tusks. They can locate bulbs 5-8cm under the ground before the new shoots are visible (Nowak, 1999). They differ from other ungulates in that their jaw movements are up and down, rather than grinding so that they can crush tough seeds (MacDonald, 1984). Collared peccaries have a three-chambered stomach and it is thought that they digest food via microbial flora as occurs in ruminants (MacDonald, 1984).

Activity Cycle

The collared peccary's activity cycle varies according to the season. During winter, the peccaries' metabolism increases by around 20% and therefore they must spend more time foraging to accommodate the increased need for food. Collared peccaries forage in the daytime during winter in order to utilise the heat and spend the nights huddled closely together in caves or self-scraped holes (Grzimek, 1990). During the hot summer peccaries, forage in the early morning and late evening, and rest for up to 10 hours during the day. During the hottest part of the day they escape the midday sun by keeping to the shade of rocks or vegetation (Grzimek, 1990).

Predators, Defence and Sensory abilities

The main predators of collared peccaries are dogs, coyotes, bobcats, jaguars, and mountain lions (MacDonald, 1984; Nowak, 1999). Collared peccaries are bitten by rattlesnakes but not harmed by them (Nowak, 1999). Predators are rarely successful in their attempts to kill collared peccaries, with their speed, agility and group defence rendering them more than a match for most predators (Nowak, 1999). Predators are usually only successful if they attack an animal separated from the group or a young animal (MacDonald, 1984; Nowak, 1999). Peccaries have poor eyesight, an exceptional sense of smell and good hearing (Byers & Bekoff, 1981; Grzimek, 1990; Sowls, 1984).

When confronted by predators, collared peccaries have been known to exhibit two types of anti-predator behaviour. If a predator gets too close before the herd detects it, all the animals will scatter while emitting the alarm call. This serves to confuse the predator, as it will not be able to single out one animal to attack. Collared peccaries can run with a fast gait, often reaching speeds of up to 35 km per hour, when they are attacked (Sowls, 1984). On the other hand, if young are present and the habitat is dense then one individual, usually a sub-adult of either sex will confront the predator. Collared peccaries fight viciously with their sharp teeth. This allows all the other animals of the herd to flee but places the individual at great risk and can often be fatal for the individual. When resting, some males are usually alert at the periphery of the group, these males are then periodically replaced with rested males (MacDonald, 1984).

Reproduction and Development

The oestrous cycle in the collared peccary averages about 24 days with the oestrus lasting four days (Sowls, 1984). Mating can occur any time of the year and there are no specialised courtship routines. Copulation lasts only a few seconds and females often mate with more than one male. Males establish a dominance hierarchy and try to prevent subordinate males from mating (MacDonald, 1984). The gestation period is around 145 days and there can be between one and four in the litter, but usually two (Sowls, 1984). The mother leaves the herd and gives birth in a thicket, hollow log, cave or a burrow left by another animal. The young are between 500 and 900 grams when born and can run within a few hours of birth. They accompany the mother when she rejoins the herd a few days after the birth. Lactation lasts for between six and eight weeks and young peccaries reach the teats from the back rather than standing at their mother's side. Young peccaries remain with their mother for two to three months (MacDonald, 1984). In the wild, peccaries live for up to ten years and have been known to live up to 21 years in captivity (MacDonald, 1984).

Social Organisation and Behaviour

Collared peccaries are very social animals and live in herds of between two and 50 individuals, but more often between five and 15 animals (Sowls, 1984). The group comprises both males and females and animals of all ages. The females often outnumber the males by 3:1. The larger herds tend to disperse into smaller family groups when the herd is resting and also during the dry season when food is scarce. The family groups are particularly cohesive when juveniles are present. The groups do not accept other members from neighbouring herds and strange males are chased away by the dominant male of the group and strange females by the dominant female (Grzimek, 1990). The family groups are permanently stable but often have subgroups or solitary animals that will split off from the family group for hours or days. The groups have a rank order, with the females usually dominating the males (Sowls, 1984). Group cohesion is reinforced by boisterous play, mutual grooming and scratching with snouts. Collared peccaries also reinforce group cohesion by rubbing each other's scent glands. The individuals stand side-by-side but backwards and each rubs their heads on the others scent glands (Grzimek, 1990).

Communication

The primary form of communication is auditory, however they communicate excitement or annoyance by raising their bristles on their back and neck and emitting a musky secretion from their dorsal gland (Nowak, 1999). The dorsal scent gland also appears to identify group members and coordinate group movements. MacDonald (1984) has distinguished six different types of vocalisations for the collared peccary:

- A cough-like call by an adult male recalls dispersed individuals back to the group.
- The alarm call is a repeated dry, short "woof".
- A "laughing" call is used during aggressive encounters between individuals.
- A clear nasal sound is emitted while the animals are eating.
- Infants indicate distress with a shrill clucking call.
- Anger or annoyance is indicated with a chattering of the canines.

Status

Collared peccaries have been hunted extensively for their skins, which have been sold for, between 20 cents and eight dollars (US) on exportation. Around 200,000 skins were exported per year in the late 1980's and prior to 1970 this figure was around 700,000 (Nowak, 1999). The thin, tough hides and skins are used to make pigskin jackets and gloves and can be recognised because the hair roots leave a pattern of three holes in evenly distributed groups (Timms, 1998). Indians and peasants also hunt peccaries for their meat, and their gregarious nature and wide distribution makes them easy to hunt. Collared peccaries have also suffered because of local campaigns to exterminate them because they eat and destroy plantations of corn, watermelons and legumes (MacDonald, 1984). Much of their habitat has also been destroyed to make way for crops and pastures and this has led to the decline and fragmentation of their populations (Nowak, 1999). Groups of collared peccaries have extended their range in the south-western United States but it is thought that they are beginning to be affected by introduced feral hogs (Nowak, 1999). Except for the populations in Mexico and the United States the collared peccary is listed on Appendix II by CITES (Nowak, 1999).

Barbary sheep

Species Classification

The Barbary sheep are classified as Artiodactyla or even-toed ungulates. The Barbary sheep comes under the family Bovidae, subfamily Caprinae, tribe Caprini, including 17 species in five genera. These include the argalis (*Ovis ammon*), wild goat (*Capra aegagrus*), blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), ibex (*Capra ibex*) and the Barbary sheep (*Ammotragus lervia*), the only representative of its genera (MacDonald, 1984). Based on morphological characteristics, the Barbary sheep was originally classified in the genus Capra along with the ibex and wild goat. Biochemical analysis has revealed that they also have a close relationship to sheep. Thus, they have been classified in their own genus, *Ammotragus* (MacDonald, 1984). There are seven sub-species of the Barbary sheep and the animals kept in captivity are likely to be hybrids of several different subspecies (Grzimek, 1990).

Morphological/ Physical Characteristics

Barbary sheep are generally a rufous tawny colour, with the insides of the ears, chin and insides of the legs a whitish colour. The Barbary sheep has no beard but does have a ventral mane of long, soft hairs on the throat, chest and upper forelegs (Nowak, 1999). They have a bushy tail that reaches halfway to their hocks and is naked on the underside at the root. The Barbary sheep has glands on the naked underside of their tail. The coat is harsh and bristly with a soft underwool and is short and smooth in summer. Both sexes have horns that sweep outward, backward and then inward but the males are considerable larger and can reach up to 85 cm in length and 40 cm in females (MacDonald, 1984). The males are considerably larger than the females and the physical dimensions for both sexes can be found in Table 4.

Table 4 – Physical dimensions for the Barbary sheep (Nowak, 1999).

Sex	Head and body length	Tail length	Shoulder height	Weight
Male	155-165 cm	15-20 cm	90-112 cm	100-145 kg
Female	130-140 cm	15-20 cm	75-94 cm	30-63.5 kg

Distribution and Habitat

Barbary sheep live mainly in North Africa, and their range extends between Morocco and the Western Sahara to Egypt and Sudan (Nowak, 1999). They inhabit rocky, inaccessible desert regions and have been found up to the snow line at an elevation of 3,800 metres in Morocco. They are also found on large desert plateaus such as Adrar des Iforas in Mali, Air in Niger, and Tibesti and Ennedi in Chad (Grzimek, 1990). Barbary sheep inhabit the rocky mountain ranges and highlands within desert to sub-desert regions (Nowak, 1999; Haltenorth & Diller, 1980). They are mainly found in rough, rocky, arid country (Nowak, 1999). Their home range size varies from between one and five sq km in summer to 13 to 31 sq km in winter (Nowak, 1999).

Diet

Barbary sheep forage primarily on grass, herbage, and the foliage of bushes and trees. They will stand on their hind legs to browse at foliage that would otherwise be out of their reach (Haltenorth & Diller, 1980). Water is not common in their habitat, but they get what they need from vegetation and the dew that forms on the plants during cold desert nights. They will drink at water holes if they encounter them. Populations of Barbary sheep decrease rapidly during periods of drought (Nowak, 1999).

Activity Cycle

Like most species that reside in hot areas the Barbary sheep feeds mainly in the early morning and late evening and rest in the shade of overhanging rocks during the heat of the day (Haltenorth & Diller, 1980). Grzimek (1990) has reported that they are also active, to some extent, during the night.

Predators, Defence and Sensory abilities

The main predators of the Barbary sheep are the leopard, caracal and lion (Haltenorth & Diller, 1980; Grzimek, 1990). The areas that the Barbary sheep inhabit usually lacks tall vegetation to hide them, so they have developed the ability to hide from predators by remaining completely motionless whenever threatened (Burton, 1980; Nowak, 1999). They are also extremely sure-footed and Grzimek (1990) has reported that they have effortlessly jumped two-meter high fences in captivity from a standing start. Thus fleeing is also another defense mechanism. Vision and hearing are very good for the Barbary sheep and their sense of smell is good (Haltenorth & Diller, 1980).

Reproduction and Development

Mating can occur at any time of the year but predominantly takes place between September and November and births occur between March and May (Grzimek, 1990; Nowak, 1999). Sexual maturity is reached at 11 months for males and 18 months for females. When a female comes into heat a male will follow her tenaciously for several days licking her anal regions and driving off all other males. When the female is ready, mating takes place and only lasts for a few seconds (Haltenorth & Diller, 1980). The gestation period is between 154 and 161 days and Barbary sheep usually give birth to one or two offspring, occasionally three (Nowak, 1999). The mother licks the lamb dry at birth, eats the afterbirth and then lies with the young for one or two days after birth. The lambs are around 4.5 kilograms when they are born and soon after birth they can negotiate moderately rugged terrain. The lambs suckle for three to four months and can live up to 10 years in the wild and 20 years in captivity (Grzimek, 1990).

Social Organisation and Behaviour

In the wild Barbary sheep occur alone or in small herds with males ranking the highest but with females leading group movements (Nowak, 1999). The groups usually consist of one adult male, several females and their young (Haltenorth & Diller, 1980). In the wild if threat is not enough then the males will fight for control of a female or females. The males stand 10-15 metres apart and then walk rapidly towards each other gaining speed until they are running; as they get closer they lower their heads so that their horns collide. A male will not attack another if the other is off-balance or unprepared (Nowak, 1999). These attacks are repeated several times, and after this they stand either head to head or next to each other and attempt either to interlock horns or put a horn over the opponents neck and force him to the ground. When doing this they are often forced to go down onto their forelegs and can sometimes free themselves through clever twisting. Barbary sheep do not rise onto their hindlegs to fight (Grzimek, 1990). At the end of the dry season several family groups often collect together (Haltenorth & Diller, 1980).

Barbary sheep bathe in damp sand by lying on their stomach and flanks and scattering sand over their back with their horns. They will bathe and wallow in water, when it is available (Haltenorth & Diller, 1980).

Communication

Barbary sheep communicate via sounds and lambs produce a clear sheep-like bleating in their first few days. The mother responds to this with deep grunts and the male in rut sounds similar but with lighter grunts (Haltenorth & Diller, 1980).

Status

Barbary sheep have been hunted by the native people of the Sahara for their meat, hide, hair, and sinew and this has formed an important part of their economy. It has only been since the introduction of modern weapons that they have become endangered (Nowak, 1999). Formerly widespread in the Sahara they are now extinct over much of their former range and are declining rapidly in other parts of their range. They were introduced into the United States during the early to mid 20th Century for sport hunting. There are now populations of Barbary sheep thriving in California, New Mexico, and Texas (Nowak, 1999). There is concern that in these areas they will spread into the range of the native bighorn sheep (*Ovis canadensis*) and compete for limited resources to the detriment of the bighorn (Nowak, 1999). There are still thousands of Barbary sheep alive in their natural habitats but these animals are spread across a large area. The Barbary sheep is classified as vulnerable by the IUCN and is listed on Appendix II of CITES (Nowak, 1999).

Appendix B - Signs

Collared peccaries, Barbary sheep, otters and zebras –

The effects of novel objects on behaviour.

The University of Adelaide, in conjunction with the Adelaide Zoo, is investigating the effects of movable, versus fixed novel objects on the behaviour of collared peccaries, Barbary sheep, otters and zebras.

One aim of this study is to increase exploratory and play behaviour through the presentation of novel objects. Exploratory and play behaviour are essential for the healthy physical and social development of animals in captivity.

A further aim is to determine if the animals pay more attention to the movable, or to the fixed novel objects, which will aid in the design of enrichment devices for these animals in the future.

Collared peccaries, otters and Barbary sheep –

The effects of novel odours on behaviour.

The University of Adelaide, in conjunction with the Adelaide Zoo, is investigating the effects of different novel odours on the behaviour of collared peccaries, Barbary sheep and otters. The novel odours include meat, fish, fruit and grass.

One aim of this study is to increase exploratory and play behaviour through the presentation of novel odours. Exploratory and play behaviour are essential for the healthy physical and social development of animals in captivity.

A further aim is to determine what odours the animals pay more attention to. This will aid in the design of enrichment devices for these animals in the future.

Collared peccaries, otters and Barbary sheep –

The effects of predator sounds on behaviour.

The University of Adelaide, in conjunction with the Adelaide Zoo, is investigating the effects of novel predator sounds on the behaviour of collared peccaries, Barbary sheep and otters.

One aim of this study is to increase flight, exploratory and play behaviour through the presentation of novel objects. This is important for increasing activity in animals in captivity.

Recently research has found that giving predator stimuli can be beneficial for prey species. This research aims to determine if the provision of predator sounds is beneficial for Barbary sheep, otters and peccaries.

Appendix C – Checksheet Design

Checksheet for the study involving the movable and non-movable novel objects.

Species: Animal:
Session: Day:
Time: Weather:

Time	Resting		Eating/Foraging	Sexual Behaviour	Agonistic Behaviour	Play Behaviour					Stereotypical Behaviour	Grooming	Vocalisation	Locomotor Norm	Locomotor Flight	Exploratory Behaviour			Comments
	Sleeping	Standing/ Sitting				Locomotor	Social	Non-movable object	Movable Object	Other						Non-movable object	Movable Object	Other	
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
Total																			

Checksheet for the study involving the novel olfactory stimuli.

Session: Day:

Time: Weather:

Time	Resting		Eating/Foraging	Sexual Behaviour	Agonisitc Behaviour	Play Behaviour			Stereotypical Behaviour	Grooming	Vocalisation	Locomotor Norm	Locomotor Flight	Exploratory Behaviour			Comments
	Sleeping	Standing/ Sitting				Locomotor	Social	Object						Odour	Type	Other	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
Total																	

Checksheet for the study involving the novel auditory stimuli.

Session: Day:

Time: Weather:

Time	Resting		Eating/Foraging	Sexual Behaviour	Agonisitc Behaviour	Play Behaviour			Stereotypical Behaviour	Grooming	Vocalisation	Locomotor Norm	Locomotor Flight	Exploratory Behaviour			Comments
	Sleeping	Standing/ Sitting				Locomotor	Social	Object						Sound	Type	Other	
1																	
2																	
3																	
4																	
5																	
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7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
Total																	

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