THE RESPONSES OF DOMESTIC FOWL TO VIDEO IMAGES OF CONSPECIFICS AND OF ABSTRACT STIMULI

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ABSTRACT

Video playback is being increasingly used in poultry behaviour research. Chickens are known to respond to video images of predators and conspecifics as if they were representations of real life. Chicks also became readily attracted to computer screensaver images. Because video images can be tightly controlled as well as easily manipulated they may provide a potentially powerful tool for studying numerous aspects of chickens' behaviour. Therefore, this project further assessed the value of video playback by investigating chickens' responses to selected video images in the following situations:

Both chicks and adult hens traversed a runway to approach video images of feeding conspecifics, regardless of whether the corresponding soundtrack was played or not. This suggests that visual and auditory components of the stimulus did not exert additive effects and that the visual features of the conspecific videos were the most important in eliciting approach.

As in previous runway tests, a familiar screensaver video image was attractive to chicks when they were placed individually in an otherwise novel environment (open field). Furthermore, regular exposure to screensaver videos during the first week of life decreased chicks' fear when they were subsequently placed in an open field with no videos present. These results suggest that chicks remember symbolic video images, that their documented attraction to familiar objects and odours in novel environments generalizes to include video images, and that video stimulation may reduce fear, perhaps by enriching the chicks' environment.

Screensaver videos presented in front of the home cage for 10 min on consecutive days reliably attracted and sustained the interest of individually housed laying hens for as long as 8 days; thereafter interest waned gradually. These results are consistent with those shown by chicks upon repeated exposure to similar screensaver videos. Thus, this phenomenon is not dependent on the stage of development. Furthermore, the hens' interest was fully reinstated when a new screensaver was shown. These results underline the importance of giving chickens the opportunity to investigate novelty.

When simultaneously presented with two video images at opposite ends of the home cage, chicks spent more time near bright rather than dull, moving rather than still, coloured rather than black & white, and complex rather than simple stimuli. These findings suggest that chicks have strong preferences for certain features of video images.

Collectively, these findings clearly demonstrate that chickens readily approach videos of conspecifics, and become attracted to and remember biologically neutral video images. They may also have important strategic implications. Firstly, video images that elicit approach may provide reliable, controllable stimuli for studies, such as gait analysis, requiring voluntary locomotion along a pre-determined path. Secondly, rearing chickens in visually impoverished environments can cause behavioural problems, e.g., heightened fearfulness or boredom. Identifying visual stimuli that are reassuring and which attract and sustain chickens' interest may help guide the design of more effective environmental enrichment. Thirdly, chicks' and adults' interest in video images presented outside their home environment confirm the importance of enriching the environment outside as well as inside the cage.

DECLARATION

I declare that this thesis is my own composition and that I conducted the studies described in it. Any advice or assistance received has been duly acknowledged.

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CHAPTER 1

General Introduction

Interest in presenting video images to animals in order to probe/influence and understand their behaviour has grown for a number of reasons. The relative merits and limitations of this approach are described below, with particular reference to the domestic fowl (*Gallus gallus domesticus*). In Section 1.1, I briefly describe the background and historical development of the use of video stimuli in animal behaviour research. In Section 1.2, I will consider the limitations of using video playback, while its advantages are illustrated in Section 1.3. Studies that have used video playback to investigate selected aspects of chickens' behaviour are described in more detail in Section 1.4. Finally, the potential strategic benefits of studying chickens' responses to video playback and the specific objectives of the project are outlined in Sections 1.5 and 1.6, respectively.

1.1 Background

Man-made visual stimuli are often used as an alternative to live 'stimulus' animals in order to examine stimulus-response relationships in many species. A number of presentation methods have been employed. For example, models, mirrors, photographs, projected slides and 8-mm movies have been used to investigate behavioural responses in a wide variety of species, including fish (e.g. Kodric-Brown and Nicoletto, 1997; Künzler and Bakker, 1998), gulls (e.g. Tinbergen and Perdeck, 1950), pigeons (e.g. Bradshaw and Dawkins, 1993; Ryan and Lea, 1994; Dawkins et al., 1996), chickens (e.g. Ryan, 1982; Ryan and Lea, 1994; Bolhuis and Honey, 1994; Dawkins, 1996), sheep (e.g. Franklin and Hutson, 1982; Vandenheede and Bouissou, 1994; Kendrick et al., 1995; 1996, Bouissou et al., 1996), cattle (e.g. Sato and Yoshikawa, 1996; Piller et al., 1999) and primates (e.g. Humphrey, 1972; Dasser, 1987). The main advantage of employing man-made stimuli such as models, slides and photographs is that the experimenter can exert a high degree of control over their presentation. Therefore, stimulus constancy can be maintained across trials and subjects and selected features of the stimulus, such as size, shape and colour, can be easily manipulated. For example, either monochromatic or coloured photographs can be presented, an animal can be photographed in such a way as to show just one feature, e.g. the head (Dawkins, 1996), or the photographed head of one animal could be superimposed onto the photographed body of another. This type of manipulation is impossible to achieve with a live stimulus animal. Furthermore, a live stimulus animal can and frequently does change its behaviour between and during trials, and it is often difficult to elicit the desired behaviour, e.g. courtship, from the live stimulus animal at the appropriate time in a laboratory situation.

There has recently been increased interest in the use of video playback to provide precise and controllable audio-visual stimuli. Indeed, this technology has been successfully exploited to investigate behaviour in species as diverse as invertebrates, fish, amphibians, lizards and mammals. For example, video images of conspecifics have been used to study: i) sexual selection in jumping spiders (Clark and Uetz, 1990; 1992; 1993), wolf spiders (Uetz et al., 1996; McClintock and Uetz, 1996), green swordtail fish (Rosenthal et al., 1996), guppies (Körner and Parzefall, 1997) and sticklebacks (Rowland, 1995; McKinnon, 1995; McDonald et al., 1995), ii) aggression in sticklebacks (Rowland et al., 1995a; Bolyard and Rowland, 1996; McKinnon and McPhail, 1996), and iii) social behaviour in fiddler crabs (Pope, 1995), cichlid fish (Balshine-Earn and Lotem, 1998), lizards (Macedonia and Stamps, 1994; Macedonia et al., 1994) and macaques (Swartz and Rosenblum, 1981; Plimpton et al., 1981; Capitanio et al., 1985). Video images of prey species have also been used to investigate predatory behaviour in jumping spiders (Clark and Uetz, 1990), wolf spiders (Persons and Uetz, 1997), green frogs (Roster et al., 1995) and American and Southern toads (Roster et al., 1995).

With regards to birds, Hodos (1993) states that "Of all the vertebrate classes, birds are the most visual dependent" and "behaviours such as foraging for food, defense of territory and the nest, selection of mates, orientation, homing and navigation depend on a well developed and highly sensitive visual system". The importance of vision in birds is reflected in the gross morphology of the brain, where the optic lobes are prominent (Portman and Stingelin, 1961). In the chicken, the weight ratio of the two eyes to the brain is almost 1:1 whereas in humans this ratio is approximately 1:25 (King-Smith, 1971). Indeed, the avian eye incorporates many adaptations that have greatly improved its visual capabilities and it is considered to be the finest ocular organ in the animal kingdom (Meyer, 1986). The retina, which mediates colour vision (see Section 1.2.2), is capable of a great range of movement detection and a high degree of visual acuity (Meyer, 1986). Therefore, it is not surprising that video images have also been used to probe the behaviour of many avian species, including chickens. There have been reports that birds may not respond to video images as they would to the corresponding real-life stimulus. For example, African grey parrots acquired complex English language learning exercises from conspecific and human tutors but not from videos of the same (Pepperberg, 1994; Pepperberg et al., 1998; Pepperberg et al., 1999) and Ryan and Lea (1994) found that male pigeons responded to unfamiliar live conspecifics with appropriate bowing behaviour but showed no natural social responses towards video images of the same conspecifics. However, apart from these studies, birds have shown appropriate responses to video images. For example, black-capped chickadees avoided the video image of a conspecific male when this was accompanied by simultaneous broadcast of multiple aggressive 'gargle' vocalizations; interestingly, the audio stimulus alone was significantly less effective (Baker et al., 1996). The video image of a conspecific male elicited vigorous singing in zebra finches (Adret, 1997), and both Bengalese finches and pigeons were easily trained to discriminate between conspecifics based on still video images (Watanabe, 1992; Watanabe and Jian, 1993; Watanabe et al., 1993; Jitsumori et al., 1999). Pigeons were also able to discriminate between moving video images of conspecifics showing a variety of activities, e.g. pecking, walking, standing and moving the head or flying (Dittrich et al., 1998; Jitsumori et al., 1999). Male pigeons also spent as much time displaying courtship behaviour to moving video images of a female as they did to a live bird (Shimizu, 1998).

More specifically, video images of feeding (Keeling and Hurnik, 1993;

McQuoid and Galef, 1993; 1994) and dustbathing (Lundberg and Keeling, 1997) chickens elicited similar behaviour in viewing hens. Chickens also delayed feeding when video images of threatening conspecifics were being shown (D'Eath and Dawkins, 1996). When presented with a hawk model passing overhead, cockerels give more aerial alarm calls in the presence of another chicken than when they are alone (Gyger at al., 1986) and the video image of an 'audience' hen was as effective as a live hen in increasing aerial-predator alarm calling by a cockerel (Evans and Marler, 1991). Additionally, cockerels reacted to televised images of aerial and ground predators with the appropriate aerial- and ground-predator alarm calls, respectively (Evans and Marler, 1992; Evans et al., 1993a; 1993b). Young chicks were also readily attracted to biologically neutral video images, i.e. ones that bore no connotations of predation, feeding or social attraction, when they were presented in their home and, subsequently, in an unfamiliar environment (Jones et al., 1996a; 1998).

Because video images can be easily manipulated and/or the information presented can be tightly controlled, they are likely to provide a potentially powerful tool for studying numerous aspects of chickens' behaviour (Evans and Marler, 1991; Jones, 1996). Therefore, my project was designed to further assess the value of video playback by investigating chickens' responses to selected video images.

1.2 Potential limitations of using video images as visual stimuli

1.2.1 Critical flicker-fusion frequency (CFF)

One of the main concerns in using video images in animal behaviour studies is that the subjects may not perceive images on a television screen as we do because television monitors are designed for human vision. For example, television pictures comprise a series of still images shown in quick succession to produce the illusion of a continuous moving image (D'Eath, 1998). Pictures are changed or 'refreshed' at a rate of 50-60 fields per second (50-60 Hertz) on standard television monitors (Carnt and Townsend, 1961; 1969). However, if this 50-60 Hertz picture refresh rate is lower than an animal's maximum recorded critical flicker-fusion frequency, (CFF, the frequency at which a flickering stimulus starts to appear continuous), then the animal is likely to perceive the television screen as flickering (D'Eath, 1998). This phenomenon occurs in chickens, which are known to have a maximum CFF of approximately 105 Hertz (Hz) (Nuboer et al., 1992). However, although human beings have a CFF of approximately 60 Hz (Landis, 1954) we do not always detect flicker on a 50 Hz television monitor. This may be because certain factors known to affect CFF thresholds come into play. For example, CFF increases with increasing stimulus luminance (e.g. Landis, 1954; Powell, 1967) or if the brightness of the surround matches that of the stimulus (e.g. Lythgoe and Tansley, 1929). Therefore, reducing screen brightness and/or using a screen with a dark surround lowers the amount of flicker perceived (D'Eath, 1998). It may also be possible to lower the chickens' CFF threshold in this way. Alternatively, a low-flicker screen could be used. For example, liquid crystal display (LCD) screens are made up of pixels (see Section 1.2.4) that do not fade when images are refreshed and therefore, the screen flicker is not perceived. However, most LCD screens are small, e.g. hand-held Sony Watchman portable televisions. Indeed, the biggest available LCD screen is approximately 25 cm diagonal (D'Eath, 1998), whereas most studies of chickens responses to video images used 33-61.25 cm screens (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b; McQuoid and Galef, 1993; 1994; D'Eath and Dawkins, 1996; Jones et al., 1996a; 1998). Therefore, an experimenter may have to consider sacrificing picture quality for size, or *vice versa*. Television sets with an increased refresh rate of 100 Hz, and thereby a low flicker screen, offer another option but they are often prohibitively priced, e.g. a 55 cm (18") monitor costs approximately £1000 (R.B. D'Eath, personal communication, 1998).

Of course, if chickens did perceive screen flicker, they may not necessarily find it aversive. For example, if we extrapolate from television screens to light sources, we find that hens can distinguish between high frequency (20-60,000 Hz) and low frequency (100 or 120 Hz) fluorescent lighting presumably because of the flicker produced by the latter (Manser, 1996). Despite this, hens showed no preference for areas with high or low frequency fluorescent lighting (Widowski and

Duncan, 1996). On the other hand, an intermittent light source elicited attraction and approach in individually housed chicks (James, 1959; Bateson and Reese, 1969).

On balance, we should control, where possible, for the potential effects of screen flicker and bear them in mind when interpreting results.

1.2.2 Colour perception

Not surprisingly, television monitors have been developed with human colour vision in mind. Human beings have three light sensitive pigments, each found in a different cone (photoreceptor) type: blue absorbing at 420 nanometres (nm), green at 534 nm and red at 560 nm (Bowmaker and Dartnall, 1980). An animal that does not visually synthesize colour information in the same way as humans is unlikely to see colours as we do on a television screen (Fleishman et al., 1998). For instance, avian species have arguably the most elaborate colour vision (Varela et al., 1993); diurnal birds, including the domestic chicken, have at least four cone types and these contain coloured oil droplets which may have a role in improving colour discrimination (Bennett and Cuthill, 1994; Meyer, 1986). These features allow many birds to see ultraviolet (UV) light (300-400 nm) as well as the human visible spectrum (Varela et al., 1993; Bennett and Cuthill, 1994). Indeed, it has been reported that chickens' spectral sensitivity is more sensitive and extends further into the UV than those of humans (Prescott and Wathes, 1998). Thus, birds may lose certain colour cues from a television screen due to the lack of ultraviolet light (D'Eath, 1998).

UV vision has a number of postulated functions in birds, including navigation, foraging and social signalling (Bennett and Cuthill, 1994); UV light can give cues as to the sun's position and certain fruit, seeds and plumage, especially iridescent feathers, reflect UV light (Bennett and Cuthill, 1994). Indeed, Ryan and Lea (1994) proposed firstly, that pigeons' failure to respond to video images of conspecifics was possibly due to the colours of the video birds appearing unnatural to the subjects and secondly, that plumage colour, especially the iridescent neck feathers, may play an important part in conspecific recognition. In chickens, UV vision has been implicated in mating behaviour (Jones et al., 1999) and it has been suggested that it may also be important in conspecific recognition (Prescott and

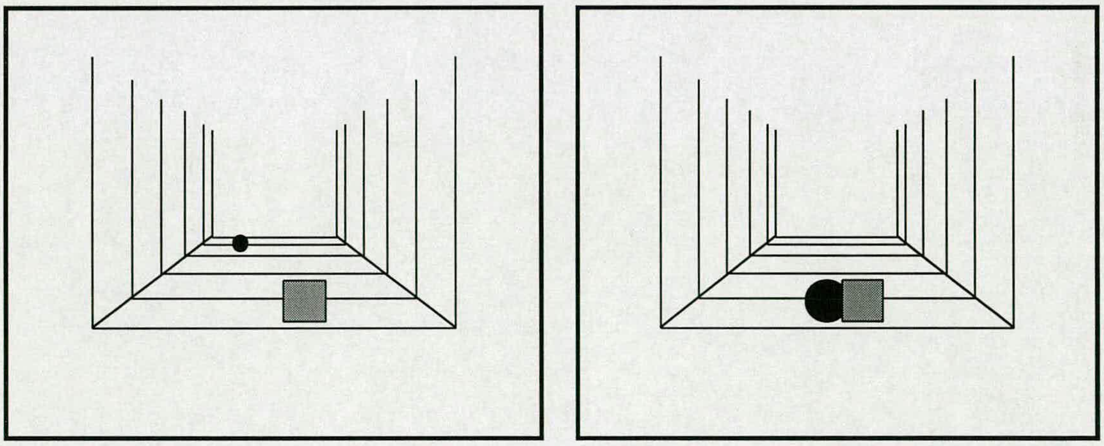
Wathes, 1999). However, if behaviours that may rely on UV cues are not central to the issues under study, video playback could well be an appropriate way of presenting visual stimuli to hens. For example, Patterson-Kane et al. (1997) found that chickens learned a food-maintained discrimination between red and green cardboard in a Y-maze. When these stimuli were replaced in one in five trials with their video images, with no reinforcer given, the hens still showed better than chance discrimination. This suggests that the birds regarded the video images of red and green cards as representative of the real life objects. Additionally, when given the choice between two food dishes, distinguished by blue or red adhesive labels, Burmese red junglefowl (*Gallus gallus spadiceus*, a predecessor of the domestic chicken) showed preferences for the same coloured food dish that they had seen conspecifics feeding from in a video clip (McQuoid and Galef, 1993; 1994). These findings suggest that chickens were able to generalise their responses from video images of coloured objects to the objects themselves.

'Greytone' video images, which are produced by turning the colour control of a television screen to 'off', have been used in some studies, mainly to determine whether colour is important for individual discrimination in Bengalese finches (Watanabe et al., 1993) and *Anolis* lizards (Macedonia and Stamps, 1994), for mate choice in female sticklebacks (Rowland et al., 1995b), or whether colour intensity affects aggression in male sticklebacks (Rowland et al., 1995a; Bolyard and Rowland, 1996). However, some authors argue that animals' responses to coloured and greytone video images may be difficult to interpret because there may be differences in brightness and contrast as well as colour differences (D'Eath, 1998; Fleishman et al., 1998). If detailed information concerning chickens' responses to colour are required, it is possible to measure the colour output of video images using a spectroradiometer (Shepherd, 1997; D'Eath, 1998). This gives a light energy output over a range of wavelengths (Shepherd, 1997; D'Eath, 1998) and allows for a correction of the spectral power output, to take into account the spectral sensitivity of the chicken (N. Prescott, personal communication). However, this equipment is prohibitively expensive (approximately £12,000; N. Prescott, personal communication). Alternatively, it may be possible to examine chickens' responses to differently coloured video images satisfactorily using carefully designed experiments. For example, Fleishman et al. (1998) pointed out that “if it can be shown that there is a consistent difference in response to two different colour patterns over a wide range of brightness conditions, it is reasonable to attribute the difference in response to differences in colour”.

1.2.3 Dimensionality differences

A video image is two-dimensional (2-D), whereas real objects are three-dimensional (3-D). It is conceivable that animals can perceive this difference in dimensionality and that this may affect their responses to a video image.

Encouragingly though, Forkman (1998) showed that chickens can use occlusion (overlap) as a depth cue much as humans do. Hens were taught to peck a touch screen; this is a computer monitor overlaid with a grid of infra-red beams that register which part of the screen has been touched. The screen showed a grid design that, to a human observer, gave an impression of depth (Figure 1.1a; 1.1b). In non-probe trials, symbols of a square and a circle were placed at random on the grid but never overlapping (Forkman, 1998).



a) Non-probe trial

b) Probe trial

Figure 1.1

Images presented to chickens on touch screens in (a) non-probe and (b) probe trials to determine whether they could use occlusion (overlap) as a depth cue in a 2-D image (redrawn from Forkman, 1998).

To enhance the illusion of depth, the symbol presented at the bottom of the grid was larger than the one shown higher up (Figure 1.1a). The hens were rewarded with food when they pecked at the symbol that was higher up on the grid/screen, i.e. the one that a human observer perceived as being furthest away. Every tenth trial was a probe (not food rewarded) and the bird was presented with a picture showing either a square overlapping a circle or *vice versa*. Both symbols were the same size and they were presented at the same height on the grid (Figure 1.1b); therefore, overlap was the only depth cue. During probe trials, where overlap was the only depth cue, chickens pecked at the overlapped symbol, suggesting that they used this cue to determine which object was further away.

1.2.4 Detail and distortion

A pixel (derived from the phrase 'picture element') is the smallest component of a display image, corresponding to a single displayed spot, or colour triad on a display (Morris, 1992). A standard television screen is made up of approximately 330,000 pixels (Watanabe and Furuya, 1997) but if the screen is viewed up close it is possible to see individual pixels. Therefore, the view of a televised image can become distorted if an animal or human being moves very close to the screen. This factor is an important one to consider, particularly if using video playback to investigate social recognition, where fine visual detail may be essential for an animal to identify a conspecific (D'Eath and Dawkins, 1996). For example, certain birds, including domestic chickens, have adapted optical aspects of the eye structure which allow stimuli to be in focus at short distances in the frontal (binocular) field and at the same time at long distance in the lateral (monocular) field (Hodos and Erichsen, 1990; Rogers, 1995). It has been suggested that chickens use their lower frontal field of vision in social interactions (Dawkins, 1995) and therefore need to be in close proximity to a flockmate before they can recognise it. This may be because of a need to identify relatively subtle distinguishing cues, such as comb shape and size (Dawkins, 1995), or the pattern of pits on the comb (D'Eath and Dawkins, 1996).

Dawkins and Woodington (1997) also found that hens' discrimination between two real objects was much better when allowed to view stimuli from 5-25 cm than when forced to choose between them at 120 cm. This was also true of their ability to discriminate between photographs of the same objects. Therefore, the distance at which a video stimulus is presented may be important, especially in studies of conspecific recognition.

Encouragingly, the NHK broadcasting company in Japan has recently developed 'High-vision' television sets which have approximately 2 million pixels, compared to the 330,000 pixels of a conventional TV (Watanabe and Furuya, 1997). Therefore, because the resolution (pixel density) is approximately 5 times greater, it would be difficult to distinguish individual pixels when close to the screen. Watanabe and Furuya (1997) used a monochromatic television but colour sets and High-vision movie cameras are also available (S. Watanabe, personal communication, 1999).

1.2.5 Lack of interaction

The lack of interaction between the audience animal and a video playback image might compromise some studies. For example, D'Eath and Dawkins (1996) suggested that hens' failure to distinguish between video images of familiar and unfamiliar conspecifics may have been due to a lack of behavioural interaction. However, there may be ways of overcoming this problem, at least for answering relatively simple questions. Firstly, for example, the experimenter could manipulate the video image according to the subject's behaviour, thus affording some degree of interaction. Secondly, an image could be automatically controlled by means of infra-red beams in front of a video screen which would be triggered by an approaching animal (D'Eath, 1998). Thirdly, one might use a touch screen (see Section 1.2.3). The computer can be programmed to display specific images when the screen is pecked/touched.

On the other hand, the lack of interaction is a particularly useful feature of video playback when it is necessary to rule out the possibility of social interaction. For example, Swartz and Rosenblum (1980) and Plimpton et al. (1981) specifically used videotaped images of adult bonnet macaques rather than live stimulus animals so that the precise visual cues regulating the social preferences of juvenile conspecifics could be investigated.

1.2.6 Absence of other sensory cues

Video playback cannot provide all of the different types of sensory stimuli that a ‘real-life’ stimulus possesses e.g. tactile, thermal, gustatory and olfactory cues. Some of these may play important roles in regulating the behaviour of many avian species, including chickens. For example, chicks are attracted to familiar odorants (Jones and Faure; 1982a; Jones and Gentle, 1985; Jones and Carmichael, 1999a), the smell of frightened chickens (Mason, 1975) or of predators (Fluck et al., 1996) is thought to elicit fear, and odorants are involved in the control of feeding and drinking, and the avoidance of noxious substances (Marples and Roper, 1996; 1997; Roper and Marples, 1997; Jones and Roper, 1997). D'Eath and Dawkins (1996) also suggested that olfactory cues might modulate individual recognition in domestic fowl. It may be possible to overcome some of these shortcomings by presenting appropriate olfactory cues (if these can be identified and isolated) during exposure to video images. For example, preen oil, which is secreted from a gland at the base of the tail and rubbed over the feathers when birds preen, can have a strong odour (Rawles, 1960; Jacob and Ziswiler, 1982) and it may be involved in pheromonal communication, at least in some avian species (Jacob and Ziswiler, 1982). Therefore, the video image of a familiar conspecific could be presented in combination with a substrate that had been impregnated with preen oil from the bird featured in the video playback.

Auditory stimuli are also very important in the regulation of certain behaviours. For example, the chicken’s calls provide a major means of communication (Wood-Gush, 1971) and they modulate behaviours as varied as hen-chick interactions (Fischer, 1975; Rogers, 1995), feeding (Evans and Marler, 1995), anti-predator responses (Evans and Marler, 1995; Marler and Evans, 1996) and territoriality (Wood-Gush, 1971). Many other extraneous noises, e.g. human voices, the sounds associated with machinery, or aircraft flying overhead, can also play an important role in the chicken’s life. Of course, video technology permits images to be presented with a corresponding soundtrack, thus allowing responses to audio-visual stimuli to be examined easily (see Section 1.3.3).

1.3 Advantages of using video images as visual stimuli

Despite the potential limitations described above, there are distinct advantages to using video images as research tools. These are described below.

1.3.1 Constancy

One of the main advantages of video playback is that it permits the repeated presentation of an exact same sequence of images to every subject animal. For example, in order to compare the predator responses of frogs with those of toads, Roster et al. (1995) presented them with the same video playback of a computer-simulated cricket. Unlike frogs, the toads responded to the video image as if it represented live prey, suggesting that frogs and toads use different visual fields when foraging. Similarly, Rosenthal et al. (1996) studied the responses of female green swordtails to video sequences of the same male engaging in a number of different behaviours, such as feeding, courtship and inactivity. The fact that the females subsequently showed a significant preference for the video of the courting male suggested that their interest depended on a specific set of behaviour patterns.

Additionally, two images of the same subject can be presented simultaneously. For example, video playbacks of a courting male, one displayed in colour and the other in greytone, were presented at the same time to females; they approached both displays, but preferred the coloured one (Rowland et al., 1995b).

Often one could not realistically expect a live animal to perform a specific behaviour for lengthy periods of time. 'Looping' video sequences can be particularly useful in providing long-term constancy in such cases. For example, Adret (1997) produced a 3-hour videotape of a male zebra finch singing whilst facing towards the camera by copying clips in serial order. This videotape was used in an operant chamber where subjects were rewarded with a timed presentation of the singing male if they pecked at the appropriate key.

1.3.2 Ease of image manipulation and control

Another major benefit of video technology is the ease with which the characteristics of a stimulus can be manipulated and/or controlled, e.g. the appearance of an animal can be altered without changing its behaviour. For example, the presentation of video sequences of a male stickleback in which the intensity of its red nuptial colouration were altered allowed researchers to determine that the response of other males depended on colour intensity (Bolyard and Rowland; 1996).

The ability to edit videotape sequences also allows greater control over the image presented and even permits the presentation of one specific behaviour. For example, Plimpton et al. (1981) edited video recordings of bonnet macaques in order to produce images of an adult female sitting quietly, an adult male sitting quietly and an adult male directing a series of open-mouth threat displays. These images were then used to study the response of juvenile bonnet macaques towards these separate social stimuli. The juveniles showed most contact with their mother and lipsmacked (a submissive gesture) more when presented with the threatening male video stimulus. They also approached the female stimulus more than either the passive or threatening male ones. These results suggested that juvenile macaques responded to video images of social stimuli in a socially appropriate manner. D'Eath and Dawkins (1996) also used simple editing techniques to produce video images of 'threat-like' postures in a domestic chicken without actually provoking threatening behaviour in the bird that was being filmed. This was achieved by filming a hen whilst a mealworm was suspended by a thread and held in front of her but out of her reach. The hen responded by standing straight, stretching her neck and trying to peck the worm. This posture is similar to that shown by a threatening chicken when she faces an opponent. Therefore, once pecking behaviour and the mealworm were edited out, the resultant video sequence simulated a hen displaying threat-like behaviour.

Computer technology, coupled with video editing, allows even greater manipulation of the components of an image (reviewed in Watanabe and Furuya, 1997; Künzler and Bakker, 1998). For example, Clark and Uetz (1992) synchronized the courtship movements of two strikingly different male jumping spiders by using a paint and animation software program. These images were downloaded from computer to videotape and then presented to females. Using these methods, the authors were able to determine that females selected mates on the basis of initial movement and not phenotypic characteristics. Similarly, McKinnon and McPhail (1996) produced completely synthetic, computer-generated animations of stickleback males with black, red, or dull grey throats on otherwise identically coloured bodies. When these were presented to conspecific males via video playback, the subjects responded aggressively, "much as they do to live males". However, they did not discriminate between the differently coloured animations, suggesting that the males' agonistic responses were not influenced by their own nuptial colouration. These responses are unlikely to have been due to the males' inability to discriminate the colours because stickleback colour vision does not differ greatly from that of humans (McKinnon, 1995).

It is also possible to use image-processing software to produce biologically impossible chimera. For example, Watanabe and Jian (1993) trained Bengalese finches to discriminate between still video images of individual conspecifics (finches A and B) played in conjunction with the sound of their contact calls. When the image of finch A was presented with the calls of finch B and *vice versa*, it was apparent that visual cues controlled the discriminative behaviour. However, when subjects were presented with chimerical images of A's head with B's body and *vice versa*, some of the subjects showed discrimination by contact calls. Thus, the authors were able to establish that when dominant visual cues did not give enough information, finches used auditory cues for individual discrimination. This type of visual manipulation can be taken a step further and two separate images can be 'morphed' into one. Thus, in order to further assess the type of cues needed for species discrimination, Watanabe and Furuya (1997) trained two groups of pigeons to differentiate between the image of a starling's head and that of a pigeon. For one group, the starling's head was positively reinforced and in the second group it was the pigeon's. Using a morphing computer programme, the two images were mixed at a rate of 20, 40, 60 and 80% of the original image, and presented to the subjects along with the original starling and pigeon images. The subjects were only able to discriminate when the image retained 80% or more of the features of one of the two species.

Collectively, these studies demonstrate that video images can easily be broken down so that the effects of specific components, such as colour, shape and size, of selected stimuli can be investigated separately. This could be especially important in the development of environmental enrichment devices, where we need to identify those features of putative enrichment devices that elicit the greatest attraction and interest. This will be discussed later.

1.3.3 Complex stimuli

Unlike the use of photographs or slide projection, video technology has the advantage that additional features (such as movement and sound) can be incorporated, thus allowing more complex, realistic stimuli to be presented. For example, sheep walked faster along a runway in response to 8-mm movie images of other sheep, especially when it depicted sheep walking away from them, than to a projected slide (Franklin and Hutson, 1982). Indeed, video image can be manipulated in order to determine the relative importance of movement in regulating animals' responses. For instance, Rowland (1995) ascertained that male and female sticklebacks were more attracted to video playbacks of courting males displaying at normal, one-and-a-half and double tempo than at half or triple tempo. Video images have also been used to establish that pigeons respond to categories of movement; they were able to discriminate between video images of pecking conspecifics and those that showed pigeons walking, flying, standing and moving the head, or standing still (Dittrich et al.,1998). Furthermore, Jitsumori et al. (1999) found that pigeons were able to discriminate between video scenes of a conspecific walking, standing and moving the head, and bowing, and ones of a pigeon searching for food, pecking on the floor and turning on the spot, regardless of whether the videos were played forward or backward.

As described previously, auditory cues can influence many behaviours (see Section 1.2.6). They may also serve to direct domestic chicks' attention to a particular object or other visual stimulus (Rogers, 1995). Indeed, sounds can often increase a behavioural response when presented in combination with a visual stimulus. For instance, when the model of a pecking hen was presented to chicks, they pecked more when the bill of the model was allowed to strike the floor, thereby producing a tapping sound (Tolman, 1967a). Video playback allows images to be presented with or without a simultaneous soundtrack or even with a different soundtrack edited on to a particular image. In this way, Evans and Marler (1991) established that the combination of visual and audio playback of an 'audience' hen was more effective in potentiating alarm calls from a cockerel than the video image of the hen alone.

Off-air television programmes have also been used as complex stimuli. For example, Platt and Novak (1997) found that videotaped footages from a television documentary featuring bonnet macaques (unfamiliar conspecifics) and a television soap opera (unfamiliar human beings) were watched significantly more by laboratory macaques than were videotapes of familiar monkeys and humans.

1.4 Chickens' responses to video playback

Some concern has been expressed regarding chickens' ability to generalize between video images and the real-life objects they are intended to represent. However, the majority of studies have reported positive findings. The negative results are dealt with first.

1.4.1 Individual discrimination

D'Eath and Dawkins (1996) asked if hens could discriminate between live familiar and unfamiliar conspecifics and between their video images. When presented with live conspecifics behind clear Perspex, hens were quicker to feed near familiar than unfamiliar birds and near subordinate than dominant ones. Conversely, no such individual discrimination was seen when the subject hens were exposed to video substitutes. However, they "approached more cautiously" and took significantly longer to begin feeding near videos of both familiar and unfamiliar chickens displaying a threat-like rather than a normal posture. Interestingly, the subject hens approached the food dish and fed sooner when it was situated near the video image of a familiar conspecific rather than the animal itself. However, delayed feeding in the latter situation may have reflected the intuitively greater distracting properties of the live hen. To summarise, although the hens failed to discriminate between video images of familiar conspecifics or strangers, they readily approached video images of other birds and were sensitive to the behaviours displayed.

1.4.2 Conspecifics and basketballs

Patterson-Kane et al. (1997) attempted to establish whether chickens could perceive video images as representative of real objects or of chickens and if so, to determine the extent of the generalization. In the first experiment, six hens accurately learned a food-maintained discrimination between a brown hen and a white empty goal box, a white hen and a white empty goal box, and sheets of red and green cardboard in a Y-maze test. When these stimuli were replaced with their video images, the hens showed only chance discrimination between the white hen and white goal box ones but better than chance discrimination between the brown hen and the white goal box stimuli and immediate, accurate discrimination between the video images of red or green cards. The authors concluded that, in the context of their study, hens may not perceive complex video images as equivalent to the real stimuli but that certain aspects of them, such as colour, may be comparable to the same aspects of the real stimuli. A more critical experiment would have examined the birds' ability to discriminate between brown hens or white hens and their video images. In the second experiment, six hens were trained to discriminate between a brown basketball and a brown hen in the Y-maze. Another 6 hens were trained to discriminate between video images of these two stimuli. The hens presented with real-life stimuli quickly learned to discriminate, only taking a mean of 5 sessions to reach 90% discrimination. On the other hand, the hens exposed to video images required 16.5 sessions to reach the same level. It was suggested that video images were poor substitutes for real-life stimuli, at least in this context. However, the fact that the birds did learn to make the discrimination indicates that the video images were simply not as powerful as real-life stimuli.

Aside from these reports (D'Eath and Dawkins, 1996; Patterson-Kane et al., 1997), there are many studies that demonstrate that chickens do show appropriate responses to video images. These are described below.

1.4.3 Anti-predator behaviour

Video images have been used very successfully to examine anti-predator behaviour in chickens. For example, a video image and general soundtrack of a hen placed next to a cockerel's cage was just as effective as a live 'audience' hen in eliciting aerial-predator alarm calling when the model of a hawk was presented overhead (Evans and Marler, 1991). Furthermore, the video image plus sounds of a hen was more effective in eliciting alarm calls than one of a bobwhite quail plus sounds, which in turn was more effective than the video image of an empty cage. It was therefore concluded that a video image could be a substitute for live audience birds, at least in this context. Although the level of alarm calling was greatest when the cockerel was exposed to the video image plus sounds of the audience hen, the video of a silent hen was just as effective in modulating alarm calls as the soundtrack alone, and both were more effective than the silent video of an empty cage. Therefore, both the visual or auditory cues alone significantly increased alarm calling and neither was more potent than the other.

Evans and Marler (1992) also found that cockerels responded to overhead video images of computer-simulated raptors with aerial-predator alarm calling. Additionally, the authors stated that "almost without exception, stimulus presentations elicited obvious non-vocal anti-predator behaviour, including crouching, sleeking the feathers and fixating upward, even when no call was produced". Furthermore, they found that chickens gave significantly more calls to the video image of a hawk silhouette than to that of a disc of the same total area, moving at the same speed (Marler and Evans, 1996). This suggests that chickens were responding specifically to the image of the hawk and not just to an object of similar size.

Evans et al. (1993a) further exploited cockerels' responsiveness to video images of hawks and they used the same animations of raptor shapes to explore the stimulus characteristics necessary for eliciting both aerial-predator alarm calls and non-vocal anti-predator behavior. By changing the apparent size and speed of the stimulus while holding other attributes, such as shape and pattern of flight, constant it was established that the elicitation of non-vocal responses, e.g. crouching and prolonged immobility, was more dependent on the apparent size than speed of the hawk silhouettes. Small images typically elicited monocular fixation and tracking movements of the head, while larger stimuli also evoked crouching. Because a large silhouette is more likely to represent a low-flying bird, the cockerels' responses to the larger stimuli would presumably minimize detection. Therefore, the subjects extracted sufficient information from the video image to allow quite subtle discriminations of size and speed.

Cockerels also responded to the video image of a raccoon with appropriate ground-predator alarm calls (Evans et al., 1993b). These calls, plus aerial-predator alarm calls elicited by a raptor video image, were recorded and subsequently played back to individual hens in the absence of the cockerel, i.e. the non-vocal cues (e.g. crouching, fixating upwards) from the calling male were not present. The aerial-predator alarm calls evoked crouching in the hens, whereas the ground-predator alarm calls caused them to adopt an erect 'vigilant' posture. Both call types increased the rate of horizontal scanning, but the hens were significantly more likely to look upward after hearing the aerial-predator alarm calls. The results demonstrate two important points. Firstly, chicken alarm calls provide sufficient information about the circumstances of production for conspecifics to respond appropriately, even in the absence of the non-vocal cues of the sender. Secondly, the video images of aerial and ground predators successfully elicited these "qualitatively different vocal responses" (Evans et al., 1993b).

Marler and Paleroni (in Marler and Evans, 1996) also used video images to study the development of anti-predator behaviour in chickens. They raised 4 broods of chicks with or without parents and with or without visual access to predators (a live ferret and a peregrine falcon, *Falco peregrinus)*. Between 20 and 27 weeks of age, the birds were tested for responsiveness to videos of a hunting ferret and a hawk image. It was found that "birds raised with parents and with predator experience behaved normally" (i.e. with appropriate anti-predator behaviour), whereas "all others displayed varying degrees of abnormal behaviour without any specific relationship between alarm calling and predator type". This suggests that the development of normal anti-predator behaviour in chickens is influenced both by the presence of parents and by experience of predators. This raises interesting questions concerning the innate vs. acquired properties of the anti-predator responses obtained in previous studies in this laboratory (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b). Unfortunately, insufficient details of methodology prevent us reaching an informed conclusion.

1.4.4 Feeding behaviour

The use of video images to probe animal behaviour is further supported by the results of studies of feeding behaviour. For example, Keeling and Hurnik (1993) found that domestic chickens ate significantly more food when presented with a video image and soundtrack of another chicken feeding rather than a silent video image of an empty cage. Consequently, they suggested that video technology could be used successfully to study the social facilitation of feeding behaviour. Of course, the birds may have simply responded to the soundtrack rather than the visual component of the stimulus but earlier studies (Tolman, 1967a) had suggested that the sound of feeding alone was not enough to stimulate feeding behaviour.

McQuoid and Galef (1993) also used video playback to investigate feeding behaviour in Burmese red junglefowl. Naive observer fowl were presented with video images of either conspecific 'tutors' feeding from visually distinctive dishes (marked by blue or red adhesive labels) or one or other of the food dishes with no bird. The images were presented with or without the soundtrack of a Burmese fowl pecking vigorously in a food dish. Following this videotape 'training', subjects were placed in an enclosure with both types of food bowl (red and blue) and their feeding behaviour was observed. Chicks exhibited significantly shorter latencies to peck at the food if they had seen the video of feeding conspecifics during training, regardless of whether auditory cues were present or not. However, only birds that had been shown videos image plus soundtrack of the feeding conspecifics showed a significant preference for the food dish that they had seen being used. Further investigation revealed that videos showing fowl actually feeding from a food dish were more effective in enhancing preference for that type of food dish than video images that merely showed the fowl close to the dish. The results suggest that both auditory and visual stimuli played a role in influencing food dish preferences, that junglefowl were able to generalize from video images of objects to the objects themselves, and that they responded differentially to video images of birds simply showing general activity near a food dish and those feeding from it. McQuoid and Galef (1994) later confirmed that Burmese red junglefowl preferred the food dishes they had seen conspecifics eating from on a video playback; such preferences were not significantly affected by allowing the subjects access to food during their exposure to the training videos.

Video images have also been used to study how hens guide the feeding responses of chicks (M.A. Richard, personal communication, 1998). In order to determine the influences of pecking behaviour and the characteristic 'food call' on feeding preferences, chicks were exposed to video images of hens feeding from blue or red dishes, with or without a corresponding soundtrack that contained food calls. Female chicks ate more from the dish that they associated with the image plus soundtrack than did males. However, the fact that the chicks were separated from their siblings and their mother and tested individually confounds interpretation of the findings for at least two reasons. Firstly, social separation distresses chicks (Jones, 1987a) and females are thought to show stronger social reinstatement motivation than males (Vallortigara et al., 1990; Jones and Williams, 1992). Secondly, male and female domestic chicks often differ in their behavioural responses to potentially frightening events (Jones, 1987a). For example, female chicks accepted novel food more readily (Jones, 1986) and walked, vocalised, fed and pecked more in a novel environment than did males (Jones and Black, 1980; Jones and Faure, 1982b). Therefore, the differing responses of the male and female chicks to the video images of feeding hens may have been due to sex differences in social motivation and/or underlying fearfulness.

1.4.5 Dustbathing behaviour

Hens also began dustbathing when they were shown videos of dustbathing conspecifics (Lundberg and Keeling, 1997) but social rank was influential here. The birds' positions in a social hierarchy were determined after observations of aggressive interactions and avoidance. They were then deprived of dustbathing material for 9 days and subsequently placed in a cage with sand on the floor in front of a TV-monitor showing either images of a dustbathing hen, a standing hen or an empty cage. There were no significant differences between treatments for low-ranking hens, but high-ranking birds dustbathed sooner if they were shown the video of the dustbathing hen rather than either of the other two images. These findings demonstrate social facilitation of another behaviour pattern, at least in high-ranking hens.

1.4.6 Approach/avoidance responses

Chicks' responses to abstract video images (see **Chapter 2** for definition) have also been examined (Jones et al., 1996a; 1998). Biologically neutral images were used in both studies in order to minimize the possible confounding effects of individual differences in hunger, social motivation or predator evasion that could arise from presenting images such as food, conspecifics or predators, respectively. Firstly, individually housed chicks were exposed to either a blank (B) monitor screen (control) or to a video recording of a complex, moving screensaver (SS) (Jones et al., 1996a). The stimulus chosen was an Apple Macintosh 'Fish' screensaver programme, which depicted small colourful fish swimming across a dark background. The stimuli were presented daily, at one end of each chick's home box, from hatching to 9 or 11 days of age. A marked and progressive approach response was seen with repeated exposure in both treatment groups, though approach developed sooner among the SS than the B chicks. When both SS and B stimuli were simultaneously presented at opposite ends of an unfamiliar runway, SS chicks spent much of their time close to the familiar stimulus, whereas the B chicks were ambivalent. When chicks were exposed daily to video recordings of one of two complex Apple Macintosh screensaver stimuli ('Fish' or 'Flying Toasters') to 9 days of age, they spent longer near the unfamiliar one in a two-choice runway test at 10 days of age (Jones et al., 1996a). Therefore, it was concluded that domestic chicks remembered the video images, that both simple and complex video images assumed relevance and acquired attractive properties with repeated exposure, that complex images might possess some intrinsic attractive qualities, and that where competing complex stimuli were not very different the novel one was more attractive.

Because rearing chicks individually is an artificial situation that effectively precludes the opportunity for filial imprinting, it could be argued that it would promote attachment to any conspicuous feature of the environment, including video images. However, chicks housed in groups of three also developed a marked approach response to SS videos, though those shown the control image of an illuminated blank screen merely habituated to it (Jones et al., 1998). Again, when tested individually in a two-choice test, with B and SS presented simultaneously at opposite ends of a runway, SS chicks preferentially approached the familiar image and spent longer near it, whereas the responses of the B chicks were ambivalent. Thus filial imprinting, which was likely to have occurred in the group-housed birds, did not prevent them from being attracted towards, and forming attachments to, video images.

1.5 Potential strategic implications

Before listing the possible benefits of using video images as stimuli in poultry behaviour research, I will summarize the previous sections. The use of video images as visual stimuli in animal behaviour research does have limitations if complex questions are being posed, mainly due to the differences between human vision and that of other species, including birds. It is sometimes possible to overcome some of these limitations by using specialized equipment or, more simply, by controlling for these differences wherever possible. However, it is always important to bear these limitations in mind when interpreting results. On the other hand, there are distinct advantages to using video playback technology to investigate behaviour and a growing number of researchers now use this technique.

Using video images to study the behaviour of chickens is particularly effective if the tasks are not too demanding. Problems surfaced during a study of individual discrimination (D'Eath and Dawkins, 1996) and in one other (Patterson-Kane et al., 1997). However, video images may not have allowed perception of sufficient detail to facilitate individual recognition in the former study and the latter task, where chickens were asked to discriminate between conspecifics and basketballs in a complex Y-maze, may have been too demanding. Collectively, their successful use in many other contexts suggests that televised images could represent a valuable research tool and may have potential strategic implications.

1.5.1 Video as a reliable alternative to live stimulus animals in selected studies

Some behavioural experiments require a subject to walk along a pre-determined path and live animals are often used to elicit approach.

For example, studies of social motivation and of social discrimination usually involve measuring the attempts made by an individually tested chick to move towards, to establish contact with and/or to remain in close proximity to a group of conspecifics placed in goal boxes at one or at both ends of a runway (Launay et al., 1991; Jones et al., 1996b; Carmichael et al., 1998). Similarly, in gait analysis studies carried out at the Roslin Institute, conspecifics are placed in a goal box to encourage a chicken to walk towards them across a pedobarograph (S. A. Corr, personal communication, 1997); this instrument records the precise placement of as well as the pressure exerted by different parts of the feet (Corr et al., 1998). However, the uncontrollability and unpredictability of the behaviour of live stimulus animals might confound elicitation of the desired response by the subjects. For example, domestic chicks prefer to approach birds which are pecking at the environment and emitting pleasure calls rather than those showing escape behaviour and distress calling (Sigman et al., 1978).

Video images might provide a viable substitute. For instance, an 8-mm movie of a sheep walking away was effective in inducing other sheep to walk towards it along a runway (Franklin and Hutson, 1982). Identification of a video stimulus that reliably elicited approach in chickens could greatly benefit tests such as the one described above. In a study of chickens' discrimination of familiar and unfamiliar conspecifics and their video images, D'Eath and Dawkins (1996) found that adult hens approached videos of conspecifics. However, their birds had been used in numerous and similar studies and were very familiar with the experimental set-up. Additionally, because they recorded the hens' latency to begin feeding from a food dish situated near the stimulus, the presence of food *per se* may have effectively elicited approach. It would be useful to find out whether chickens will approach videos of conspecifics *per se*, especially if these are to be recommended for use in studies of social motivation.

1.5.2 Attachment, reassurance and interest: implications of video playback in environmental enrichment

Examining chickens' responses to video images of biologically relevant stimuli, e.g. conspecifics, predators or food, as well as those of biologically neutral ones, e.g. abstract screensavers, may provide insights into how they perceive and regulate their visual world. For example, when placed in a two-choice runway, chicks spent more time near the video image of a screensaver to which they had been regularly exposed than a blank, lit television (Jones et al., 1996a; 1998). This not only indicated that a familiar video was attractive in an unfamiliar situation but it also clearly demonstrated that the chicks remembered the familiar screensaver and that they were able to discriminate it from the blank screen.

Vision is arguably the main sensory system modulating the way that chickens interact with their social and physical environment (Rogers, 1995). It regulates behaviours as varied as orientation, exploration, feeding, imprinting, aggression, territoriality, social recognition, and mate choice (Fischer, 1975; Rogers, 1995). However, many commercially reared birds are housed in visually restricted environments (Jones, 1996). There is growing evidence that this practice may lead to behavioural problems such as heightened fearfulness, boredom and aggression and that these potentially harmful states can seriously compromise their welfare and performance (Wemesfelder, 1990; Jones, 1996; 1997; Newberry, 1999).

Environmental enrichment, which involves increasing the complexity and stimulus value of the home cage by the incorporation of diverse objects, pecking stimuli, or pictures is often proposed as a remedial measure. For instance, the provision of conspicuous, manipulable objects reduced fear, feather pecking and mortality (Jones, 1982; Vestergaard, 1989; Jones and Waddington, 1992; Nicol, 1992; Gvaryahu et al., 1994; Jones, 1996), increased growth, food conversion efficiency and egg production (Jones, 1985; Gvaryahu et al., 1989; 1990; Nicol, 1992; Bell et al., 1998), and improved plumage and foot condition (Braastad, 1990) in chickens, at least in the laboratory.

Regular video stimulation is also regarded as a form of environmental enrichment *per se* by some researchers (Lincoln et al., 1994; Platt and Novak, 1997), at least in laboratory primates and, as already mentioned, one effect of enrichment in chickens is the reduction of underlying fearfulness (Jones, 1996). Therefore, it would also be useful to ascertain whether prior exposure to video images would reduce chicks' fear of an open field even in the absence of a familiar screensaver video.

Most studies of enrichment have focused on increasing the level of complexity within the cage. However, there is growing evidence that chickens show strong interest in what is beyond their four walls (Newberry, 1995). For example, chicks are readily attracted to abstract video images presented outside their cages (Jones et al., 1996a; 1998); broiler chickens readily entered areas peripheral to the home pen when these contained novel objects that were changed daily (Newberry, 1999); hens looked through spyholes to view novel objects (McKenzie et al., 1998), and playing the radio made laying hens calmer and more productive (Jones and Rayner, 1999). These findings raise the question of whether adult hens would also show interest in abstract video images presented outside their home.

Domestic chicks are attracted to familiar companions, objects, drawings and odours in otherwise novel situations and their presence can also reduce fear (e.g. Bateson, 1964; Wilson and Rajecki, 1974; Zajonc et al., 1974; Jones, 1996; Jones and Roper, 1997). Chicks also approached and stayed near a familiar screensaver video in an unfamiliar runway (Jones et al., 1996a; 1998), but it is not known if this phenomenon would generalize to include a more novel and, hence, intuitively more frightening situation, such as the open field.

Environmental enrichment devices and/or reassuring agents would intuitively be more effective if they attracted and sustained the birds' interest. However, little effort has been devoted to determining the precise types of enrichment stimuli and their component features that chickens actually find attractive, interesting or reassuring (Jones, 1996; Jones and Carmichael, 1999b). By offering tight control and rapid, easy manipulation of selected attributes of the images, video playback could help identify some of these important features and thereby guide the design of environmental enrichment devices and procedures (also see **Chapter 7**).

1.6 Specific objectives

My project addressed five main questions concerning chickens' responses to video images of conspecifics and of selected abstract stimuli (see **Chapter 2**):

1.6.1 Can videos substitute for live animals in selected situations and, if so, are both auditory and visual cues necessary?

I asked if chicks and adult hens would approach a video of conspecifics situated at the opposite end of a runway even in the absence of food reinforcements. Chicks' responses were compared when the runway goal box contained a video image of feeding chicks with corresponding soundtrack or one of an empty goal box with background noise. The relative importance of adding a soundtrack was also examined and chicks' runway behaviour was measured when the goal box contained a video image of feeding chicks with or without the corresponding soundtrack, or a video image of an empty goal box with or without the soundtrack of feeding chicks. This latter experiment was repeated using adult hens to determine whether their responses paralleled those of chicks. These studies are fully described in **Chapter 3**.

1.6.2 Are familiar videos attractive to chicks that have been placed in an open field?

Familiar videos are attractive to chicks when presented in a novel two-choice runway situation (Jones et al., 1996a; 1998), but is their presence attractive in a more frightening environment? Because the open field test has been devised to elicit fear (Jones, 1987b; 1996) it was considered likely to provide a more critical test of the putative attractiveness of a video image than the aforementioned runway. The effects of incorporating a familiar video in the open field on chicks' responses are described in **Chapter 4**.

1.6.3 Can prior video stimulation reduce fear?

I wanted to ascertain whether prior exposure to video images can reduce fear in chickens, like other forms of environmental enrichment (Jones, 1996). Therefore, the hypothesis that regular exposure to video images would reduce chicks' fear of an open field even in the absence of a familiar video was also tested (see **Chapter 4**).

1.6.4 Do adult hens show interest in video images presented outside their cages?

Chicks become readily and strongly attracted to video images presented outside their homes (Jones et al., 1996a; 1998) but do adult hens show similar responses? I addressed this question by measuring the responses of hens to either the video image of a computer screensaver, a blank lit television screen, or just a hide when these were presented in front of their battery cages for up to 21 days. I also examined the development of their responses to these stimuli i.e. whether they would habituate, summate or remain the same after repeated presentation. These experiments are described in **Chapter 5**.

1.6.5 What component features of videos are effective in eliciting and sustaining attraction?

Environmental enrichment procedures could benefit from knowing what chickens find attractive/interesting. Therefore, I studied chicks' responses to individual components of an abstract video image that were likely to be important in eliciting attraction/interest, including movement, brightness, colour and complexity. The potency of these variables was systematically examined by repeatedly and simultaneously presenting abstract videos, differing in one aspect, at opposite ends of chicks' home cages. The variables examined included moving vs. still, bright vs. dull colour vs. black & white and simple vs. complex. These studies are reported in **Chapter 6**.

The results of the project are drawn together in **Chapter 7** and fully discussed in terms of their implications for certain behavioural studies, e.g. gait analysis, and environmental enrichment. Suggestions for future research are also outlined in this chapter.

CHAPTER 2

General Methods

In this chapter, the procedures that were common to the majority of my experiments are described. Any alternative methods or modifications to the above are described in detail in the appropriate chapters.

2.1 Animals and Husbandry

2.1.1 Chicks

All the chicks used in the present study were female ISA Browns (a medium weight hybrid laying brown eggs, originally derived from a Rhode Island Red × Rhode Island White cross). This strain has been the leader in laying performance (up to 95% lay per hen per day) for nearly 35 years and it has become the largest selling brown-egg bird in the world (ISA Brown Management Guide, 1996. Hubbard ISA, Worldwide Layer Operations, France).

There have been conflicting reports regarding sex differences in fear and social reinstatement behaviour of domestic chicks. Firstly, for example, Faure and Folmer (1975) and Faure (1979) reported sex differences in the fear behaviour of only one of 13 strains placed in a novel environment (open field). However, a number of other authors found that males showed less activity, vocalization and feeding, indicative of greater fear, than females during open field testing (Jones, 1977a; Jones and Black, 1980; Jones and Faure, 1982b). Secondly, female chicks ran faster than males along a runway for social reinforcement i.e. contact with cage mates (Vallortigara et al., 1990). Females also showed more pronounced social reinstatement behaviour i.e. they vocalized sooner and walked more, when their companion was removed from the home box than did males (Jones and Williams, 1992). Collectively, these results suggest that males are more fearful than females when placed in a novel environment and that females are more motivated to gain reinstatement with companions after separation. Some of the treatments and tests used in the present project combined elements of fear and social stress. Firstly, for example, a television monitor and video image will likely be perceived as novel stimuli by the chicks, at least initially. Novelty is a potent fear-elicitor (Hogan, 1965; Jones, 1996) that can, in turn, cause immobility or avoidance. Secondly, open-field and runway tests involve separation of the chick from its companions (see **Chapters 3** and **4**). Therefore, in order to avoid any possible confounding effects of sex, only female birds were used in the present studies. Females were chosen because hens, rather than cockerels, make up the vast majority of chickens kept in industry.

Figure 2.1

The room in which chicks were housed, showing the home boxes and overhead dull emitter heaters. The micro camera used for observation (c) and playback monitor (p) are also pictured.

The chicks were obtained from a commercial supplier at 1 day of age, randomly allocated to groups of various sizes (described in the appropriate chapters) and housed in wooden boxes measuring 110 × 38 × 48 cm (length × width × height). These rested on shelving raised 1 m off the floor and all the boxes were aligned (Figure 2.1). The 1-cm wire-mesh floor of each box was raised 2 cm off the shelving to allow the passage of excreta.

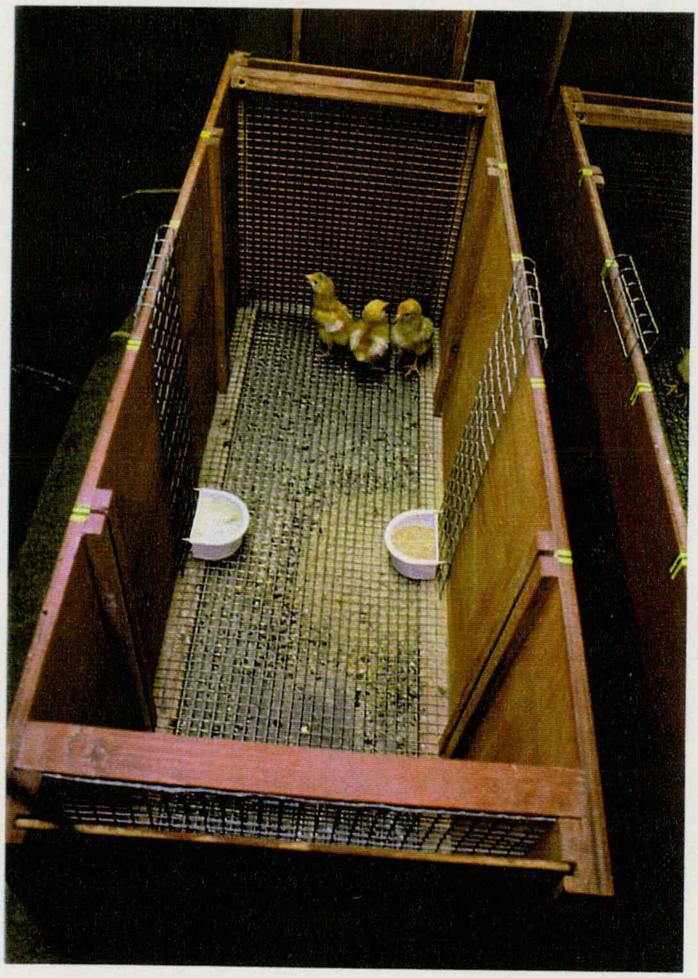


Figure 2.2

The home boxes, showing the food and water hoppers attached to removable wire grids.

Chick starter mash and water were provided *ad libitum* in semi-circular plastic hoppers attached to wire grids suspended from the walls of each box (Figure 2.2). For maintenance purposes, these grids could be removed and replaced remotely, thus minimizing the chicks' visual contact with the experimenter which may have provided additional extraneous visual stimulation. Ambient temperature was maintained at approximately 30°C by placing a dull emitter heater above each cage. During the winter months, two electric convection heaters provided supplementary heating when necessary. The photoperiod ran from 05.00 to 19.00 hours.

Unless otherwise stated, the 38 × 48 cm walls at each end of the box slotted into grooves and could thus be easily removed with minimum disturbance prior to the presentation of a television monitor (see Section 2.2) at each end of the home box. Wire-mesh grids situated directly behind the removable end walls prevented the chicks escaping at this time while still allowing them a clear view of the monitor screen.

2.1.2 Adult hens

The majority of adult hens used in these studies were ISA Browns, although Tetra-SL Brown hens were also used in a runway behaviour experiment (**Chapter 3**). The Tetra is also a medium weight hybrid strain which lays brown eggs; it has a high laying performance and is produced by Bábolna Rt. TETRA, Hungary. All these birds had been obtained from commercial suppliers in England and Ireland, respectively, at 1 day of age. The majority of them were then group-reared (approximately 12 birds) in commercial brooders before being group-housed (2-4 birds) in rearing cages measuring 60 × 50 × 77 cm (width × length × height) from 4 to 16 weeks of age. They were then transferred to individual cages measuring 30 × 45 × 44 cm (width × length × height) in a three-tier battery system. Hens used in the study of runway behaviour (**Chapter 3**) were reared in groups of 8 from 1 day of age in pens measuring 150 × 240 m (width × length). At 33 weeks of age, they were moved to individual cages as described above.

The heights of the tiers of the battery system in which hens are housed can affect certain behaviours. For example, laying hens housed either individually or socially in the top tier showed more pronounced fear responses in a variety of frightening situations than did those from the middle and bottom tiers (Jones, 1985a; 1985b; 1987a; 1987c) which behaved "remarkably similarly" (Jones, 1985b). Therefore, to avoid any confounding effects of tier on the hens' behaviour, only birds that were caged in the middle or bottom tiers were tested.

The photoperiod ran from 06.00h to 18.00h. Due to the spacing of the tungsten lamps on the ceiling, the light intensity along the bottom and middle tier levels ranged from 9-23 and 18-39 lux, respectively (14.1 and 30 lux average over 10 measurements along the battery, respectively). Food (commercial layers' pellets) and water were provided *ad libitum*, the former in a trough at the front of the cage and the latter via nipple drinkers at the back of the cage.

2.2 Presentation of video stimuli

All video images were presented to the birds using Panasonic TC-15 M1R 36-cm colour television monitors with a flicker rate of 50 Hz. These were connected to Panasonic Superdrive NV-SD30B video recorders. With the exception of experiments designed to identify those variables of a video image that were most attractive to chicks (**Chapter 6**), the colour, brightness and contrast levels on the television monitors remained on the standard settings used for human vision.

When exposing chicks to video images in their home environment the end wall of each home box was removed and a television monitor was moved into place (Figure 2.3) for various durations (described in the appropriate chapters). Any gaps between the sides of the box and the monitor were covered with black cardboard in order to minimise visual contact with the experimenter, or any other extraneous stimuli, at this time. Because removal of the end wall immediately prior to video presentation was considered likely to cause some disturbance, at least initially, the end walls of the boxes containing control chicks that received no video stimulation were also removed. A wooden board painted the same colour as the home box was immediately moved into place in the control boxes.

When presenting adult hens with video images in their home environment the television monitor and video recorder were placed either on a two-tier trolley (**Chapter 3**) or on the base of a moveable hide (**Chapter 5**). The hide consisted of a sheet of black plastic stretched over a metal frame and it was used to conceal the observer during direct behavioural observations of the birds. The trolley or hide was then positioned in front of the cage for various durations (see **Chapters 3** and **5**).

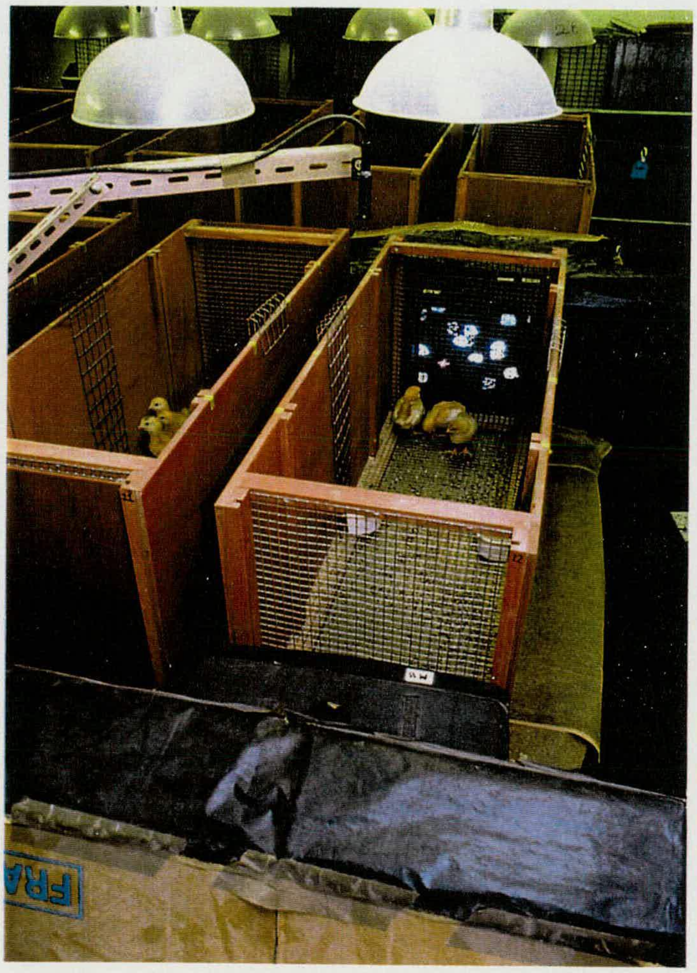


Figure 2.3

Television monitors *in situ* during chicks' exposure to video images in their home environment

2.3 Video stimuli

2.3.1 Screensavers

The birds were exposed to video images of screensaver programmes in most of the experiments. Such programmes are normally used to prevent the degradation of a computer screen. The screensaver videos used here were filmed from a computer monitor that had a similar flicker rate to a standard television screen (50-60 Hz) using a Hitachi GP-61MK colour movie camera. Filming was adjusted to ensure that only the screen of the computer monitor was included in the video image (i.e., no surrounding casing). All the screensaver images used were thought to be biologically neutral. In other words, unlike those used in previous studies (e.g. Evans and Marler, 1991; 1992; McQuoid and Galef, 1993; Keeling and Hurnik, 1993), they bore no connotations of predation, feeding or social attraction. They were considered likely to be interesting to the birds in that they incorporated considerable colour and movement. Furthermore, they possessed no 'looming' properties, which are known to elicit withdrawal in chicks and adults (Salzen, 1979; Jones et al., 1981; Jones, 1987a). The following screensavers were selected from the Apple Macintosh® 'After Dark' screensaver package (2.3.1.1 – 2.3.1.5) or from the Microsoft® WindowsNT® Workstation (2.3.1.6). Where the screensaver set-up options included a control for speed of movement, the median speed was chosen.

2.3.1.1 'Fish' - a number of small, multi-coloured (white, red, yellow, blue, pink and brown) fish swimming back and forth across a black background. An arbitrarily chosen number of fish (12) appeared on the screen at any one time. This screensaver was used in most of the studies because it was already known to be attractive to chicks (Jones et al., 1996a; 1998).

2.3.1.2 'Doodles' - a number of coloured (white, red, yellow, blue, pink and green) wavy lines appear on the screen at random. The screen is refreshed after a few seconds and a different number of lines appear (from 2 to 42).

2.3.1.3 'String Theory' - several bundles of lines change colour (red, yellow, blue, green and purple) as they curve and sweep across a black background.

2.3.1.4 'Satori' - a complex coloured (blue, purple, yellow and black) pattern moving in swirls and ripples and filling the whole screen.

2.3.1.5 'Flying Toasters' - symbols of small, winged, white toasters and pieces of brown toast moving diagonally across a black background, from right to left. As with 'Fish', 12 symbols appeared on the screen at any one time.

2.3.1.6 'Simple screensaver' - one green square (4.5 × 4.5 cm) bouncing diagonally across a black background. This was made by altering one of the standard screensavers ('3D FlowerBox') available on the Microsoft® WindowsNT® Workstation. Like the Apple Macintosh® screensavers it was set at an intermediate speed.

2.3.2 Cartoon

In an experiment that compared chicks' responses to a complex video image vs. a simple one, a cartoon was presented simultaneously with the video image of the 'Fish' screensaver (2.3.1.1) at opposite ends of their home boxes. The cartoon stimulus chosen was an excerpt from an episode of The Simpsons™ ('Bart sells his soul' from 'The Simpsons™ – Heaven and Hell', 20th Century Fox Entertainment®); this depicts simplistic animations of humans and animals that have few features in common with their real life counterparts. This experiment is described in detail in **Chapter 6**.

Throughout my thesis, the video images of screensavers or of cartoons are collectively referred to as 'abstract'. The dictionary definition of an abstract image is one that "[achieves] its effect by grouping shapes and colours in satisfying patterns rather than by the recognizable representation of physical reality" (Allen, 1991). Although The Simpsons™ cartoon (2.3.2) and some of the screensaver videos, such as 'Fish' (2.3.1.1) and 'Flying Toasters' (2.3.1.5), incorporate images that represent real animate and inanimate stimuli to human beings, this definition was deemed appropriate in the context of these experiments because even these representations were considered to have very little or no relevance to laboratory-reared chickens.

2.3.3 Videos of conspecifics

To assess whether a video image of conspecifics elicited approach along a runway (**Chapter 3**) chicks and adults were exposed to goal boxes containing monitors showing either video images of one or two conspecifics, with or without corresponding soundtracks, or to video images of empty goal boxes, with or without the soundtracks of conspecifics. The content of these videos and the ways in which they were filmed are fully described in **Chapter 3.**

2.3.4 Control stimulus

The birds' responses to a blank, illuminated television screen were also recorded in most studies in order to control for the effects of certain factors, such as screen flicker (see **Chapter 1**) and possible attraction towards a television monitor *per se*. This control stimulus consisted simply of a television monitor that was switched on and tuned to the Audio/Video (AV) mode, thus providing a black screen. The colour, brightness and contrast settings were always identical to those of the television monitor showing the video stimuli.

2.4 Recording behavioural responses onto videotape

In most of the experiments, the behavioural responses of the test birds were recorded onto videotape via an unobtrusive Panasonic WV-KS152E colour micro camera (8 × 2 cm). This was mounted onto a metal bracket attached to a trolley (Figure 2.3). The camera was connected to a Phillips 14TVCR240/05 36-cm colour playback monitor (video recorder and television monitor combined) placed on the trolley. The camera could be suspended either over a runway (**Chapter 3**), an open field (**Chapter 4**) or a home box (**Chapter 6**) thus allowing the birds' behaviour to be observed remotely. The recording equipment was easily manoeuverable; this was especially important when recording the behaviour of chicks in their home boxes (**Chapter 6**) because only one of the 18 boxes could be observed at any one time. Therefore, the recording equipment had to be transferred at regular intervals between boxes.

CHAPTER 3

Runway responses of chickens to video images of conspecifics

3.1 Introduction

Chickens, like many species of precocial birds, are highly social animals which, when allowed to do so, form a cohesive social structure (McBride et al., 1969; Wood-Gush, 1971) and readily aggregate with conspecifics (Bradshaw, 1992). As a consequence, conspecifics are often used as an incentive or 'goal' stimulus to elicit approach in behavioural experiments that require a chicken to walk along a pre-determined path. For example, runway (Suarez and Gallup, 1983a; Jones et al., 1996b) and treadmill (Mills and Faure, 1990a) tests are both widely accepted methods of assessing social reinstatement behaviour as well as social discrimination (Suarez and Gallup, 1983a; Vallortigara et al., 1990; Mills et al., 1995; Jones et al., 1996b). These tests usually involve measuring the attempts made by an individually tested chick to move towards, to establish contact with and/or to remain in close proximity to a group of conspecifics (Launay et al., 1991; Jones et al., 1996b; Carmichael et al., 1998). In both tests, the chick has to traverse a long 'corridor' with a holding compartment or 'goal box' at one end but, as the name suggests, a treadmill test requires the chick to work to remain close to the goal box (Mills and Faure, 1990a). Similarly, gait analysis studies, which assess the incidence and severity of leg problems, also often use conspecifics placed at one end of a corridor to encourage a chicken to walk along a pedobarograph (S.A. Corr, personal communication, 1997). This instrument records the pressure placed on different parts of the feet and, when related to underlying pathologies, it yields useful information concerning the aetiology of leg problems (Corr et al., 1998).

All the above types of experiments share a potential weakness: the behaviour of a test bird may be influenced by that of the stimulus birds (Jones, 1987a; Regolin et al., 1994). For example, domestic chicks prefer to approach birds which are pecking at the environment and emitting pleasure calls rather than those showing escape behaviour and distress calling (Sigman et al., 1978). The expression of fear-related or aggressive behaviours by the birds in the goal box might also elicit immobility or avoidance in the test birds. However, the behaviour of stimulus birds is both uncontrollable and unpredictable. This makes it difficult to standardize the attractiveness of a live stimulus animal and, in turn, it introduces a potentially confounding variable.

Video technology may help to overcome some of these problems by providing the means to present a controllable, constant visual stimulus. Encouragingly, an 8-mm movie of a sheep walking away was effective in inducing other sheep to walk along a pre-determined path (Franklin and Hutson, 1982). It has also been shown that chickens feed or dustbathe when shown video images of feeding (Keeling and Hurnik, 1993; McQuoid and Galef, 1993) or dustbathing (Lundberg and Keeling, 1997) conspecifics and that they show appropriate anti-predator responses to videos of ground and aerial predators (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b). If video images of conspecifics were found to reliably elicit approach in chickens, they could perhaps provide a controllable, standardized and viable alternative to live stimulus animals. In a study of chickens' discrimination of familiar and unfamiliar conspecifics and their video images, D'Eath and Dawkins (1996) found that adult hens approached silent videos of conspecifics. However, they placed a food dish close to the stimulus bird or its video image and used the test bird's latency to feed from this dish as their criterion for social discrimination. Therefore, it could be argued that the presence of food *per se* was the primary feature eliciting approach rather than the stimulus hen. Furthermore, the birds used by D'Eath and Dawkins (1996) were 61 weeks old, they were tested in seven consecutive trials, and they had been used in other similar studies. Because of their previous experiences, these birds may not have been representative of other chickens. Therefore, the present experiments were designed to determine whether chickens would approach videos of conspecifics *per se*. Although a food dish was displayed in the videos used here, the contents were not visible and the birds were only tested once.

A pilot experiment revealed that when no food was present, chicks approached live conspecifics faster than their video image. However, when compared to the real stimulus, responses to video images may often be reduced in frequency, magnitude or character (D'Eath, 1998). An interesting observation in the pilot experiment was that chicks tended to run along the runway towards other chicks, whereas those presented with the video of conspecifics walked towards it. In gait analysis studies it is usual to try to control the subjects' speed (Corr et al., 1998) and a walking gait is often preferred (S.A. Corr, personal communication, 1998). Therefore, apart from their controllability, video images may be a more suitable stimulus in such studies.

The video image of conspecifics used in the pilot study was silent but it is known that auditory cues can serve to direct domestic chicks' attention to a visual stimulus (Rogers, 1995) and that including the appropriate soundtrack during televised presentation of an 'audience' hen increased alarm calling by cockerels that were exposed to a potential predator (Evans and Marler, 1991). Therefore, the video stimulus used in the pilot experiment may have been more attractive if it had included the corresponding soundtrack.

Chicks make distinctive 'twitter' or pleasure calls in the absence of threatening cues (Kruijt, 1964) and when feeding and drinking (Andrew, 1964; Andrew, 1969; Wood-Gush, 1971). Low intensity vocalizations such as this can release approach responses in chicks (Kruijt, 1964; Andrew, 1964). Furthermore, feeding conspecifics are attractive stimuli for other domestic hens (Mills and Faure, 1985; Keeling and Duncan, 1988; Mills and Faure, 1989), as are food-associated vocalizations (Marler et al., 1986a; 1986b; Evans and Evans, 1999).

Experiment 1 was designed to determine if chicks would approach video images of feeding conspecifics presented at one end of a runway. Thus, chicks' runway responses were compared when the goal box contained a television monitor either showing the video image and playing the soundtrack of feeding conspecifics or displaying that of an empty goal box with a soundtrack of the background noise normally present in the test room (an extractor fan). Even though the chicks in the video treatment group could see a food dish, but not the food, on the monitor screen there were no other food reinforcements present. Experiment 2 was designed to establish if the visual and auditory cues associated with the video of feeding chicks exerted additive effects. Therefore, chicks' runway responses were compared when the goal box contained the video image of feeding chicks with or without the appropriate soundtrack or the video image of an empty goal box with or without the same soundtrack of the feeding chicks. Finally, I investigated whether chicks' responses to videos of conspecifics *per se* would be paralleled in adult hens (Experiment 3).

3.2 Experiment 1

3.2.1 Animals and husbandry

Fifty ISA Brown female chicks were obtained at 1 day of age and housed in the wooden boxes previously described (**Chapter 2**). Two chicks were randomly selected to act as the stimulus birds and they were housed together in a separate box. The remaining chicks were randomly assigned to groups of eight. Maintenance followed the normal regime (see **Chapter 2**).

3.2.2 Treatments, video stimuli and testing

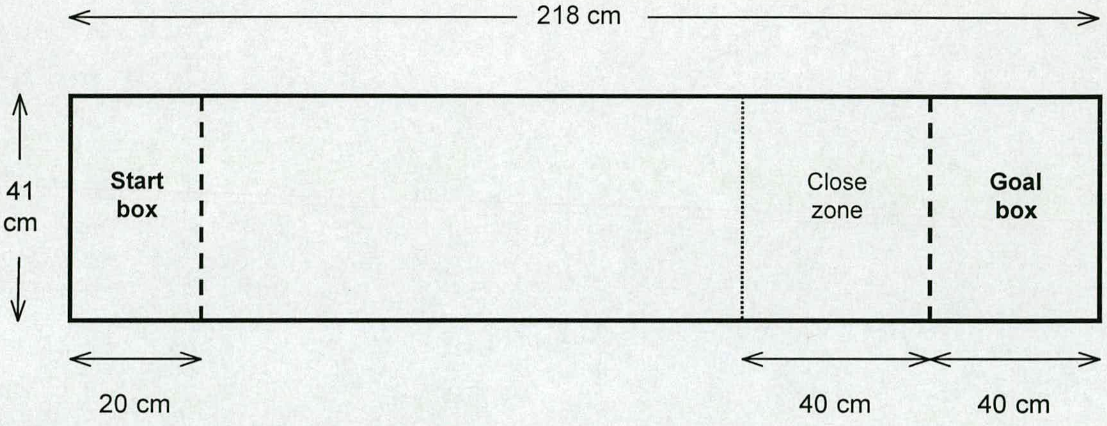
Each group was exposed in random order to a blank, lit television for 10 minutes per day from 2 to 7 days of age in order to reduce the likelihood that the chicks would find a monitor aversive at test. As previously described (**Chapter 2**), the end wall of the home cage was removed and the monitor was moved into place.

Preparation of video stimuli

The two stimulus chicks were food deprived for two hours when they were 7 days old. This was thought likely to increase the likelihood that they would feed during filming. They were then placed in the goal box at the end of the runway (see below). The wire-mesh wall of the goal box prevented the chicks from moving down the runway, whilst another sheet of wire mesh placed over the top of the goal box prevented them from jumping out. A Panasonic NV-S88B colour movie camcorder was placed opposite the goal box and its position and lens were adjusted until the chicks approximated to life-size on the television screen. They then remained undisturbed for 30 minutes before being offered a dish of food (the dish was visible on the video image but its contents were not). The chicks fed as soon as the food was offered and continued to do so for much of the ensuing 15-minute period of filming. The camcorder's in-built microphone automatically recorded all vocalizations that were emitted during filming as well as the background noise of an extractor fan that was present in the test room. The chicks were then removed and a 15-minute recording of just the goal box containing the food dish was made. When the television monitor showing the video stimuli was presented in the runway goal box during testing, the settings (brightness, colour and contrast), which had been adjusted to produce the most life-like picture as perceived by a human observer, remained constant across presentations to all of the test chicks.

Test procedures

To ensure auditory isolation, the runway in which chicks were tested was situated in a separate room with a similar ambient temperature (approximately 30ºC) to that of the home environment. The runway (Figure 3.1) consisted of a wooden corridor measuring 218 × 41 × 46 cm (length × breadth × height) that rested on shelving raised 1 m off the floor. Its walls were covered in matte black paper and the 1-cm wire-mesh floor was raised 2 cm off the shelving to allow the passage of excreta. Two removable 2-cm wire mesh screens were slotted into grooves in the walls at 20-cm and 40-cm from the two ends of the runway. The holding areas thus created served as the start box and the goal box, respectively. The start box also had a 'lid' consisting of wire mesh that prevented test chicks from jumping out during the acclimatization period (see below).



Key

- - - - - = Wire-mesh screen

……… = Line drawn on an acetate sheet (placed over the monitor screen) during remote observation of the chicks' responses. This delineated the 'close zone'.

Figure 3.1

Diagrammatic representation of an overhead view of the runway used to test chicks (Experiments 1 and 2).

Chicks were tested individually and once only at 8 or 9 days of age. Each chick was chosen at random from one of the home boxes, carried in a cardboard box to the test room and placed in the runway start box. The goal box contained a monitor showing either the video image plus soundtrack of the stimulus chicks feeding (VC) or one of the goal box (VGB) with a soundtrack of background noise (an extractor fan). The test chick was given two minutes to acclimatize and then the wire wall of the start box was lifted, allowing it full access to the runway. The chick's behaviour was observed remotely, via an overhead micro camera connected to a monitor. The screen of the monitor was covered with a sheet of acetate and the positions of the start box, the goal box and the 40-cm length of runway nearest the goal box, labelled the 'close zone' (Figure 3.1), were marked on it. The latencies to leave the start box and to enter the close zone were measured. The test ceiling was 5 minutes but the test was terminated as soon as a chick entered the close zone. If a chick failed to leave the start box or to enter the close zone, it received maximum latencies of 300 seconds. The numbers of chicks that entered the close zone in each of the test conditions were also noted. At the end of the test, the chick was removed and its head was marked with indelible black ink before its return to the home box. This facilitated identification of untested chicks.

3.2.3 Statistical analysis

A two-way analysis of variance was used to examine the effects of test condition (VC, VGB), day of testing and their interactions on the latencies to leave the start box and to enter the close zone. The data were log transformed to better fit the assumptions of the analysis. The numbers of chicks in each test condition that entered the close zone were compared using a chi-squared test.

3.2.4 Results and discussion

The analysis of variance revealed no detectable effects of day of testing and no significant interactions (p never < 0.22). Neither was there a significant effect of test condition on the latency to leave the start box ($F_{1,44} = 1.0$, $df = 1$, $p = 0.3$) (Table 3.1). However, VC chicks entered the close zone significantly sooner than VGB ones ($F_{1,44} = 8.2$, $df = 1$, $p < 0.01$) (Table 3.1). Additionally, more chicks entered the close zone in the VC than the VGB test condition (20 versus 12, respectively, $\chi^2 = 4.59$, $df = 1$, $p < 0.05$).

The present results demonstrate that the video image plus soundtrack of feeding chicks was more effective in eliciting approach than the video image of an empty goal box with a soundtrack of background noise. However, it was not possible to ascertain the relative importance of the visual or auditory components of the stimulus here. This question was addressed in Experiment 2.

Table 3.1

Responses of female domestic chicks in a runway test when the goal box contained either a video image and soundtrack of feeding chicks (VC) or a video image of the empty goal box with a soundtrack of background noise (VGB). Table shows back-transformed means ± standard errors.

MEASURE	TEST CONDITION		*p* <
	VC (n = 24)	VGB (n = 24)	
Lat. leave start box (s)	11.8 ± 4.8	22.1 ± 8.9	0.3
Lat. enter 'close zone' (s)	68.31 ± 13.4	149.3 ± 29.4	0.01

Lat. = Latency to; (s) = seconds

3.3 Experiment 2

3.3.1 Animals and husbandry

Two batches of 80 1-day-old ISA Brown female chicks were obtained at an interval of three weeks and housed as in Experiment 1. Because the video stimuli used in Experiment 1 were also used in this experiment, none of the chicks were set aside as stimulus birds on this occasion.

3.3.2 Treatments, video stimuli and testing

The chicks were acclimatized to a blank, lit television monitor using the procedure described in Experiment 1.

An additional video stimulus was produced by dubbing the soundtrack from the video of feeding chicks used in Experiment 1 onto the empty goal box video (VGBS). When silent versions of the video stimuli were required (VCN, VGBN), the volume control on the television monitor was set at zero. The chicks were tested at 8 or 9 days of age in the same runway that was used in Experiment 1. In the present experiment, the goal box contained a monitor showing either the video image and soundtrack of feeding chicks (VCS), a silent video image of the feeding chicks (VCN), the video image of the goal box dubbed with the soundtrack of feeding chicks (VGBS), or a silent video image of the goal box (VGBN). The test procedure and behavioural measurements recorded were as described in Experiment 1.

3.3.3 Statistical analysis

A three-way analysis of variance was used to examine the effects of batch, test condition, day of testing and their interactions on the latencies to leave the start box and to enter the close zone. The data were not normally distributed so they were transformed to logarithms to better fit the assumptions of the analysis. Between-treatment comparisons were made using a *t*-test of means in the log scale. The numbers of chicks that entered the close zone were compared between test conditions using a chi-squared test.

3.3.4 Results and discussion

There were no detectable effects of batch or day of testing on either of the measures (p never < 0.47). The analysis of variance did reveal a significant interaction between day and test condition on the latencies to leave the start box ($F_{3,144} = 3.4$, $df = 3$, $p < 0.02$). VCS chicks were quicker to leave the start box on Day 1 than on Day 2 (14.2 ± 6.5 and 33.2 ± 15.1, respectively; back-transformed means ± standard errors), whereas the opposite was true for VCN chicks (62.9 ± 28.7 and 11.7 ± 5.3, respectively). There was also a significant interaction between batch, day and test condition on the latencies to enter the close zone ($F_{3,144} = 3.5$, $df = 3$, $p < 0.02$). Within Batch 1, VCN chicks were quicker to enter the close zone on day 1 than on day 2 (251.2 ± 72.9 and 81.1 ± 23.5, respectively; back-transformed means ± standard errors), whereas the opposite was true for VGBN chicks (161.8 ± 46.9 and 118.3 ± 34.3, respectively). Within Batch 2, VGBS chicks entered the close zone sooner on Day 2 than on Day 1 (247.2 ± 17.7 and 135.5 ±

39.3, respectively). However, because there was no logical pattern of response, these results are considered likely to simply reflect chance effects.

Table 3.2

Back-transformed means ± standard errors of the responses of female domestic chicks in a runway test when the goal box contained either a video image and soundtrack of feeding chicks (VCS), a silent video image of the feeding chicks (VCN), a video image of the goal box with (VGBS) or without (VGBN) the soundtrack of feeding chicks (VGBS).

MEASURE	TEST CONDITION				*P*<
	VCS (n = 40)	VCN (n = 40)	VGBS (n = 40)	VGBN (n = 40)	
Lat. leave start box (s)	21.7 ± 9.0	27.1 ± 11.2	63.7 ± 26.3	57.3 ± 23.6	0.02
Lat. enter 'close zone' (s)	90.4 ± 12.6	124.4 ± 17.4	179.1 ± 25.0	166.7 ± 23.3	0.003

Lat. = latency to; (s) = seconds

The analysis of variance also revealed significant effects of test condition on the latencies to leave the start box ($F_{3,144} = 4.1$, $df = 3$, $p < 0.02$) and to enter the close zone ($F_{3,144} = 5.1$, $df = 3$, $p < 0.003$) (Table 3.2). Between-test comparisons showed that chicks left the start box significantly sooner when they were presented with the VCS stimulus rather than the VGBS or VGBN ones ($t = -2.86$, $df = 144$, $p < 0.01$ and $t = -2.56$, $df = 144$, $p < 0.01$, respectively). VCN chicks were also quicker to leave the start box than VGBS and VGBN ones ($t = -2.27$, $df = 144$, $p < 0.05$ and $t = -2.00$, $df = 144$, $p < 0.05$, respectively). There were no detectable differences between the chicks' responses in the VCS and VCN test conditions or in the VGBS and VGBN ones.

VCS chicks entered the close zone significantly sooner than VGBS or VGBN ones (t = -5.00, df = 144, $p < 0.001$ and t = -4.44, df = 144, $p < 0.001$, respectively). VCN chicks were also quicker to enter the close zone than VGBS and VGBN ones (t = -2.58, df = 144, $p < 0.01$ and t = -2.10, df = 144, $p < 0.05$, respectively). Again, there were no significant differences between the chicks' responses to the VCS and VCN or to the VGBS and VGBN test conditions.

Additionally, significantly more VCS and VCN chicks entered the close zone than did VGBS or VGBN ones (33 and 35 *vs.* 21 and 18, respectively, $\chi^2 = 24.47$, $df = 3$, $p < 0.001$).

The results are consistent with those of Experiment 1 in that a video image of feeding chicks elicited more approach than did that of an empty goal box. The present results also strongly suggest that the video images of feeding chicks, with or without the corresponding soundtrack (VCS and VCN), were more effective in eliciting approach than either the video image of the goal box with the soundtrack of chicks feeding (VGBS) or a silent video image of the goal box (VGBN). Interestingly, the videos of the feeding chicks (VCN, VCS) were equally attractive regardless of whether they were accompanied by the soundtrack or not. These findings suggest that the visual and auditory components of the stimulus did not exert additive effects and that approach reflected attraction to the visual image.

Collectively, the results suggest that video images of feeding conspecifics might be successfully used to elicit approach along a pre-determined path, at least in young chicks. The possibility that this phenomenon might be paralleled in adults was examined in Experiment 3.

3.4 Experiment 3

3.4.1 Animals and husbandry

The subjects were 48 ISA Brown and 46 Tetra laying hens, obtained at 1 day of age on the same day from a commercial supplier. They were reared in 11 same-strain groups of eight, and one of six, in floor pens. At 33 weeks of age they were transferred to individual cages in the middle or bottom tier of a three-tier battery system. They were tested at 34 and 38 weeks of age, respectively. Full descriptions of housing and maintenance are given in **Chapter 2**.

3.4.2 Treatments, video stimuli and testing

Prior to testing, the hens were exposed in random order to a blank, lit television monitor for 10 minutes on each of three consecutive days in order to reduce the likelihood that they would find the monitor aversive at test. Constraints imposed by the design of the battery system meant that only three birds at a time could have a clear view of the television monitor when it was presented in front of their cages. Therefore, the hens were grouped into 15 blocks of three (ISA Browns) or 14 blocks of three and 2 blocks of two adjacent birds (Tetras) before being exposed to the television as described in **Chapter 2**.

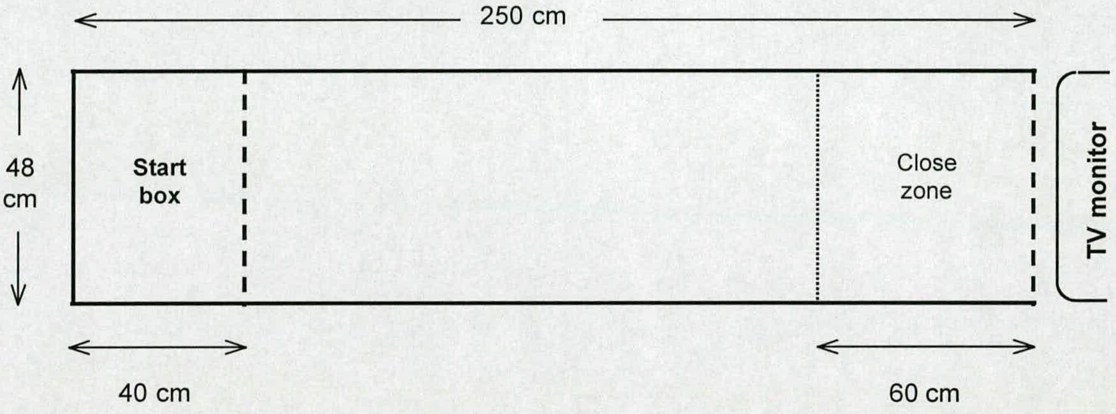
Preparation of video stimuli

An unfamiliar hen of the same strain and age as the test birds was deprived of food for five hours to encourage it to feed during filming. It was then placed in a wooden box, measuring 64 × 40 × 40 cm (length × breadth × height). Three of the walls were covered in white matte paper and the fourth comprised a 2-cm wire mesh screen. This ensured that the hen was easily visible but that it could not escape during filming. A wire-mesh lid was also placed on top of the box to prevent the hen from jumping out. The camcorder (as used in Experiment 1) was placed opposite the wire mesh screen and its position and lens were adjusted until the hen approximated to life-size on a television screen. The bird then remained undisturbed for 30 minutes before a food dish was placed inside the box and attached to the wire mesh wall; this meant that the hen had to face the camcorder in order to feed. The food dish was visible on the video image but its contents were not. The hen was then filmed for 15 minutes; both ISA Brown and Tetra stimulus hens fed as soon as the food was offered and continued to do so during much of the filming period. As in Experiment 1, the camcorder's in-built microphone automatically recorded all vocalizations that were emitted during filming as well as the background noise of an extractor fan that was present in the test room. The hens were then removed, and a 15-minute video recording of the box (including food dish) was made. The soundtrack from the video of the feeding hen was also dubbed on to a copy of the goal box one.

Test procedure

The runway (Figure 3.2) in which the hens were tested was situated in a separate room, of similar ambient temperature to their home environment, to ensure auditory isolation. It consisted of a wooden corridor measuring 250 × 48 × 52 cm (length × breadth × height) which was placed on the concrete floor of the test room. One end wall (nearest the monitor) consisted of 2-cm wire-mesh. This prevented the hens from escaping during testing but it afforded them a clear view of a television monitor that was placed 6 cm behind the wire-mesh wall but outside the runway during video presentation. Gaps between the sides of the runway and the monitor were covered with sheets of wood, thus minimizing the hens' visual contact with other extraneous stimuli. A removable 2-cm wire mesh screen placed 40 cm from the opposite end of the runway formed a start box. A long wire-mesh lid covered the runway to prevent the hens from jumping out during testing.

The ISA Brown and Tetra hens were tested at an interval of four weeks i.e. at 34 and 38 weeks of age, respectively. Each bird was tested individually and once only; testing spanned two days. The hen was carried in a cardboard box to the test room, placed in the start box and left for two minutes to acclimatize. The television monitor situated 6 cm behind the wire-mesh wall displayed either the video image of a feeding hen of the same strain with (VHS) or without (VHN) the appropriate soundtrack, the video image of the empty box dubbed with the soundtrack of the feeding hen (VGBS) or a silent video image of the empty box (VGBN). The test procedure and behavioural measurements recorded were similar to those described in Experiment 2. However, this time the close zone was designated as the 60-cm length of runway nearest the wire-mesh wall (Figure 3.2) and marked as such on the acetate sheet covering the screen of the playback monitor. The floor of the runway was wiped clean with a dry tissue after each test.



Key

- - - - - = Wire-mesh screen

.... = Line drawn on an acetate sheet (placed over the monitor screen) during remote observation of the hens' responses. This delineated the 'close zone'.

Figure 3.2

Diagrammatic representation of an overhead view of the runway used to test adult hens (Experiment 3).

3.4.3 Statistical analysis

Unfortunately, only 61 of the 94 hens tested left the start box and only 32 entered the close zone. This resulted in a large number of ceiling (300-second) latency scores. Consequently, the data sets were badly skewed and this was not improved by transformation. Therefore, only the numbers of hens entering the close zone in each test condition were analysed. In order to estimate the effect of treatment and to take into account the uneven sample sizes and the possible effects of breed of hen and day of testing, the data were analysed using a Generalised Linear Model with binomial distribution (Genstat 5, Release 4.1, 1997). This test allows analysis of binomial data, i.e. in this case, the birds' behaviour is classed as a "success" (entering the close zone) or not. The output from the analysis is compared with a chi-squared distribution with the appropriate degrees of freedom.

3.4.4 Results and discussion

There were no detectable effects of strain of hen ($\chi^2 = 0.8$, $df = 1$, $p = 0.84$) or day of testing ($\chi^2 = 0.77$, $df = 1$, $p = 0.77$) and no significant interactions ($\chi^2 = 3.6$, $df = 3$, $p = 0.31$). However, there was a numerical effect of test condition. More VHS and VHN hens entered the close zone than did VGBS and VGBN ones (12 and 10 *vs.* 5 and 5, respectively). This difference only narrowly failed to achieve significance ($\chi^2 = 7.2$, $df = 3$, $p = 0.066$). Despite the lack of statistical significance, this finding suggests that, like chicks, the video image of a hen feeding, with or without the corresponding soundtrack, elicited more approach than did video images of a silent goal box or one with the soundtrack of a feeding hen.

3.5 Discussion

The results of these experiments clearly demonstrate that a video image of conspecifics elicits approach along a runway by young chicks and adult hens. These findings are consistent with those of social motivation studies that have used live conspecifics as stimuli. For example, domestic chicks traversed a runway significantly sooner when the goal box contained another chick than when it was empty or contained a guinea pig (Suarez and Gallup, 1983a). Similarly, Japanese quail (another precocial avian species) ran faster and further on a treadmill when the goal box contained conspecific chicks than when it was empty or contained Guinea fowl or domestic fowl chicks (Mills et al., 1995). Adult hens also approached the video image of a conspecific, at least when food was present near the television monitor (D'Eath and Dawkins, 1996). The present findings strongly suggest that chickens are attracted to video images of conspecifics *per se*, even though a food dish was displayed on the screen. Chickens are known to find familiar stimuli attractive in otherwise unfamiliar situations (Bateson, 1964; Jones, 1987a; Jones and Carmichael, 1999a). Therefore, because the type of food dish featured in the chick videos was familiar, as was the television monitor, it could be argued that the test chicks were responding to these stimuli and not to the image of the filmed birds. However, the findings that, in both Experiments 1 and 2, the video image of feeding conspecifics was much more attractive to chicks than that of the goal box containing the food dish suggest that this was not the case. At most, the food dish might have exerted an additive effect. Furthermore, the fact that the contents of the food dish were not visible in any of the video playbacks suggests that the chicks were attracted to the image of feeding conspecifics and not to food *per se*.

Experiment 2 showed that the video of feeding conspecifics was attractive to the chicks, regardless of whether the soundtrack was played or not. Furthermore, adding the soundtrack of feeding chicks to the video image of the empty goal box failed to make it as attractive as the silent video of conspecifics, or more attractive than the video of the silent goal box. These results were supported by those of Experiment 3 where there was a strong tendency, albeit non-significant, for more adult chickens to approach a video of a feeding hen than one of an empty goal box, regardless of whether the conspecific video included the corresponding soundtrack or not. Collectively, these findings strongly suggest that the visual and auditory components of the stimulus did not exert additive effects and that the visual component of the conspecific videos was the most important feature in eliciting approach. These results are particularly interesting because they do not conform to the results of some previous studies of the responses of chickens and other avian species to selected audio-visual stimuli. For example, although Watanabe and Jian (1993) found that visual cues were more important than auditory ones when Bengalese finches were asked to discriminate between two conspecifics, they also reported that when visual cues did not provide appropriate information, e.g. when the head of one was superimposed onto the body of the other, the finches used auditory cues for the discrimination.

It has also been suggested (Tolman, 1967a; 1967b; Evans and Marler; 1991) that combining auditory and visual cues in the same stimulus can increase its potency. For example, when the model of a pecking hen was presented to chicks, they pecked more at food when the bill of the model was allowed to strike the floor, thus producing a tapping sound (Tolman, 1967a). Similarly, Faure (personal communication, 1999) found that chicks were more attracted to two hens present behind a wire mesh screen (sight plus sound) in a T-maze than when they were hidden behind a cardboard screen, or when just loudspeakers emitted recorded calls of the two hens (sound alone). Additionally, Evans and Evans (1999) found that though hens did not approach a loudspeaker broadcasting the food calls of a conspecific male they readily approached live food-calling males and took the food item from them (Marler et al., 1986a). This led Evans and Evans (1999) to conclude that "there is clearly the potential for visual information to act synergistically with that encoded in the acoustic signal to affect female behaviour". This phenomenon has also been observed when certain video images were used as stimuli. For example, Evans and Marler (1991) found that when a hawk model was presented overhead, the level of aerial-alarm calling was greater when the test cockerel was exposed to the video image plus sounds of an audience hen, rather than a silent video of the hen, a video of an empty cage plus sounds of the hen or a silent empty cage video. Male black-capped chickadees also avoided the video image of a conspecific male more when it was accompanied by the simultaneous broadcast of multiple aggressive 'gargle' vocalizations than when it was silent (Baker et al., 1996). Furthermore, McQuoid and Galef (1993) found that only red Burmese junglefowl chicks that had experienced the combination of a video of a feeding conspecific with a soundtrack showed a significant preference for the food dish that they had seen being used by that conspecific. There are no obvious explanations for the apparent inconsistency between the results of the above studies and those of the present experiments. However, various call systems seem to have quite different properties (C.S. Evans, personal communication, 1999) and McQuoid and Galef (1993) concluded that the "feeding behaviour of fowl can be influenced both by auditory and visual stimuli received from fellow flock members, but the particular social stimuli causing modifications of foraging behaviour will depend both on the details of the situation….and on the aspects of feeding behaviour selected for study". Therefore, the present findings may be specific to the context in which the tests were conducted, i.e. a video of feeding conspecifics presented at one end of a runway.

Although statistical significance was not achieved in Experiment 3, the responses of hens paralleled those of the chicks in that more of them approached the video of a feeding conspecific, with or without corresponding soundtrack, than that of a goal box with or without the sounds of a feeding hen. Therefore, it would appear that approach towards a video image of conspecifics is not dependent on the chickens' stage of development. However, unlike the chicks, large numbers of the hens failed to leave the start box and/or enter the close zone during the runway test, regardless of test condition. Possible explanations are discussed below. Firstly, it seems unlikely that the hens' responses reflected maturational effects on social reinstatement. Indeed, a study of feral chickens reported that "when a female [adult] was left behind feeding after the group had left, she would eventually look up, apparently disturbed, and move quickly after the group" (McBride et al., 1969). Furthermore, Japanese quail from two lines that had been genetically selected for high (HSR) or low (LSR) levels of social reinstatement behaviour show marked line differences in this behaviour that persist into near adulthood i.e., approximately 6 weeks of age at which point the birds are sexually mature (François et al., 1998; Jones and Mills, 1999). Secondly, certain postural cues and physical characteristics can predict dominance (Fischer, 1975) and low-ranking, submissive hens often avoid high-ranking, aggressive conspecifics (McBride, et al., 1969; Appleby et al., 1992; Grigor et al, 1995). Therefore, the weaker attraction shown towards videos of conspecifics by adult hens may have been due to the fact that some of them perceived the video hen as a dominant individual. On the other hand, chickens are not thought to begin establishing dominance hierarchies until approximately 5-6 weeks of age (Guhl, 1962; McBride et al., 1969) so avoidance of dominants is unlikely to have affected the responses of the 8- and 9-day-old chicks tested here. Thirdly, because strangers often fight when they meet, there may also be a tendency to avoid unfamiliar hens (Grigor et al., 1995). Indeed, the presence of unfamiliar conspecifics can inhibit hens' movement along a runway more than that of higher-ranking familiar birds (Grigor et al., 1995). However, the suggestion that hens avoid videos of strangers is weakened by the report that chickens are apparently unable to discriminate between video images of familiar and unfamiliar conspecifics and readily approach both (D'Eath and Dawkins, 1996). Fourthly, I have argued previously that the food dish visible in the video of feeding chicks did not influence the responses of the test birds because its familiarity. Conversely, the food dish shown in the adult video was novel to the test hens. Novelty can elicit fear that may, in turn, inhibit activity and/or cause avoidance (Jones, 1987a; 1987b; Jones, 1996). Therefore, a possible explanation for many of the hens not leaving the runway start box and/or failing to enter the close zone is that they may have been more frightened of the food dish featured in the video, as well as the novel test situation *per se*, than were the chicks. If this was the case, such neophobia could perhaps be overcome by allowing the hens previous exposure to the test situation and/or a longer acclimatization period in the start box before beginning the test. It may be prudent to bear these factors in mind when designing future experiments of a similar nature.

The present results support previous suggestions that chickens modulate their behaviour in response to video images of conspecifics (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b; Keeling and Hurnik, 1993; McQuoid and Galef, 1993; 1994; D'Eath and Dawkins, 1996; Lundberg and Keeling, 1997). Regardless of the mechanisms underpinning the attraction found here, the results suggest that this controllable and easily manipulated video playback procedure could provide a reliable alternative to live stimulus animals. It may also illuminate the roles played by various features of a component stimulus. For example, Evans and Evans (1999) suggest that it may be possible to explore systematically the interaction between the acoustic and visual components of a live stimulus by means of video playback experiments in which visual and acoustic information is manipulated independently. The present results and those of Evans and Marler (1991) and McQuoid and Galef (1993) (see above) suggest that this may indeed be a viable approach.

The current results may also have important strategic implications. For example, video images of conspecifics could be particularly beneficial in studies of gait analysis (see **Section 3.1**), where voluntary movement along a pre-determined path is essential and control over the subjects' speed is desirable (Corr et al., 1998). The fact that the birds tested here tended to walk rather than run towards the conspecific video is an added advantage for gait analysis procedures (S.A. Corr, personal communication, 1998).

Videos of conspecifics might also prove useful in studies of social motivation and of the disinhibition of fear after frightening events, both of which often require voluntary locomotion towards a stimulus. The strategic relevance of the present findings is further discussed in **Chapter 7**.

CHAPTER 4

Effects of prior video stimulation on open-field behaviour in domestic chicks

4.1 Introduction

It is widely recognized that domestic chicks are attracted to familiar companions, objects, drawings and odours in otherwise novel situations and that the presence of these familiar stimuli can reduce fear (Jones, 1977b; Jones, 1987a; Bolhuis and Honey, 1994; Jones and Roper, 1997; Jones and Carmichael, 1999a). For example, chicks were quicker to approach an unfamiliar model when it was painted with a pattern similar to that of their rearing pen (Bateson, 1964); they spent more time in that half of a novel cage containing a familiar drawing (Jones, 1977b) and they preferred the familiar soiled substrate from their home cage to that soiled by an unfamiliar conspecific or clean wood shavings when placed in a novel environment (Jones and Faure, 1982a). Additionally, chicks that had been dyed red or green pecked more (suggesting reduced fear) at an unfamiliar non-dyed chick of the same strain when they were tested in the presence of a conspecific dyed the same, i.e. familiar, colour (Wilson and Rajecki, 1974). Chicks also exhibited less fear behaviour in a novel environment when it contained either coloured foam shapes with which they were familiar (Zajonc et al., 1974) or wood shavings treated with a familiar odour of geranium oil (Jones and Gentle, 1985). It has also been established that chicks readily approach familiar video images of computer screensavers when these are presented in a novel two-choice runway situation (Jones et al., 1996a; 1998). The present study asked whether the attractive and fear-reducing properties of familiar birds, objects and odours in otherwise novel environments would generalize to include familiar video images presented in a different and intuitively more frightening situation than the runway test. Therefore, an open field test was used in the present experiment. This test has been commonly used to estimate emotionality or fear in a variety of species, including laboratory rodents, chickens and cattle (Gray, 1979; Jones, 1987b; 1989; Boissy, 1995). However, the open field test has caused controversy (Jones, 1987b; 1996) and some authors have criticized its effectiveness for measuring fear in species as varied as rats, mice and chickens (Archer, 1973; Walsh and Cummins, 1976; Gallup and Suarez, 1980). The arguments put forward by both the opponents and proponents of this test are described in the Discussion (Section **4.4**). The open field test involves separating the animal from its companions and exposing it to a novel, barren environment. Novelty is a potent fear elicitor (Jones, 1987b; 1996) and the open field used in the current experiments was considered more frightening than the runway used by Jones et al. (1996a; 1998) because of its greater dissimilarity from the home cage in terms of dimension, colour and type of flooring.

Two experiments were carried out to examine the effects of regular exposure to video images on chicks' subsequent behaviour in open-field tests. In Experiment 1, chicks were either exposed to a video of a single computer screensaver (SS) in their home cage from 2 to 8 days of age or not. Their approach/avoidance responses towards a window situated in one wall of an open field were then compared when the SS image was either visible through the window or not. It has been suggested that regular video stimulation might be regarded as a form of environmental enrichment (Washburn and Rumbaugh, 1992; Lincoln et al., 1994; Platt and Novak, 1997) and one effect of enrichment in chickens is the reduction of underlying fearfulness (Broom, 1969; Jones and Waddington, 1992; Reed et al., 1993; Jones, 1996). Therefore, Experiment 2 was designed to test the hypothesis that regular exposure to a more complex video (a composite of five screensavers) would reduce chicks' fear of an open field, even in the absence of the familiar video. Fear responses in chicks fluctuate during the first week of life (Andrew and Brennan, 1984; Rogers, 1995) but they are thought to become relatively stable from day 9 and 10 onwards, as overall bias to control by the right hemisphere of the brain develops (Andrew and Brennan, 1984; Rogers, 1995; Jones and

Carmichael, 1997). Therefore, chicks were always tested at 9 days of age or older. Additionally, sex differences in the fear reactions of domestic chicks are occasionally reported so only females were used here (see **Chapter 2**).

4.2 Experiment 1

4.2.1 Treatments and testing

Eighty 1-day-old female ISA Brown chicks were randomly allocated to groups of 10 and housed in wooden boxes as previously described (**Chapter 2**) with the exception that only one end of the box could be removed for video presentation; this wall was fixed in place by hinges. The groups were then assigned at random to one of two treatments. Half of them were exposed to the video image of the Apple Macintosh 'Fish' screensaver (SS) programme for 20 minutes, twice a day (morning and afternoon), from 2 to 8 days of age. During video presentation, the end wall of the home box was removed and the television monitor was moved into place. This procedure is fully described in **Chapter 2**. The remaining four groups (controls) received no video stimulation (N); here the end walls were removed and then replaced immediately with a wooden board painted the same colour as the home box (see **Chapter 2**).

The open field (Figure 4.1) was situated in a separate room to ensure auditory isolation and the ambient temperature was maintained at a similar level to that of the home environment. It consisted of a wooden box measuring 75 × 75 × 60 cm (length × width × height). One of the walls contained a 'window' measuring 40 × 40 cm (length × width) and covered with 2-cm wire-mesh. Thus, when a television monitor was placed behind this window, the screen was clearly visible to the chick under test, but the chick could not escape. The walls of the open field were painted matte black and, when the monitor was not being presented, the window was covered with a sheet of black card to ensure uniform wall colour. The floor was painted light grey and it was delineated with black ink to form a grid of 16 squares (4 × 4), each measuring 18.75 × 18.75 cm. This grid pattern facilitated recording of the chick's position and its locomotor activity. Each row of 4 squares was designated as a zone, 'Zone 4' being nearest to and 'Zone 1' furthest from the window. The chicks' responses were recorded on videotape using an overhead micro camera (see **Chapter 2**). The open field was rotated between trials, to minimize any confounding effects of positional cues.

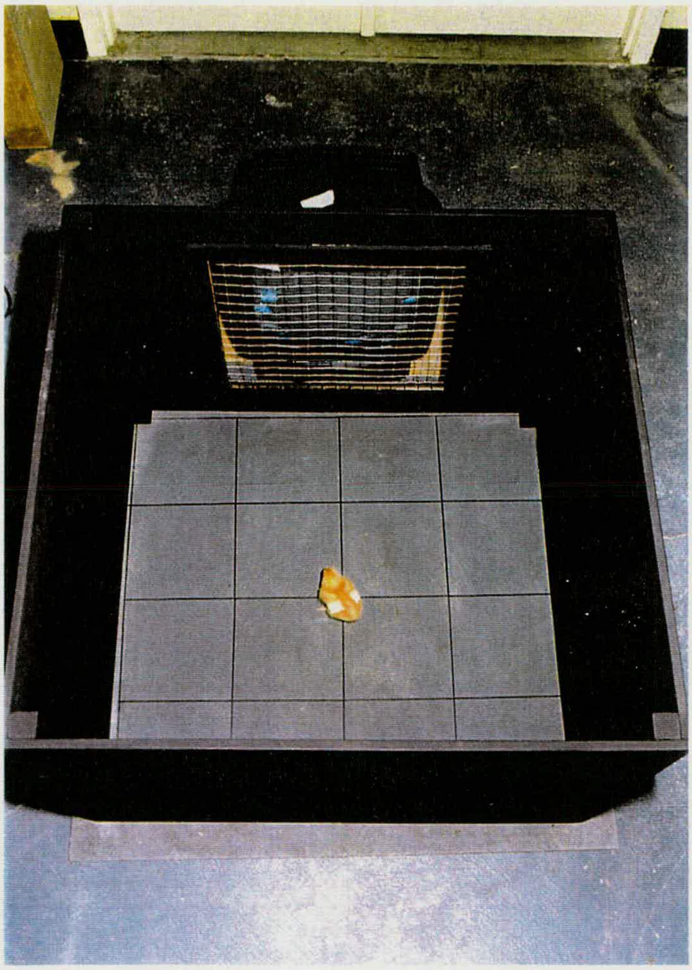


Figure 4.1

A chick under test in the open field with a monitor displaying the screensaver visible behind the wire-mesh window

At test, each chick was placed individually in the open field at either 9, 10 or 11 days of age. Each chick was captured individually, carried in a cardboard box to the test room and placed in the centre of the open field facing the 'window' behind which one of two stimuli was already in place. These consisted of either the familiar ‘Fish’ screensaver video (SS) or just a matte black cardboard sheet (BC) that matched the walls. Thus, the four test groups consisted of: 1) reared and tested with the screensaver (SS/SS); 2) reared with SS, but tested with the black card (SS/BC); 3) reared without SS but tested with it (N/SS), and 4) no exposure to SS during rearing and then tested with the black card (N/BC).

The latency to vocalize and the number of vocalizations were recorded directly during the four-minute test. Other behaviours were recorded on videotape for later analysis using a micro camera suspended directly over the open field (see **Chapter 2** for a full description of the camera equipment). At the end of the observation period, the chick was removed and its head was marked with black ink before its return to the home box. This facilitated subsequent identification of untested chicks. The floor of the open field was wiped clean with a dry tissue after each test.

Upon analysis of the videotapes, the latencies to the first step and to enter Zone 4, i.e. the row of squares closest to the window, were measured as well as the numbers of steps and of squares entered. An ‘approach’ score was also estimated for each chick. Its position was recorded at 5-second intervals during the 4-minute test period; it scored 1 when it was in Zone 1 and this score progressed through 2 and 3 to 4 if it was in the zone nearest the window. If the chick remained in the centre of the open field, i.e. on the line separating Zones 2 and 3, after the first 5 seconds it was given a score of 2.5 until it moved fully into one of the zones. Thereafter, if a chick was observed on the border between zones, it was judged to be in the zone containing the major part of its body. Because position was recorded 48 times, the overall score ranged from a minimum of 48 to a maximum of 192. Thus, higher scores reflected closer approach to the stimulus.

4.2.2 Statistical analysis

Sample sizes were uneven across treatments and days because mortality reduced the number of available chicks to 78. Therefore, the effects of rearing (SS or N), test condition (SS or BC), day of testing and their interactions on the recorded behaviours were examined using a General Linear Model analysis of variance (Minitab, Release 12.22, 1998), which takes unbalanced data sets into account. Because the data did not fit a normal distribution, they were transformed to logarithms to better fit the assumptions of the analysis.

4.2.3 Results and discussion

There were no detectable effects of day of testing on any of the behaviours (p never < 0.24). On the other hand, there were significant effects of rearing on the chicks' latencies to enter zone 4 ($F_{1,66} = 5.0$, $df = 1$, $p < 0.03$) as well as on their approach scores ($F_{1,66} = 5.9$, $df = 1$, $p < 0.02$), numbers of steps ($F_{1,66} = 4.8$, $df = 1$, $p < 0.04$) and of areas entered ($F_{1,66} = 4.8$, $df = 1$, $p < 0.04$) (Table 4.1). In general terms, SS chicks entered zone 4 sooner, spent longer in that area and were more active than the controls. However, there were significant interactions between rearing and test conditions on the latency to enter zone 4 ($F_{1,66} = 6.5$, $df = 1$, $p < 0.02$) and approach scores ($F_{1,66} = 13.8$, $df = 1$, $p < 0.001$); SS/SS chicks entered zone 4 sooner and scored higher approach than SS/BC ones whereas the reverse was true for N/SS and N/BC chicks (Table 4.1). These findings probably reflect attraction towards the video image in the open field by SS chicks because of its familiarity whereas the novelty of this stimulus likely elicited neophobia and avoidance in the naive controls.

Analysis of variance also revealed a significant effect of test condition on the latency to vocalize ($F_{1,66} = 5.3$, $df = 1$, $p < 0.03$); the presence of SS in the open field delayed vocalization regardless of rearing condition (Table 4.1). This effect in the N controls, which had never experienced the video, probably reflected their fear of this novel stimulus whereas the presence of this familiar stimulus may have dampened the expression of this social reinstatement behaviour (Faure et al., 1983) in SS ones.

Table 4.1

Open-field responses (back-transformed means ± standard errors) of female domestic chicks reared with (SS) or without (N) daily exposure to a screensaver video and then tested with the video (SS/SS, N/SS) or a black card (SS/BC, N/BC) and the results of tests of the effects of rearing, test conditions and their interactions ($df = 1$)

MEASURE	**TREATMENT / TEST**				**EFFECT OF (p)**		
	SS/SS (n = 20)	**SS/BC (n = 20)**	**N/SS (n = 20)**	**N/BC (n = 18)**	**Rearing (SS or N)**	**Test (SS or BC)**	**Rearing × Test**
Lat. Vocalize (s)	10.8 ± 2.1	7.8 ± 1.5	15.5 ± 3.1	8.6 ± 1.8	NS	< 0.03	NS
Lat. First step (s)	39.1 ± 6.8	32.9 ± 5.8	42.1 ± 7.5	47.2 ± 8.9	NS	NS	NS
Lat. Enter Zone 4 (s)	72.3 ± 11.1	109.9 ± 17.2	153.1 ± 24.3	104.7 ± 17.6	< 0.03	NS	< 0.02
Vocalizations (no.)	385.4 ± 4.7	433.7 ± 74.1	363.6 ± 62.8	333.7 ± 61.2	NS	NS	NS
Steps (no.)	67.7 ± 12.5	57.4 ± 10.8	42.5 ± 8.1	40.4 ± 8.1	< 0.04	NS	NS
Areas entered (no.)	18.6 ± 3.5	15.9 ± 3.0	11.1 ± 2.1	11.7 ± 2.4	< 0.04	NS	NS
Approach score	159.6 ± 7.8	125.9 ± 6.2	117.2 ± 5.9	134.3 ± 7.1	< 0.02	NS	< 0.001

Lat. = latency to; (s) = seconds; (no.) = number; NS = Not significant, $p > 0.05$

Fear inhibits all other behaviour systems, including exploration and social reinstatement (Hogan, 1965; Faure et al., 1983; Jones, 1987b; Jones, 1996). Therefore, our findings that SS chicks were significantly more active in the open field and tended to vocalize sooner and more than N ones, regardless of test condition, suggested that prior video stimulation may have reduced underlying fearfulness. This suggestion was examined in Experiment 2.

4.3 Experiment 2

4.3.1 Treatments and testing

Forty-eight female ISA Brown chicks were obtained at 1 day of age. Groups of six birds were housed as described in **Chapter 2** and assigned at random to one of two treatments. Half the chicks were exposed to a composite video (CV) of five Apple Macintosh screensaver programmes for 20 minutes, twice a day, from 2 to 8 days of age. The videotape consisted of four minutes of each of 'String Theory', 'Fish' (as in Experiment 1), 'Satori', 'Flying Toasters' and 'Doodles', respectively (see **Chapter 2** for full details of the screensavers). The video was presented to the chicks as described in Experiment 1.

At 9 or 10 days of age, the birds were tested individually in the same open field that was used in Experiment 1, although this time the window was covered with black card so that all the walls were uniformly black. No video images were presented at test on this occasion. The latency to vocalize, the number of vocalizations and the duration of freezing (a high intensity fear behaviour characterised by silence and immobility) were recorded directly; the chicks' responses were also recorded onto videotape, as in Experiment 1. Freezing was also measured as an all or none groups, i.e. the numbers of chicks in each treatment that did or did not freeze. Upon reviewing the videotapes, the latency to the first step and the number of areas entered during the 10-minute test period were measured.

4.3.2 Statistical analysis

The numbers of experimental (CV) and control (C) chicks that exhibited freezing were compared using a chi-squared test. The remaining data were not normally distributed and were therefore transformed to logarithms. An analysis of variance was then used to examine the effects of treatment, day of testing and their interactions.

4.3.3 Results and discussion

Fewer CV than C chicks exhibited freezing behaviour (8 versus 17, respectively, $\chi^2 = 8.35$, $df = 1$, $p < 0.01$).

Table 4.2

Open field responses (back-transformed means ± standard errors) of chicks that had either received regular exposure to a composite video of five screensavers (CV) or not (controls, C).

MEASURE	**TREATMENT**		***p***
	CV (n = 24)	**C (n = 24)**	***df* = 1**
Duration of freezing (s)	2.7 ± 0.8	8.1 ± 2.6	< 0.05
Lat. vocalize (s)	5.7 ± 1.4	13.5 ± 3.3	= 0.06
Lat. step (s)	55.7 ± 11.9	53.3 ± 11.5	NS
Vocalizations (no.)	895.0 ± 44.6	882.7 ± 44.0	NS
Areas entered (no.)	58.9 ± 4.7	34.9 ± 2.8	< 0.01

df = degrees of freedom; Lat. = latency to; (s) = seconds; (no.) = number; NS = Not significant, *p* > 0.05

The analysis of variance revealed no detectable effects of day of testing and no significant interactions (p never < 0.23). However, treatment effects were apparent. The CV chicks showed significantly shorter durations of freezing ($F_{1,4} = 8.4$, $df = 1$, $p < 0.05$) and they entered significantly more areas of the open field ($F_{1,4} = 21.0$, $df = 1$, $p < 0.01$) than did C ones (Table 4.2). A numerical tendency for CV birds to vocalize sooner than C chicks only narrowly failed to reach significance ($F_{1,4} = 6.7$, $df = 1$, $p = 0.06$). The present results provide further evidence that regular exposure to a complex video image during the first week of life reduced chicks' later fear of a strange environment, perhaps by serving as a form of environmental enrichment.

4.4 Discussion

The present findings are consistent with previous reports that domestic chicks are strongly attracted to familiar objects, shapes, drawings and odours when these are encountered in otherwise novel situations (Bateson, 1964; Jones, 1977b; Bolhuis and Honey, 1994; Jones and Roper, 1997; Jones and Carmichael, 1999a). Experiment 1 showed that chicks that had received daily exposure to a video image of a computer screensaver (Fish) approached it sooner and spent longer near it when it was presented in a novel environment (open field) than did control chicks that had not received such stimulation. These findings are also in agreement with previous reports of chicks' attraction to familiar video images presented in intuitively less frightening (see **Section 4.1**) two-choice runway tests (Jones et al., 1996a; 1998). Collectively, they clearly demonstrate that domestic chicks are capable of remembering symbolic video images and that their documented attraction to familiar objects and odours in novel surroundings (see above) generalizes to include such video images.

It might be argued that the chicks in Experiment 1 were attracted to the video image when it was presented in the open field solely because they were imprinted onto it. Imprinting is the process whereby "newly hatched chicks rapidly form a social preference for a conspicuous stimulus to which they are exposed" (Bolhuis, 1999). Even if this was the case in this particular experiment, it does not weaken my conclusion concerning the attractive properties of familiar stimuli. However, it may not even be necessary to invoke the concept of imprinting. For example, the chicks used in Experiment 1 were reared in groups of 10 and they were exposed to the video stimulus for only 40 minutes per day from 2 days of age onwards. Chicks are extremely likely to imprint onto each other when reared socially (Guiton, 1959; Bolhuis, 1991; van Kampen and de Vos, 1995). Such filial imprinting is considered likely to "block" imprinting onto a novel stimulus i.e. attachment to a novel object is impaired when it is presented together with an object to which the chick has been imprinted previously (van Kampen and de Vos, 1995; van Kampen, 1996), in this case, its siblings. Likewise, imprinting on to siblings could "overshadow" imprinting onto a novel object i.e. attachment to either of two simultaneous stimuli is impaired by the presence of the other (van Kampen and de Vos, 1995; van Kampen, 1996). It has also been documented that chicks can become familiarized with potential imprinting objects without ever developing filial responses to them (van Kampen, 1993; Bateson and Horn, 1994). Furthermore, when similar symbolic video images were shown to chicks housed in trios, their responses followed a pattern of neutrality on day 1, avoidance on day 3 and then progressively increasing approach on successive days, rather than a steady increase in approach and following (Jones et al., 1998).

The interpretation of avian open-field behaviour is controversial (Gallup and Suarez, 1980; Jones, 1987b; 1989) and it has been discussed in terms of fear, social motivation, predator defence, arousal, and exploration (Jones, 1989; 1996). For example, it has been proposed that the usual method of conducting open-field tests unwittingly subjects animals both to a simulated predatory encounter with a human during removal from the home cage and placement in the open field, as well as sudden social separation from familiar conspecifics (Gallup and Suarez, 1980; Suarez and Gallup, 1981; 1982; 1983b). Consequently, these authors argued that open-field behaviour can be viewed as a compromise between opposing tendencies to reinstate contact with their companions and to evade predation by remaining still and silent (Gallup and Suarez, 1980, Suarez and Gallup, 1983b). However, many of the effects of environmental, social, pharmacological and genetic manipulations conform to an interpretation of open-field behaviour based on fear (Faure et al., 1983; Jones, 1987b; 1996). Furthermore, social reinstatement and exploratory behaviours can only be expressed when the inhibitory effects of fear have waned sufficiently (Jones, 1987b; 1989). Therefore, birds that remain silent and inactive in an open field are widely considered to be more frightened than those which vocalize, ambulate and/or explore the environment (Ossenkopp, 1980; Faure et al., 1983; Jones, 1987b; 1989; 1996). The fact that SS chicks walked significantly more and tended to vocalize sooner and more than controls in the absence of the video in Experiment 1 actually suggested that previous video stimulation may have reduced underlying fearfulness, i.e. the propensity to be easily frightened by a wide range of potentially alarming stimuli (Jones, 1996; 1997). This suggestion was strongly supported by the results of Experiment 2 in which the familiar video was not shown during open-field testing. Here, chicks that had received regular exposure to a composite video of five screensavers showed significantly shorter durations of freezing (a high intensity fear behaviour), walked more and tended to vocalize sooner in the open field than those that had received no such stimulation.

Environmental enrichment involves increasing the complexity and stimulus value of the home cage and it is usually achieved by the introduction of conspicuous objects, pictures, pecking stimuli or coloured walls (Gvaryahu et al., 1989; Reed et al., 1993; Jones, 1996). Not only may this procedure increase the behavioural repertoire and perhaps help satisfy animals' need for stimulation (Mench, 1994; Newberry, 1995; Jones, 1996), but it is also thought to decrease chickens' fear of unfamiliar places, objects and food (Broom, 1969; Jones, 1982; 1986; Gvaryahu et al., 1989; Jones and Waddington, 1992; Reed et al., 1993; Jones, 1996). The apparent reduction of fear following regular exposure to SS videos observed in the present experiments suggests that such video stimulation may also have functioned as a form of environmental enrichment, at least in the context of open-field tests.

The majority of intensively housed poultry are reared in barren, invariant environments and this practice can cause behavioural problems such boredom, feather pecking and heightened fearfulness (Wemesfelder, 1990; Vestergaard et al., 1993; Jones, 1996; 1997). Intense or prolonged fear can seriously harm chickens' welfare and productivity. For example, when disturbed, frightened chickens often show inappropriate responses such as panic and escape, often running into obstacles or trampling one another (Mills and Faure, 1990b; Jones, 1996; 1997). In turn, this can lead to injuries, chronic pain, infection and sometimes even the death of the bird (Jones, 1987a; Mills and Faure, 1990b; Jones, 1996). Because environmental enrichment can reduce fear in chickens (see above), the present results may have strategic implications. Video stimulation is already used to enrich the lives of captive primates (Washburn and

Rumbaugh, 1992; Platt and Novak, 1997) and it is possible that projected images could provide highly visible sources of diverse and easily varied visual stimulation in poultry sheds (Jones, 1996). This concept is fully discussed in **Chapter 7**.

CHAPTER 5

Responses of adult laying hens to abstract video images presented repeatedly outside the home cage

5.1 Introduction

Environmental enrichment involves increasing the complexity and stimulus value of the home cage of a captive animal, and is usually achieved by the incorporation of diverse objects, pecking stimuli, or pictures (Jones, 1996). Indeed, Mench (1994) points out that "investigating novel aspects of environments….appears to have particular value for animals". Recently, there has been increased interest in using video stimulation as a form of environmental enrichment, at least for laboratory primates (Washburn and Rumbaugh, 1992; Andrews and Rosenblum, 1993; Lincoln et al., 1994; 1995; Platt and Novak, 1997) and for pet cats (PetAVision Inc., Morgantown, WV, USA). For example, primates readily perform 'video tasks'; they will manipulate a computer joystick to solve an on-screen problem in order to receive a food pellet or to view video images of conspecifics (Rumbaugh et al., 1989; Washburn et al., 1990; Andrews and Rosenblum, 1993; Washburn and Hopkins, 1994). Additionally, rhesus monkeys readily watched videos of conspecifics and humans and exposure to these stimuli increased their activity (Platt and Novak, 1997). This latter result is particularly encouraging because it has been suggested that one of the aims of environmental enrichment is to increase an animal's behavioural repertoire beyond that of responding to the enrichment device (Mench, 1994; Platt and Novak, 1997). Televised images are currently being used as a form of environmental enrichment for primates kept at Twycross Zoo, Warwickshire, UK (from television documentary entitled 'Molly's Zoo', British Broadcasting Corporation, 1998). Additionally, commercially available videos have been produced specifically to 'entertain' pet cats. For example, 'Video Catnip' (PetAVision Inc., Morgantown, WV, USA) and 'Cat TV' (Global Video Inc., d.b.a. Media West Home Video, Lake Grove, OR, USA) contain edited compilations of animals such as birds, squirrels, chipmunks and fish and anecdotal evidence suggests that 'Video Catnip' is "most effective on indoor cats" and that "the cats least impressed were [those] that spend most of their lives outdoors" (see http:/www.cattv.com/main.htm, the PetAVision Internet website). One of the main benefits of using video stimulation in this way is that it provides a relatively convenient and safe method of introducing variety into an animal's visual environment. Furthermore, its pervasive nature means that numerous animals can receive such stimulation at any one time (Jones, 1996; Platt and Novak, 1997).

Laboratory monkeys are frequently provided with environmental enrichment because they almost invariably experience a lower level of visual and other sensory stimulation than they would in a natural setting (Platt and Novak, 1997). The same could be said of commercially reared domestic fowl, which are also generally kept in barren, visually impoverished environments. There is growing evidence that this practice can lead to behavioural problems such as heightened fearfulness and boredom that, in turn, can compromise chickens' welfare and performance (Jones, 1996; 1997; Newberry, 1999). Encouragingly, environmental enrichment is known to alleviate some of these problems (see Section **5.4**), at least in the laboratory (Jones, 1996; 1997).

Most studies of enrichment have focused on increasing the level of complexity within the cage. However, there is growing evidence that animals show strong interest in what is beyond their four walls (Newberry, 1995). For example, individually-housed monkeys showed less abnormal behaviour when their cage was situated next to a window (O'Neill, 1989) and farmed foxes preferred a cage with a platform (Mononen et al., 1993) or one that afforded them an unobstructed view of their surroundings (Mononen et al., 1998). Similarly, hens readily looked through spyholes to view novel objects (McKenzie et al., 1998), broiler chickens readily entered areas peripheral to the home pen when these contained novel objects that were changed daily (Newberry, 1999), and playing the radio made laying hens calmer, less aggressive and more productive (Jones and Rayner, 1999). It has also been documented that domestic chicks quickly become attracted to abstract video images displayed on a monitor located just outside their cages (Jones et al., 1996a; 1998). Thus, when either individually or socially housed chicks received daily exposure from 1 to 9 or 11 days of age in their home cages to a blank, illuminated television screen (B) or to a video image of a computer screensaver (SS) they showed progressively greater approach to both stimuli, though the trend was much more pronounced in SS than B chicks (Jones et al., 1996a; 1998). Attraction to SS appeared to plateau after 6 days in grouped chicks, but it did not diminish over the remaining 3 days (Jones et al., 1998).

It is widely recognized that young birds reared in the absence of a mother or siblings may become imprinted onto any of a wide range of inanimate stimuli (Bolhuis, 1991; van Kampen, 1996). This may at least partially explain the strong attraction to SS videos shown by individually caged chicks (Jones et al., 1996a). However, the similar responses shown by birds reared in trios (Jones et al., 1998) suggested that social housing, and the consequent likelihood of filial imprinting, did not prevent attraction and attachment to the abstract videos. There are also sharp changes in lateralization of function in the central nervous system of the chicken during the first few weeks of life (Andrew, 1988; Rogers, 1995; Vallortigara et al., 1997). In other words, there are shifts in bias towards control by the left or the right hemispheres of the forebrain, which are concerned with categorization of stimuli, and with spatial analysis and response to novelty, respectively (Andrew, 1988; Workman and Andrew, 1989; Rogers, 1995). As a result, chicks exhibit definite age-dependent changes in behaviour at these times. For example, chicks are thought to show sharp increases in exploratory behaviour and move further away from the mother hen from 5 days of age onwards (Workman and Andrew, 1989; Vallortigara et al., 1997). Additionally, fear responses in chicks fluctuate during the first week of life; in females, fear levels appear low on days 1 and 2, gradually rise until days 5-7, decline again around day 8, rise sharply again but then become relatively stable from days 9 and 10 onwards (Andrew and Brennan, 1983; 1984; Jones, 1987b; Rogers, 1995). Therefore, it is conceivable that chickens' attraction to or their interest in biologically neutral video images might also vary substantially with age. For this reason, the present study was designed to establish whether or not the responses of young chicks to repeated presentations of screensaver videos outside their home-cage were paralleled in adult laying hens.

In Experiment 1 the responses of individually caged hens were compared when they were presented with either the video image of a computer screensaver stimulus (SS, 'Fish'), a blank but illuminated television monitor (B), or a hide (H) in front of their battery cage for brief periods on each of five consecutive days. The exposure period was extended to 20 days in Experiment 2, which also examined the effects of stimulus change by introducing a new video image ('Doodles') on day 21.

5.2 Experiment 1

5.2.1 Animals and husbandry

Forty-five ISA Brown laying hens were tested at 31 weeks of age in the present experiment. They were individually housed in cages measuring 30 × 45 × 44 cm (width × length × height) in the bottom row of a three-tier battery system (see **Chapter 2** for a full description of husbandry conditions). The wire sides of the cages were covered with stiff beige cardboard two days prior to testing to ensure that each hen was visually isolated from its neighbours on both sides. However, this did not prevent birds from seeing conspecifics housed in the row of cages behind them or in the battery system across the aisle.

5.2.2 Treatments and testing

Constraints imposed by the design of the battery system meant that only three birds at a time could have a clear view of the television monitor when it was presented in front of their cages. Therefore, the 45 hens were arranged into 15 groups of three adjacent birds. Each group was randomly assigned to one of three treatments (5 groups per treatment). Thus, 15 hens were exposed to the video image of the ‘Fish’ screensaver (SS) programme for 10 minutes per day on five consecutive days, 15 were presented with a blank, lit television monitor (B) as a control for screen flicker (see **Chapter 2** for full descriptions of these stimuli), and the remaining 15 saw only a black hide (H) (see below).

I was concealed behind the hide during each observation. This was wheeled into place 1 min before each observation began. It consisted of a sheet of black plastic stretched over a metal frame 54 × 5 × 150 cm (width × length × height) that extended from a 53 × 30 cm base raised 20 cm off the floor. A viewing slit in the plastic at eye-height allowed remote observation. The hide was positioned approximately 50 cm away from the front of the cages and cardboard partitions extended from both sides to reduce the likelihood that birds from the adjacent groups would see the stimuli. During presentation of the SS and B treatments, a video recorder and television monitor were placed on the base in front of the hide. The video recorder was operated from behind the hide to minimize visual contact with the experimenter.

A pilot study showed that hens spent a higher proportion of observational scans with their heads out of the front of the cage when food was present, regardless of whether they were actually feeding or not (40.8 ± 2.9% *vs.* 18.3 ± 1.8%, when food was present or not, respectively; back-transformed means ± standard errors). Therefore, food was removed from each trough 10 minutes before the test stimuli were presented in order to minimize any food-related approach.

During stimulus presentation, the position of each bird within each of the 3 cages in the group was recorded from left to right at five-second intervals during the 10-minute observation period. Thus, each individual's behaviour was noted every 15 seconds and a composite ‘approach’ score was estimated for each bird (e.g. Barnett et al., 1993). The hen scored 3 if its head was through the bars at the front of the cage, 2 if it was in the front half of the cage with its head in, and 1 if it was at the rear of the cage. Because position was recorded 40 times, the approach score ranged from a minimum of 40 to a maximum of 120. Therefore, high scores reflected high approach towards the stimulus.

The orientation of each hen's head was also recorded at each of the above scans and then assigned to one of four categories. These included: Head Out (HO) - the hen's head was outside the cage; Face Forward (FF) - its head was inside the cage but facing the front within a 90° angle; Face Back (FB) - the hen's head was orientated towards the back of the cage, or Face Other (FO) - the hen's head was either directed towards the side or bottom of the cage or it was not visible to the experimenter because the hen was preening. Chickens often use binocular vision to view nearby stimuli (Andrew and Dharmaretnam, 1993) but they view distant stimuli using monocular vision (Dawkins, 1995; Dawkins and Woodington, 1997). Therefore, since the monitor was positioned 50 cm away from the cage, the hens may still have been examining the screen with one eye when they were facing the side. However, for present purposes, I felt that the 90° angle used to label 'Face Front' was an acceptable compromise. Previous studies have also used similar categorisation of response (Sefton, 1976; Jones, 1985a).

The bird's interest (INT) in the stimulus was also assessed by calculating a composite score of Head Out plus Face Front. All scores were expressed as percentages of the total observations. For example, if bird 1 was seen to face the front of its cage on 5 of the 40 scans its score for FF would be 12.5%.

5.2.3 Statistical analysis

A split-plot analysis of variance (ANOVA) for repeated measures (Genstat 5, Release 4.1, 1997) was used to analyze the data. It examined the effects of treatment, repeated exposure and their interactions on approach scores and on the percentages of observations on which INT, FO and FB behaviours occurred, using the group of three adjacent birds (rather than individuals) as the unit of analysis. The orientation results were not normally distributed and were therefore transformed to the logistic (logit) scale to better fit the assumptions of the analysis. Additionally, the null hypotheses that neither the approach nor the interest scores would deviate from neutral values of 80 (signifying neither attraction nor aversion) or of 50%, respectively, were examined within treatment groups for each day using a one-sample *t*-test; with respect to interest scores, means in the logistic scale were analyzed. Because each represented just one of four measures the neutrality scores for FO and FB were 25%. Between-treatment comparisons were made using students *t*-tests (unpaired) of the means in the logistic scale.

5.2.4 Results and discussion

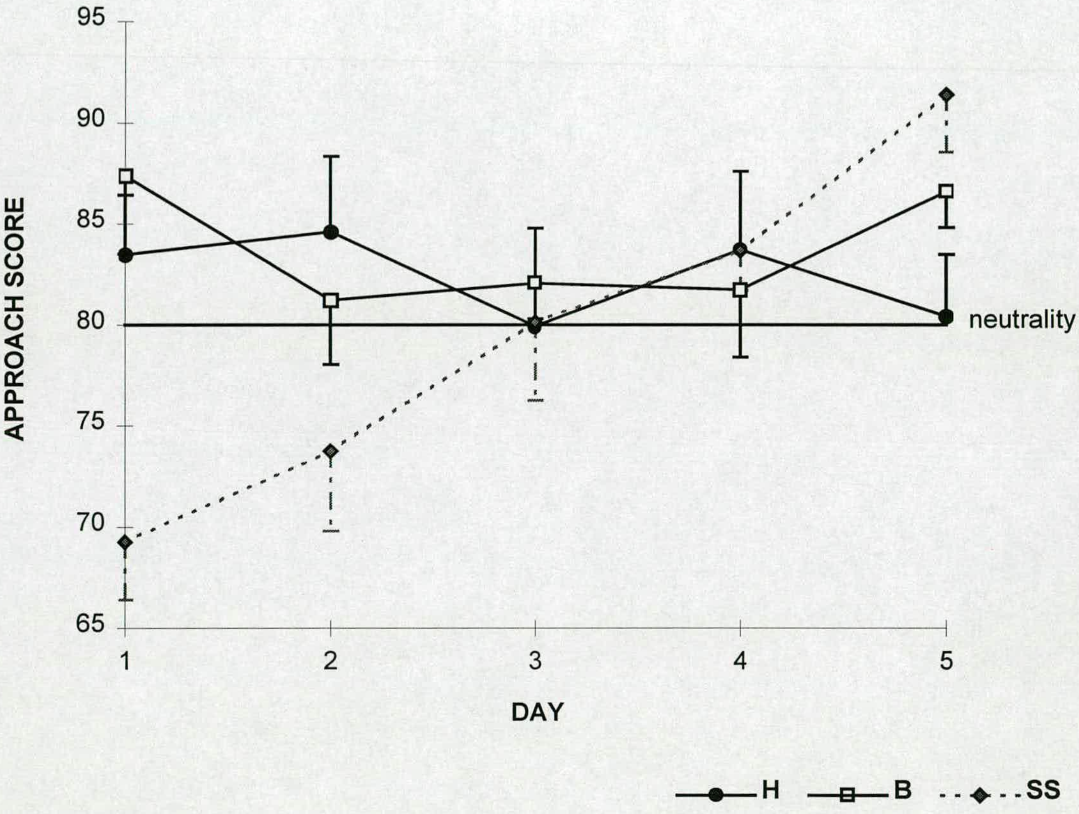


Figure 5.1

Approach scores of individually caged laying hens when they were presented with either a hide (H), a blank illuminated television (B), or a video of a screensaver (SS) at the front of their cages for 10 minutes per day on each of 5 consecutive days. Back-transformed means ± standard errors are based on 5 groups of 3 hens.

There were no significant overall effects of treatment on approach (**Figure 5.1**) towards the stimulus ($F_{2,12}$ = 0.79, *df* = 2, *p* = 0.475,) but there was a significant interaction between day and treatment ($F_{8,48}$ = 3.60, *df* = 8, $p < 0.003$). Approach scores on day 1 fell significantly below neutrality (80) in SS birds (t = -2.50; *df* = 48; $p < 0.02$), suggesting initial avoidance of the stimulus. Thereafter, their approach scores increased; these reached neutrality on day 3 and they were significantly greater than would be expected by chance on day 5 (t = 2.66, *df* = 48, $p < 0.02$). There were no detectable deviations from neutrality in the approach scores of either the B or the H treatment groups at any time.

Treatment exerted no significant overall effect ($F_{2,12}$ = 0.61, *df* = 2, *p* = 0.56) on FB behaviour but there was a significant interaction between treatment and day ($F_{8,48}$ = 3.31, *df* = 8, $p < 0.004$). Significantly more SS hens showed FB on day 1 than did either B (t = 2.86, *df* = 48, p <0.01) or H ones (t = 3.13, *df* = 48, p <0.01) (back-transformed means ± standard errors of 23.3 ± 2.3%, 10.8 ± 4.1% and 14.2 ± 5.1%, respectively). No time trends were apparent in B or H birds but FB fell steadily in SS birds. This finding is consistent with the increasing approach scores of SS hens and it again suggests that although they found the video aversive initially, this aversion waned quickly with repeated exposure.

There was a significant overall effect of treatment on Face Other (FO) behaviour ($F_{2,12}$ = 20.69, *df* = 2, $p < 0.001$); both B and H birds showed significantly more than SS ones (back-transformed means ± standard errors of 28.3 ± 5.7%, 34.9 ± 6.2% and 11.7 ± 3.5%, respectively). There was also a significant interaction between treatment and day ($F_{8,48}$ = 3.26, *df* = 8, $p < 0.005$); both B and H birds showed increasing FO with time compared to SS ones. These results mirrored interest behaviour (see below).

Overall, the SS video elicited significantly more ($F_{2,12}$ = 15.58, *df* = 2, $p < 0.001$) interest (HO plus FF) than did the B or H stimuli (back transformed means and standard errors of 71.2 ± 5.5%, 55.3 ± 6.5% and 45.0 ±6.5%, respectively); there was no significant difference between the 2 latter groups (t = 2.0, *df* = 12, $p > 0.05$). Indeed, the SS birds showed significantly greater INT than would be expected by chance on each of the test days ($t > 2.31$, $df = 48$, $p < 0.05$). The SS video also elicited progressively more interest (Figure 5.2) with repeated exposure ($F_{8,48} = 6.08$, $df = 8$, $p < 0.001$). The B hens showed more than 50% INT on day 1 ($t = 3.64$, $df = 48$, $p < 0.001$) but thereafter, this measure did not deviate significantly from neutrality. Hens showed a neutral response to the hide until day 4 after which INT decreased significantly ($t = -3.75$, $df = 48$, $p < 0.001$).

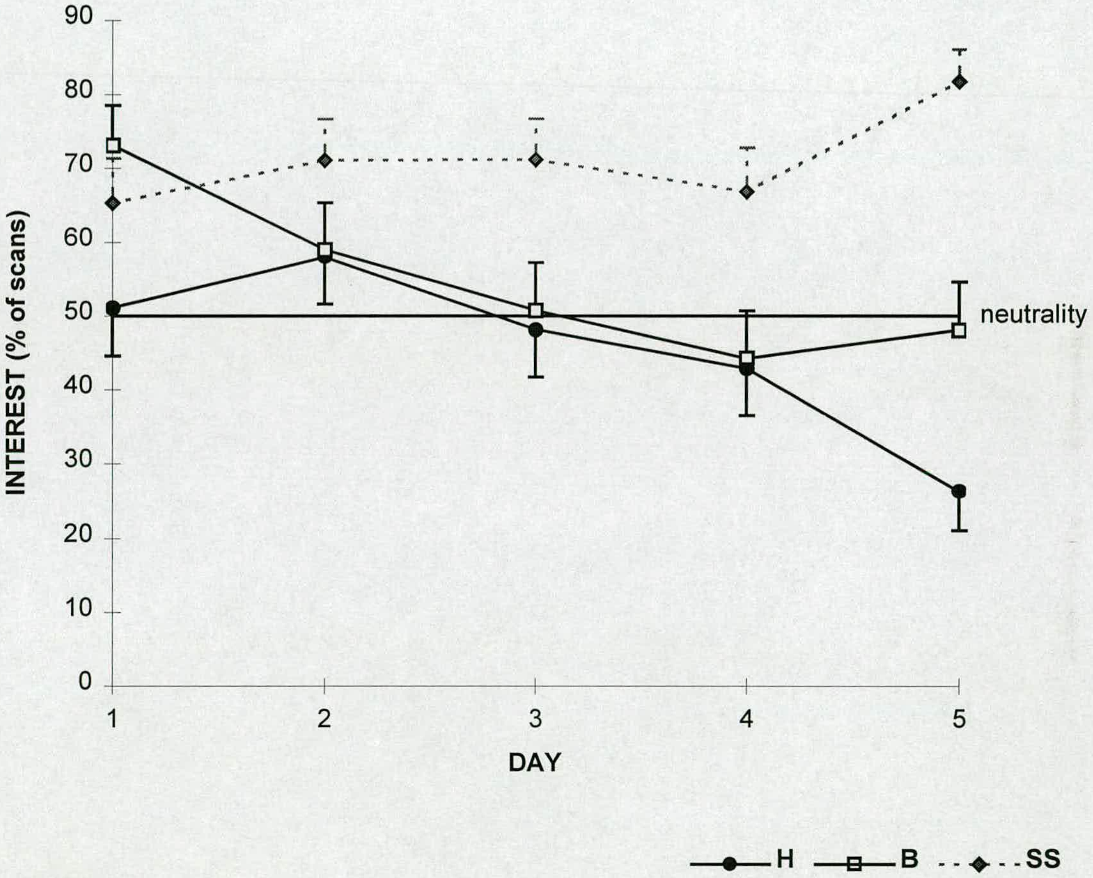


Figure 5.2

Interest (head out + face front) scores (expressed as percentages of the scanning observations made) of individually caged laying hens when they were presented with either a hide (H), a blank illuminated television (B), or a video of a screensaver (SS) at the front of their cages for 10 minutes per day on each of 5 consecutive days. Back-transformed means ± standard errors are based on 5 groups of 3 hens.

The finding that the INT scores of SS hens exceeded neutrality even on day 1 does not conflict with the observation that they showed the lowest approach scores at that time. Their high INT scores on day 1 likely reflected the fact that the birds faced the front, i.e. looked at the video, a lot regardless of their position within the cage.

Collectively, the present results indicate that, following initial avoidance, hens became progressively more interested in the screensaver video whereas interest in the blank television or the hide showed few deviations from neutrality. Thus, there are distinct similarities between the responses of adult hens and young chicks (Jones et al., 1996a; 1998) to SS videos.

The present findings also raised two questions. Firstly, would hens' interest in SS videos increase, be sustained at a steady level, or fall during exposure to the same image for longer than 5 days? Secondly, would stimulus change modify responsiveness? These issues were addressed in the next experiment.

5.3 Experiment 2

5.3.1 Animals and husbandry

Twenty-eight, 19-week-old ISA Brown laying hens were used. They were housed individually in cages, as described in **Chapter 2**, and each cage was separated from adjacent ones by metal partitions. These prevented visual contact between neighbours but, as in Experiment 1, hens housed in cages to the rear and across the aisle were visible.

5.3.2 Treatments and testing

The cages in the present battery system were wider than those used in the previous experiment. Therefore, on this occasion, the hens were assigned to 14 groups of two adjacent birds to ensure that each hen received a full view of the television screen during testing. Because there were no significant differences between hens' responses to the blank, lit monitor and the hide in Experiment 1, the latter treatment was omitted from the present experiment. Thus, each group was randomly assigned to one of two treatments (7 groups per each of the SS and B treatments). The birds were exposed for 10 minutes per day on 20 consecutive days to either the 'Fish' screensaver (SS) programme or to a blank, lit television monitor (B) for 21 days. On day 21, the SS birds were presented with a new screensaver video ('Doodles', see **Chapter 2**).

The hens were observed on each of days 1-5 and then on days 8, 11, 14, 17, 20 and 21. Each bird's position in the cage and its head orientation were recorded from left to right every 5 seconds, as in Experiment 1 but this time, since there were only two birds per group, scans were conducted at intervals of 10 rather than 15 seconds. Therefore, body position was recorded 60 times, and the overall approach score ranged from a minimum of 60 to a maximum of 180. Composite scores of interest were also calculated and logit transformed as described above. The data were analysed using similar methods to those described in Experiment 1.

5.3.3 Results and discussion

Overall, approach scores (Figure 5.3) were significantly higher ($F_{1,12} = 6.96$, $df = 2$, $p < 0.03$) in SS than in B hens (116.3 ± 5.3 and 107.1 ± 4.6, back-transformed means ± standard errors, respectively). There was also a significant interaction of treatment and day ($F_{10,120} = 2.00$, $df = 10$, $p < 0.04$). Both SS and B hens showed lower approach scores than would be expected by chance on day 1 ($t = -4.55$ and -3.77, respectively, $df = 120$, $p < 0.001$), thus suggesting initial avoidance of the stimuli, as in Experiment 1. Hens in both treatments then showed increasing approach scores that reached neutrality on day 3. Thereafter, approach scores fell in B hens and, with the exception of days 8 and 17, remained less than expected by chance ($t > 2.05$, $df = 120$, $p < 0.05$). On the other hand, those of SS birds hardly deviated from neutrality, indicating neither significant approach nor avoidance. Interestingly though, they showed much greater approach than B hens on day 21 when a new SS image was presented ($t = 3.63$, $df = 120$, $p < 0.001$).

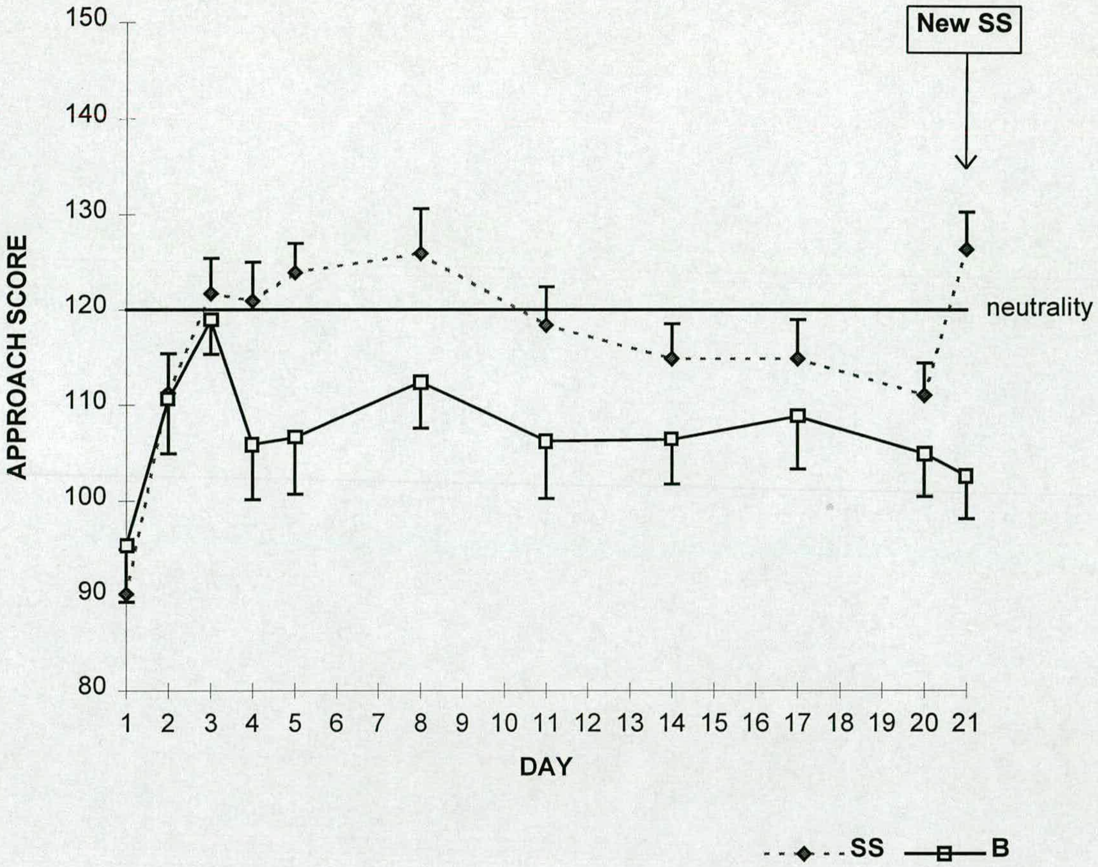


Figure 5.3

Approach scores of individually caged laying hens when they were presented with either a blank illuminated television (B) or a video of a screensaver (SS) at the front of their cages for 10 minutes per day on each of 21 and 20 consecutive days, respectively. The SS birds were exposed to a different SS on day 21. Back-transformed means ± standard errors are based on 7 groups of 2 hens.

Treatment significantly affected overall FB behaviour ($F_{1,12} = 6.33$, $df = 1$, $p < 0.03$). SS hens showed significantly less FB than did B ones (16.8 ± 2.3% and 23.8 ± 2.8%, back-transformed means ± standard errors, respectively). There was also a significant day/treatment interaction ($F_{10,120} = 2.02$, *df* = 10, $p < 0.04$). SS hens showed steadily decreasing FB which fell significantly ($t = -2.15$, *df* = 120, $p < 0.05$) below chance (25%) by day 4. After day 8, FB behaviour increased slightly, but then fell significantly below neutrality again ($t = -2.62$, *df* = 120, $p < 0.01$) when the new SS was shown on day 21. Hens in the B treatment also showed decreasing FB for the first 3 days but thereafter they did not deviate significantly from the neutral score of 25%. In other words, FB behaviour mirrored that of approach.

Overall, SS birds showed significantly less ($F_{1,12} = 18.01$, *df* = 1, $p < 0.002$) FO behaviour than did B ones (16.4 ± 1.9% and 26.8 ± 2.5%, back-transformed means ± standard errors, respectively). There was also a significant interaction between day and treatment ($F_{10,120} = 3.00$, *df* = 10, $p < 0.003$). FO was significantly less (t always < -2.3, *df* = 120, p always < 0.05) than expected by chance (25%) in SS hens until day 11. It then surpassed 25% but fell again when the birds were exposed to the new SS on day 21. Hens in the B treatment showed increasing FO which exceeded 25% as early as day 5 and was greater than chance by day 14 ($t = 2.22$, *df* = 120, $p < 0.05$).

Treatment also affected overall interest (INT) scores (Figure 5.4); these were significantly greater in SS than in B hens (58.5 ± 2.9% and 37.4 ± 2.8%, back-transformed means ± standard errors, respectively ($F_{1,12} = 37.54$, *df* = 2, $P < 0.001$). There was also a significant interaction between treatment and time ($F_{10,120} = 8.45$, *df* = 10, $p < 0.001$). The SS hens showed significantly greater interest than would be expected by chance on each of days 3 ($t = 2.39$, *df* = 120, $p < 0.02$), 4 ($t = 3.39$, *df* = 120, $p < 0.001$), 5 ($t = 3.65$, *df* = 120, $p < 0.001$), and 8 ($t = 2.71$, *df* = 120, $p < 0.01$). A numerical trend towards greater interest values than neutrality on day 11 failed to reach significance ($t = 0.81$, *df* = 120, $p > 0.2$) and the scores fell slightly below the 50% level on days 14, 17 and 20. However, positive interest, i.e. greater than neutrality, was re-established on day 21 when the SS birds were presented with the new SS image ($t = 3.87$, *df* = 120, $p < 0.001$). Interest was slightly but non-significantly greater than neutrality in B hens on days 2 and 3 but it waned rapidly thereafter; indeed from day 11 onwards the scores fell significantly below the 50% level (p always < 0.01).

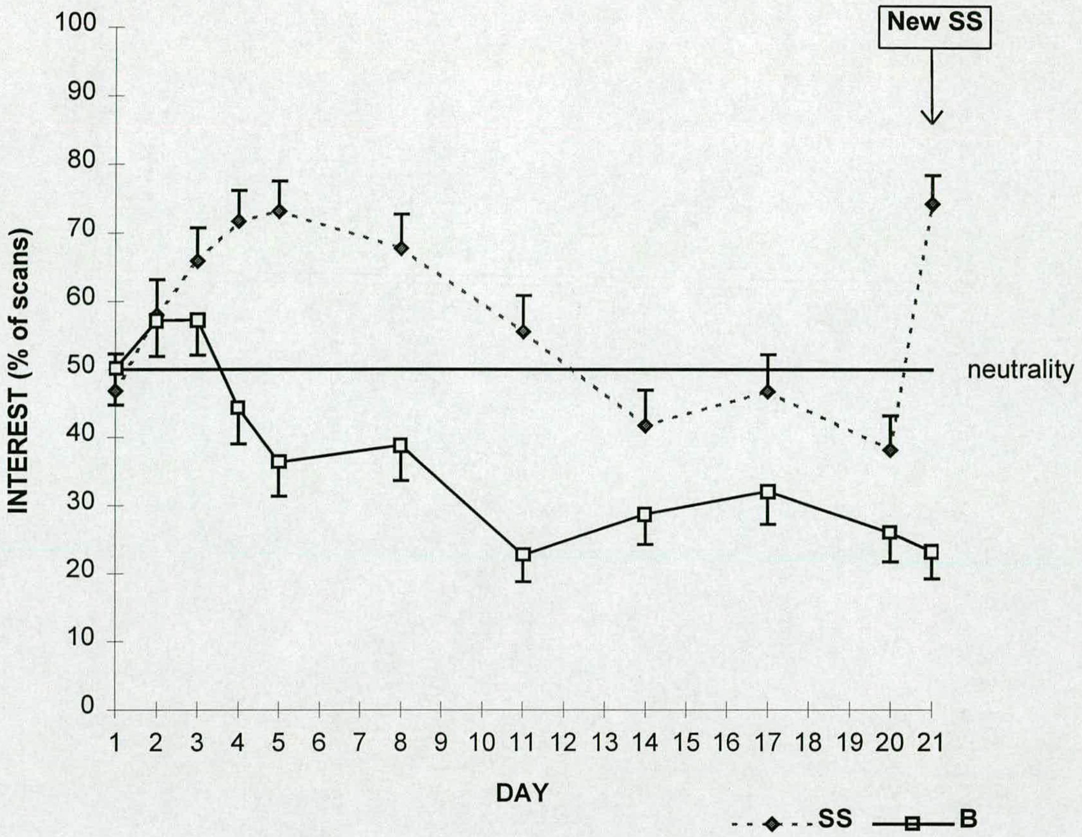


Figure 5.4

Interest (head out + face front) scores (expressed as percentages of the scanning observations made) of individually caged laying hens when they were presented with either a blank illuminated television (B) or a video of a screensaver (SS) at the front of their cages for 10 minutes per day on each of 21 and 20 consecutive days, respectively. The SS birds were exposed to a different SS on day 21. Back-transformed means ± standard errors are based on 7 groups of 2 hens.

Collectively, these results indicate that the birds were initially wary of both the B and SS stimuli. SS hens soon began to show significant interest in the video image which was sustained till at least day 8. Interest then waned with continued daily exposure but it was fully reinstated when a new SS image was presented. Conversely, not only did a blank, lit television screen fail to elicit significant interest at any time during the 21-day observation period but the scores consistently fell below neutrality from day 5 onwards.

5.4 Discussion

The responses of adult laying hens to the biologically neutral video images (screensavers) used in the present study were similar in many respects to those shown by young domestic chicks to similar videos (Jones et al., 1996a; 1998). Thus, following initial avoidance, individually-housed hens showed increasing approach towards and interest in the video image of a computer screensaver (SS) when it was presented at the front of their home cages for 10 minutes per day on consecutive days. Such interest was maintained from days 3 to 5 (when the study was terminated) in Experiment 1 and until at least day 8 in Experiment 2. Similarly, individually housed chicks were attracted to the same 'Fish' screensaver video from days 5 through 11 (Jones et al., 1996a) while socially housed ones showed positive attraction as early as the third exposure; this then increased before reaching a plateau at day 6 (Jones et al., 1998). The present adult parallel to video-induced effects in chicks clearly demonstrates that attraction towards and interest in abstract video images is not dependent on the chickens' stage of development. In other words, there is no apparent sensitive period for the development of this phenomenon. Thus, it is not necessary for chickens to receive their first exposure to a video when exploratory behaviour and/or fear levels are at their lowest, i.e. 1-2 days of age (Kruijt, 1964; Andrews and Brennan, 1983; Rogers, 1995; Vallortigara et al., 1997) (see **Section 5.1**). The current parallel is supported by the studies described in **Chapter 3**, where adult hens' responses towards videos of conspecifics presented at one end of a runway were similar, at least numerically, to those shown by chicks.

There is at least one interesting dissimilarity between the present findings and those obtained in individually housed chicks (Jones et al., 1996a) though. In the latter study, the chicks became attracted to the blank, illuminated television screens (B) as well as to the screensaver and it was consequently suggested that both flicker, which is known to attract young chicks (James, 1959; Bateson and Reese, 1969; Jones et al., 1996a), and the presence of the television monitor itself were sufficient to make this simple stimulus attractive (Jones et al., 1996a). In the present studies, though, the B stimulus elicited no more interest than would be expected by chance in either experiment; indeed, it elicited significant avoidance or disinterest in Experiment 2. This suggests that the responses of the hens in the SS treatment group reflected attraction to the content of the video playback rather than to screen flicker or to the television monitor *per se*.

Because novelty is a potent fear-elicitor (Jones, 1987a; Jones, 1996), the initial avoidance (on days 1 and 2) of the SS video in Experiment 1 and of both the SS and B stimuli in Experiment 2 likely reflects neophobia. These early neophobic reactions were more pronounced when the SS video rather than the blank screen was shown, at least in Experiment 1. Fear is considered to be positively related to the novelty, intensity and / or complexity of the stimulus (Clayton and Andrew, 1979; Jones, 1987a). Therefore, this finding was not unexpected because the SS stimulus possessed the additional features of shape, colour and movement.

Like most animals, chickens often habituate (learn not to respond) rapidly upon the repeated presentation of a stimulus (Appleby et al., 1992; Rogers, 1995; Jones, 1996). For example, hens ceased to peck at simple objects introduced into their cages (Sherwin, 1991) and chicks soon approached rather than avoided human beings after repeated visual contact (Jones, 1995; 1996). Similarly, although the SS videos sustained interest for at least 8 days here, this decreased thereafter. It must also be pointed out that the birds were only exposed to SS for 10 min per day and that habituation might have been more rapid had they received continuous exposure. However, the finding in Experiment 2 that the SS birds showed fully renewed responsiveness when a different video image was presented on day 21 is interesting and strategically relevant for at least two reasons. Firstly, since novelty generally elicits fear (Jones, 1987a; 1996) we might have expected avoidance rather than strong interest. However, regular video stimulation reduced chicks' subsequent fear of an unfamiliar environment (**Chapter 4**; Clarke and Jones, 1999a) and chicks with previous experience of one type of SS video often preferred another in a two-choice test (Jones et al, 1996a). A similar phenomenon may have occurred here and thereby allowed the expression of an attraction towards mild to moderate novelty. Secondly, hens' interest in videos might be sustained indefinitely if the images were changed at regular intervals.

Collectively, the present findings may have strategic implications for the development of environmental enrichment procedures. As mentioned previously, chickens that receive limited sensory information are more likely to show heightened fearfulness, boredom and aggression; these potentially harmful states can seriously compromise their welfare and performance (Jones, 1996; 1997; Newberry, 1999). Environmental enrichment, usually achieved by the incorporation of diverse objects, pecking stimuli, or pictures, can reduce fear and feather pecking and improve productivity (Jones, 1982; Vestergaard, 1989; Jones and Waddington, 1992; Nicol, 1992; Gvaryahu et al., 1994; Jones, 1996). It has been suggested that video stimulation *per se* could be used to provide environmental enrichment, at least for captive primates (Washburn and Rumbaugh, 1992; Platt and Novak, 1997). It is also conceivable that images could be projected on to the walls and roofs of poultry sheds to increase the complexity of the visual environment for intensively housed chickens (Jones, 1996). This methodology has the added advantage that the stimuli could be easily changed thus perhaps helping to overcome the potential problem of habituation that is seen when static devices are used. Finally, the present findings and those of Jones et al. (1996a; 1998) clearly demonstrate that both chicks and adult laying hens were readily attracted to abstract video images presented outside their cages, and they further illustrate the importance of enriching the environment outside as well as inside the cage. The potential strategic relevance of this work is further discussed in **Chapter 7**.

CHAPTER 6

Which selected components of an abstract video image are attractive to domestic chicks?

6.1 Introduction

Previous studies had shown that both individually- and socially-housed chicks became readily attracted to the video images of the Apple Macintosh 'Fish' or 'Flying Toaster' screensaver programmes (see **Chapter 2** for detailed descriptions) when these were presented to them in their home boxes for periods of 5 minutes on each of 9 or 11 consecutive days (Jones et al, 1996a; 1998). The 'Fish' video also attracted and sustained adult hens' interest when it was presented outside their home cages for brief periods on several consecutive days (**Chapter 5**; Clarke and Jones, 1999b). Chicks that had received regular exposure to the 'Fish' video then showed strong attraction to it when it was presented to them in an otherwise novel two-choice runway test (Jones et al., 1996a; 1998) as well as in a different type of novel environment, i.e., open field (**Chapter 4**; Clarke and Jones, 1999a). Furthermore, regular video stimulation significantly reduced chicks' fear responses in an open field even in the absence of the video image (**Chapter 4**; Clarke and Jones, 1999a). Such reduction of fear and elicitation of interest is consistent with previous suggestions that video playback might represent a form of environmental enrichment (see **Chapters 4** and **5**). For example, laboratory primates readily interacted with video equipment, watched video images over prolonged periods, and increased their activity when exposed to them (Andrews and Rosenblum, 1993; Lincoln et al., 1994; 1995; Brent and Stone, 1996; Platt and Novak, 1997).

The nature of enrichment stimuli is likely to be important in eliciting the desired effects (Mench, 1994; Jones, 1996). Indeed, some attempts at environmental enrichment have actually elicited adverse effects. For example, the provision of broken bricks and flowerpots resulted in more aggression in mice (McGregor and

Ayling, 1990) and chickens housed in a room equipped with straw, shoe laces, plastic rods and 'Agro-Toys' actually showed increased feather pecking (Lindberg and Nicol, 1994). Many animals also rapidly lose interest in some putative environmental enrichment stimuli (Sherwin, 1991; 1993; Jones, 1996). Various authors have warned that, despite this, little thought has been given to the type of stimuli that animals might prefer or that would benefit them most (Mench, 1994; Newberry, 1995; Jones, 1996). For example, Mench (1994) pointed out that "unfortunately….it sometimes appears that the selection of enrichment devices depends more on their durability, availability, cost, or appeal to the investigator (or to the company marketing them) than for any properties relevant to the animal". Newberry (1995) also proposed that "a common shortcoming of attempts at environmental enrichment is that the provision of toys, music, or other stimuli has little functional reference to the animals" and she suggested that "there is a need for greater thought regarding the design of [enrichment] objects to achieve specific goals". However, the catalogue of enrichment objects is extensive and varied. For example, rods, hose pipes, chains, tyres, shoe laces, aluminium foil, balls, baubles, leg bands, flowers, chairs, straw and string have all been utilised in various studies (Lindberg and Nicol, 1994; Newberry, 1995; Jones, 1996; Mench et al., 1998; Jones and Carmichael, 1998; 1999b, Sherwin et al., 1999).

The present studies were designed to dissect the Fish screensaver image and to determine which of its components, e.g. movement, brightness, colour, complexity, were important in eliciting and sustaining chicks' attraction/interest. This was done by simultaneously presenting chicks with two video stimuli differing in one of the above features at each end of the home box for five minutes on each of 10 consecutive days and observing the development of approach/avoidance behaviour.

Preference tests are not without controversy (Hughes, 1977; Duncan, 1978; van Rooijen, 1982; Bayne et al., 1991; Mench, 1994; Fraser and Matthews, 1997). For example, some authors have suggested that they raise difficulties of interpretation (Dawkins, 1977; Duncan, 1977; Duncan, 1978; Mench, 1994) and that preference testing demands careful experimental design and analysis (Hughes, 1977; Duncan, 1978; Mench, 1994; Fraser and Matthews, 1997). However, that sentiment applies to all scientific studies. It has also been argued that preference tests provide limited information because of the difficulty in determining short versus long-term preferences (Duncan, 1978; van Rooijen, 1982; Mench, 1994). Despite such reservations, it has been proposed that preference tests at least allow for some determination of what is attractive to the animal (Hughes, 1977; Bayne et al., 1991; Jones and Carmichael, 1999c) and that "if the various stimuli are equally healthful (or neutral), the observer may be able to draw conclusions about those stimuli to which the animal prefers being exposed" (Bayne et al., 1991).

It has been reported that domestic chicks established strong preferences for one half or other of a seemingly symmetrical home cage (Jones and Carmichael, 1999c). Therefore, Experiment 1 was designed to provide base-line information regarding how chicks distributed themselves within the home box in the absence of video stimuli. In subsequent studies, chicks were simultaneously presented with two televised stimuli that differed in one respect each time. In Experiment 2, chicks' responses towards moving vs. still Fish screensaver videos were investigated. In Experiment 3, bright vs. dull Fish screensaver videos were used; bright vs. dull blank, lit televisions were also included to determine chicks' responses towards stimuli differing in brightness but that incorporated no discernible shapes, colour or movement. In Experiment 4, chicks' responses to a coloured Fish screensaver video were compared with those to a black & white version of the same stimulus. The relative attractiveness of simple vs. complex video images was then assessed in two further experiments. Firstly, the Fish screensaver video was used as the complex image and was tested against that of a simple screensaver programme depicting one bouncing square (Experiment 5). Secondly, chicks' responses to a video incorporating an intuitively greater level of complexity was studied; here, the Fish screensaver image was used as the simple stimulus and tested against an excerpt from an episode of The Simpsons™ cartoon (Experiment 6).

6.2 Materials and Methods

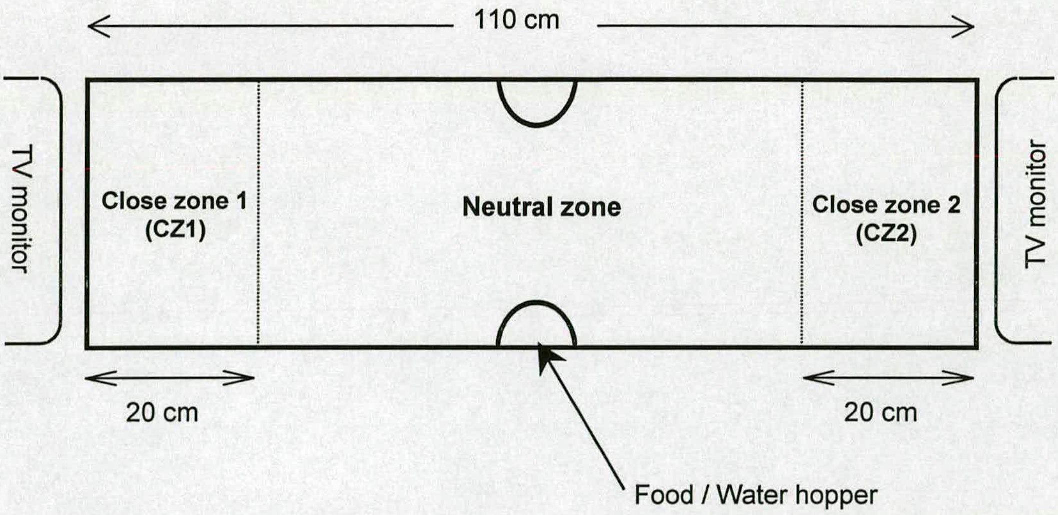
6.2.1 Animals and husbandry

Twenty-four (Experiment 1) or 54 (Experiments 2 – 6) female ISA Brown chicks were randomly allocated to groups of three and housed in wooden boxes as previously described (**Chapter 2**). Chicks housed in small groups tend to remain in close proximity to one another (Jones and Carmichael, 1999c) and, for practical purposes, a decision was made to observe the behaviour of just one chick in each box. This focal chick was chosen at random and its head was marked with black indelible ink to facilitate later identification. The food and water dishes were placed directly opposite one another in the centre of the home box (Figure 6.1). The chicks were then left undisturbed for the first 24 hours.

6.2.2 Treatments and testing

To help record the focal chick's position during observations, the home box was divided into 3 parallel zones; the 20-cm long sections of the box nearest the end walls were labelled 'close zone 1' (CZ1) and 'close zone 2' (CZ2) and the remaining section (70 cm long) comprised the 'neutral zone' (Figure 6.1). A micro camera linked to a playback monitor (television monitor and video recorder combined) was positioned over the home box (see **Chapter 2**). An acetate sheet was placed over the television screen and the positions of the zones were marked on it (Figure 6.1). This arrangement enabled the focal chick's behaviour to be observed remotely and back-up videotape records to be made.

From 2 to 11 days of age, the behaviour of the focal chicks was observed for 5 minutes per day, either in the absence of any extraneous stimuli (Experiment 1) or during simultaneous exposure to two blank, lit televisions or to two video images positioned at either end of the home box (Experiments 2 – 6).



Key

………… = Lines marked on to an acetate sheet placed over playback monitor screen during remote observation of the chicks' responses. These delineated the 'close zones' (CZ1 and CZ2).

Figure 6.1

Diagrammatic representation of an overhead view of the home box showing labelled zones and positions of the television monitors

One minute before behavioural observations began, all three chicks were herded into a 1-cm wire mesh box measuring 29 × 15 × 30 cm (length × width × height) and gently moved to the centre of the home box; this standardised their position in the box immediately before observations began. In Experiments 2 – 6, the two televisions showing the blank screens or video stimuli were then moved into place at either end of the home box and the end walls were removed thereby revealing the stimuli to the chicks (see **Chapter 2** for a full description of this procedure). Because removal of the end wall prior to video presentation was considered likely to cause some disturbance, at least initially, the end walls of the boxes containing control chicks that received no video stimulation (Experiment 1) were also removed. In that experiment, wooden boards painted the same colour as the home box were immediately moved into place in order to minimize visual contact with the experimenter or any other extraneous stimuli. In all experiments, the chicks were then left undisturbed for 1 minute, after which the wire mesh cage was lifted thus allowing them full access to the home box. The latency to enter each of the close zones and the accumulated times spent in them were then recorded. The test ceiling was 5 minutes and if a chick failed to enter either of the close zones it received a maximum latency of 300 seconds.

The order in which the home boxes were observed was randomized daily, as were the ends of the box at which the wall was first replaced (Experiment 1) or each televised stimulus was presented (Experiments 2 – 6). Such randomization reduced the likelihood that previously established side preferences (Jones and Carmichael, 1999c) might confound the results.

6.2.3 Data manipulation and statistical analysis

Because the chicks were simultaneously presented with two stimuli at opposite ends of the box, the latencies to enter the close zones were not independent of one another. Therefore, differences between the two latencies were calculated, i.e. (Latency to enter CZ1 – Latency to enter CZ2). Negative values indicated that chicks were quicker to enter CZ1 whereas positive values indicated that they were quicker to enter CZ2. However, it was noted that chicks often tended to 'panic run' away from the centre of the box when the cage was lifted and immediately ('accidentally') enter one of the close zones, regardless of the stimulus that was being presented at that end. They were considered unlikely to have made an 'informed choice' in this case. The statistical analysis (see below) confirmed this tendency in that the latency data showed no significant or logical pattern of response. For that reason, the latency data was omitted from further consideration.

Use of the two-choice situation also meant that the times spent in the close zones were not independent of one another. Therefore, using Experiment 1 as an example, the accumulated time (in seconds) spent in CZ1 (α) was expressed as a percentage of the time spent in CZ1 + CZ2 ($\alpha + \beta$), in order to provide a more critical measure of attraction/preference for one end of the box over the other:

$$SA = 100 \left[\alpha / (\alpha + \beta) \right]$$

This percentage value is considered to reflect **Specific Attraction (SA)**. CZ1 and CZ2 were of equal size so values greater than 50% indicated that chicks spent longer in CZ1 whereas those below 50% signified more time spent in CZ2.

Because the locations of CZ1 and CZ2 remained fixed and the end at which the stimuli were presented was rotated, specific attraction scores of chicks that were exposed to videos or blank, lit televisions stimuli (Experiments 2 – 6) was calculated by expressing the time spent near Video A (α) as a percentage of the time spent near Video A + Video B ($\alpha + \beta$). In these cases, values greater than 50% indicated that chicks spent longer near Video A whereas those below 50% signified more time spent near Video B (see sections 6.4.1., 6.5.1., 6.6.1, 6.7.1 and 6.8.1).

During observations, the chicks could also be situated in the neutral zone rather than in one of the close zones. Therefore, general attraction towards the ends of the box (Experiment 1) or the diametrically opposed video stimuli (Experiments 2 – 6), regardless of preferences, was estimated. Here, the accumulated time (seconds) spent in both CZ1 + CZ2 ($\alpha + \beta$) was expressed as a percentage of the total observation time (300 seconds):

$$GA = 100 \left[(\alpha + \beta) / 300 \right]$$

This percentage value is considered to reflect **General Attraction (GA)** to the close zones. Here, because CZ1 and CZ2 only accounted for a 40-cm length of the 110-cm long home box, values greater or lower than 36.36% signified that the chicks spent more or less time in the close zones than in the neutral zone, respectively.

The need to randomize the end of the box at which the wall was first removed and replaced (Experiment 1) or at which each video was presented (Experiments 2 – 6) meant that the data sets were unbalanced across days. Therefore, a residual maximum likelihood (REML) analysis was used to examine the effects of the ends at which the wall was first replaced (Experiment 1) or the videos were presented (Experiments 2-6), as well as those of repeated exposure and their interactions on SA and GA. In Experiment 2, there were two test conditions (bright vs. dull screensaver video or bright vs. dull blank, lit television) and this factor was also included in the data analysis for that experiment. REML is an extension of an analysis of variance but one that allows examination of unbalanced data sets obtained from repeated measures (Genstat 5, Version 4.1, 1997). To obtain probability (*p*) values, the Wald statistic provided by the analysis output is divided by the degrees of freedom (*df*) for the factor analysed (e.g. *df* for day = 9) and compared with an F-distribution at the *df* for factor and the *df* for group, e.g. 7 (Experiment 1), 16 (Experiment 2) or 17 (Experiments 3-6). The SA and GA data sets did not follow a normal distribution and were therefore transformed to the logistic (logit) scale to better fit the assumptions of the analysis. The null hypothesis that SA and GA would not deviate from the neutral values of 50% and 36.36%, respectively, was also examined within days using a one-sample *t*-test of means in the logistic scale. Comparisons between test conditions (Experiment 2) were made using two-sample (unpaired) *t*-tests of means in the logistic scale.

6.3 Experiment 1 – Distribution of chicks in the absence of video stimuli

This experiment was conducted to determine how chicks distributed themselves within the home box in the absence of any video stimuli and to establish whether or not they showed preferences for one side or another. This information would then provide a base line with which to compare (though not statistically) the results of subsequent experiments that incorporated video exposure.

6.3.1 Treatments and testing

Eight groups of three chicks were used but the responses of just one focal chick per group were recorded. The test procedures, behaviours measured and statistical analyses were as described in the Materials and Methods (6.2).

6.3.2 Results and Discussion

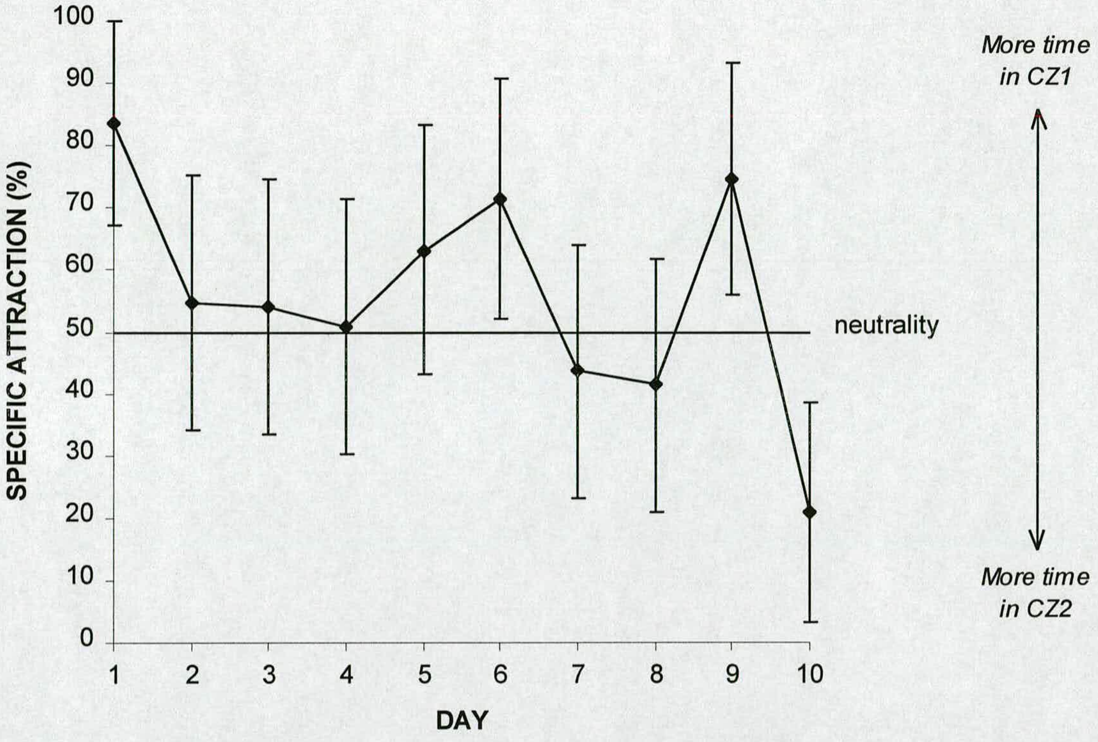


Figure 6.2

Chicks' 'specific attraction' (SA) scores (time spent in CZ1 as a percentage of the total time spent in CZ1 + CZ2) for each end of their home box during a 5 minute observation period on each of 10 consecutive days; back-transformed means ± standard errors, n = 8.

There was no overall effect of day (Wald statistic = 5.8, *df* = 9, $F_{9,7} = 0.6$, $p > 0.1$) or of the end at which the wall was first replaced (Wald statistic = 0.2, *df* = 1, $F_{1,7} = 0.2$, $p > 0.1$) and no significant interactions (Wald statistic = 2.5, *df* = 9, $F_{9,7} = 0.3$, $p > 0.1$) on specific attraction (SA) scores. The finding that SA did not deviate significantly from the neutral value of 50% (t never > 1.39, *df* = 7, $p > 0.1$) on any of the test days (Figure 6.2) indicated that the chicks showed no overall preference for either of the close zones.

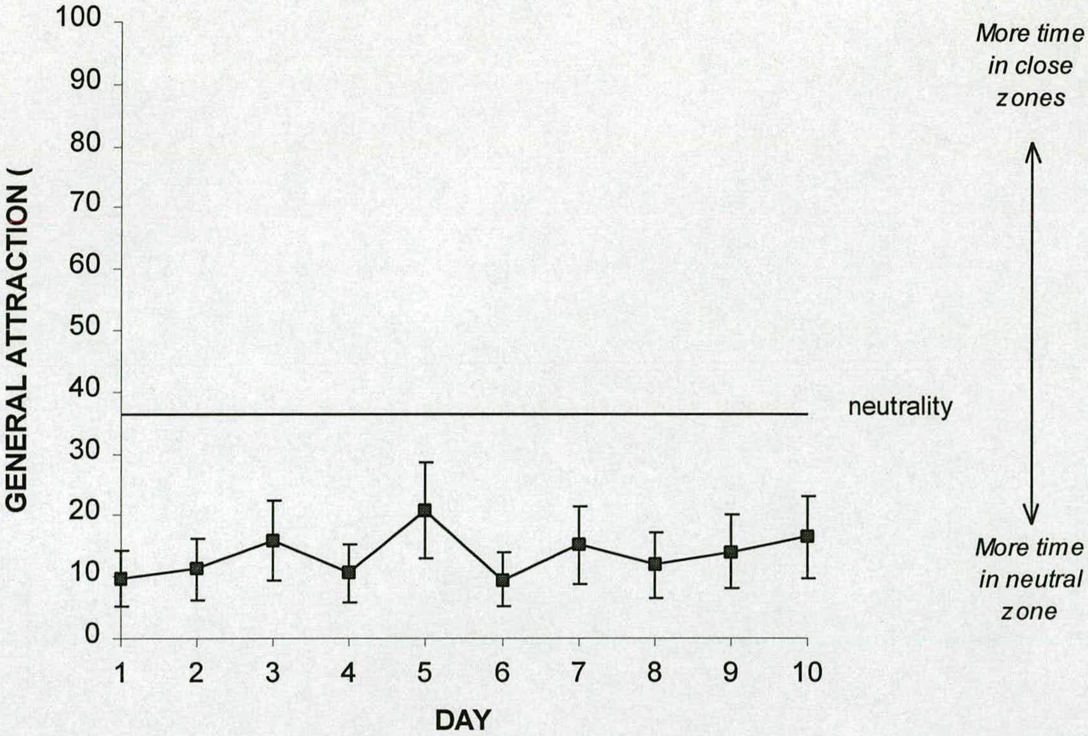


Figure 6.3

Chicks' 'general attraction' (GA) scores (time spent in close zones as a percentage of the 300 second observation time) during a 5 minute observation period on each of 10 consecutive days; back-transformed means ± standard errors, n = 8.

Neither were there any significant effects of day (Wald statistic = 4.7, *df* = 9, $F_{9,7} = 0.52$, $p > 0.1$), of end at which the wall was first replaced (Wald statistic = 0.7, *df* = 1, $F_{1,7} = 0.7$, $p > 0.1$) or their interaction (Wald statistic = 16.5, *df* = 9, $F_{9,7} = 1.8$, $p > 0.1$) on general attraction (GA) scores. The overall GA (13.2 ± 2.5%, back-transformed mean ± standard error) was significantly lower than 36.36% ($t = -6.06$, *df* = 7, $p < 0.001$); this clearly demonstrates that the chicks spent more time in the neutral zone than in the combined close zones. Indeed, the chicks' total GA scores were significantly less than 40% (t always < -2.22, *df* = 7, $p < 0.01$) on each of the test days (Figure 6.3).

Collectively, the present results demonstrated that the chicks showed no overall preference for one end or other of the home box. Not surprisingly, given that there was no extraneous stimulation in the close zones, they spent more time in the larger neutral zone. These findings suggest that the times spent in each of the two close zones when different videos were presented simultaneously at each end of the home box in the subsequent experiments would be acceptable measures of their relative attractiveness.

6.4 Experiment 2 – Moving vs. still video

Newly-hatched chicks readily approach and follow moving, conspicuous stimuli (Sluckin, 1972; Bolhuis, 1991). Indeed, moving three-dimensional objects or two-dimensional patterns projected onto screens are often used as stimuli in imprinting studies (Bolhuis, 1999). Because movement is thought to increase the attractiveness of an imprinting object (Sluckin, 1972; Hoffman, 1978; Eiserer, 1980; Ten Cate, 1989; Bolhuis, 1991), it is conceivable that the movement of the Fish screensaver may have been particularly important in attracting chicks (Jones et al., 1996a; 1998) and adult laying hens (**Chapter 5**; Clarke and Jones, 1999b) in earlier studies. This issue was addressed in the present experiment by comparing chicks' responses to moving and static images of the Fish screensaver when these were presented simultaneously at opposite ends of their box for five minutes on each of 10 consecutive days.

6.4.1 Treatments and testing

The moving video image was the 'standard' Fish stimulus (see **Chapter 2**), i.e. it had been produced by filming the Fish screensaver from a computer monitor; the median speed had been chosen in the screensaver set-up options. This meant that the depicted images took approximately 19 seconds to cross the screen. The still video was produced by filming a television monitor displaying a video of the same Fish screensaver on pause (see **Chapter 2** for full details of the filming procedures). At test, the brightness, contrast and colour settings on both the television monitors were maintained on standard settings, i.e. the two videos were similar apart from the movement aspects.

Eighteen groups of three chicks were used but the responses of just one focal chick per group were recorded. The order of behavioural observations of the boxes was randomized daily, as was the end of the box at which the moving and still videos were presented. The test procedures, behaviours measured and statistical analyses were as outlined in the Materials and Methods (Section 6.2). Specific attraction (SA) and general attraction (GA) were calculated as follows:

$$SA = 100\ [\ M / (M + S)\ ]$$

and

$$GA = 100\ [\ (M + S) / 300\ ]$$

where M = time (in seconds) spent in the close zone nearest the moving Fish video

S = time (in seconds) spent in the close zone nearest the still Fish video

Thus, if the SA score was larger or smaller than the neutral value of 50% it would denote more or less time, respectively, spent near the moving than the still video image. If the GA score was larger or smaller than the neutral value of 36.36% it would denote more or less time, respectively, spent in the close zones than in the neutral zone.

6.5.2 Results and discussion

There were no significant effects of day (Wald statistic = 9.4, *df* = 9, $F_{9,17} = 1.044$, $p > 0.1$) or of the end of the box at which the stimuli were presented (Wald statistic = 0.3, *df* = 1, $F_{1,17} = 0.3$, $p > 0.1$) on SA, and no significant interaction.

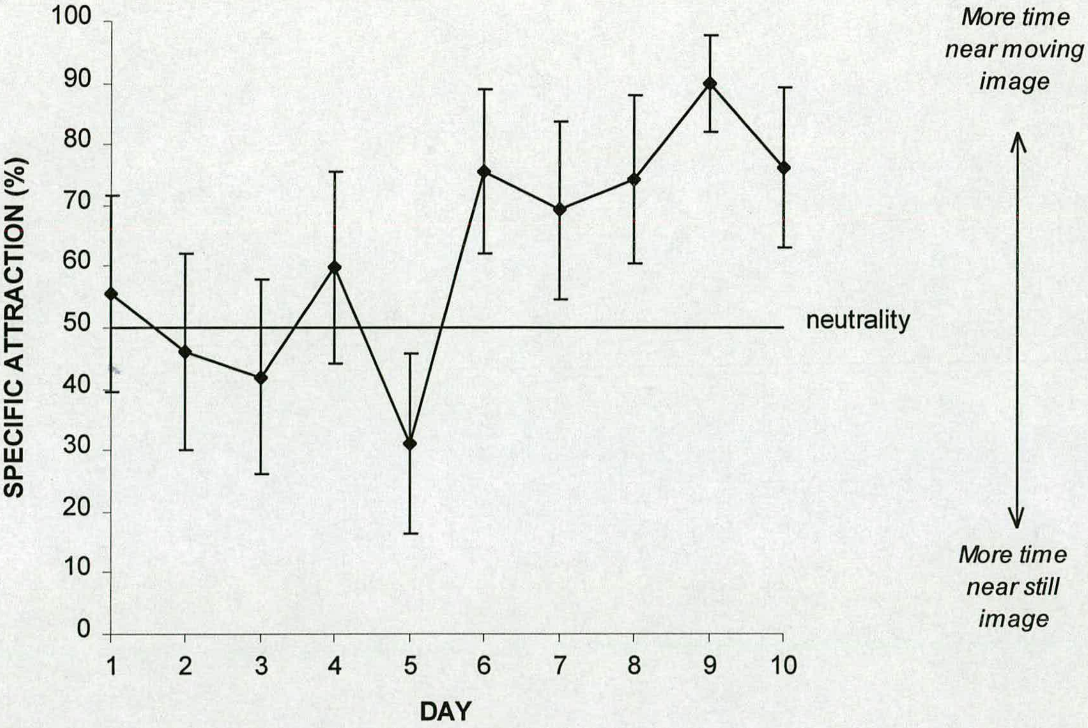


Figure 6.4

Chicks' 'specific attraction' (SA) scores (time spent near moving as a percentage of the time spent near moving + still) when a moving and a still screensaver video were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

However, SA increased numerically upon repeated exposure (Figure 6.4); it surpassed neutrality (50%) by day 6 and was significantly greater than neutrality on day 9 ($t = 2.18$, $df = 17$, $p < 0.05$). Supplementary analysis revealed that the mean of the SA scores shown on days 6-10 (78.0 ± 4.1%, back-transformed mean ± standard error) was significantly greater (paired *t*-test; $t = 6.58$, $df = 4$, $p < 0.003$) than that of the SA scores of days 1-5 (46.7 ± 5.2%). Additionally, the overall SA mean was significantly greater than the neutral value of 50% (back-transformed mean ± standard error of 63.8 ± 5.5%; $t = 2.36$, $df = 17$, $p < 0.05$). These findings suggest that chicks were more attracted to the moving rather than the still video image.

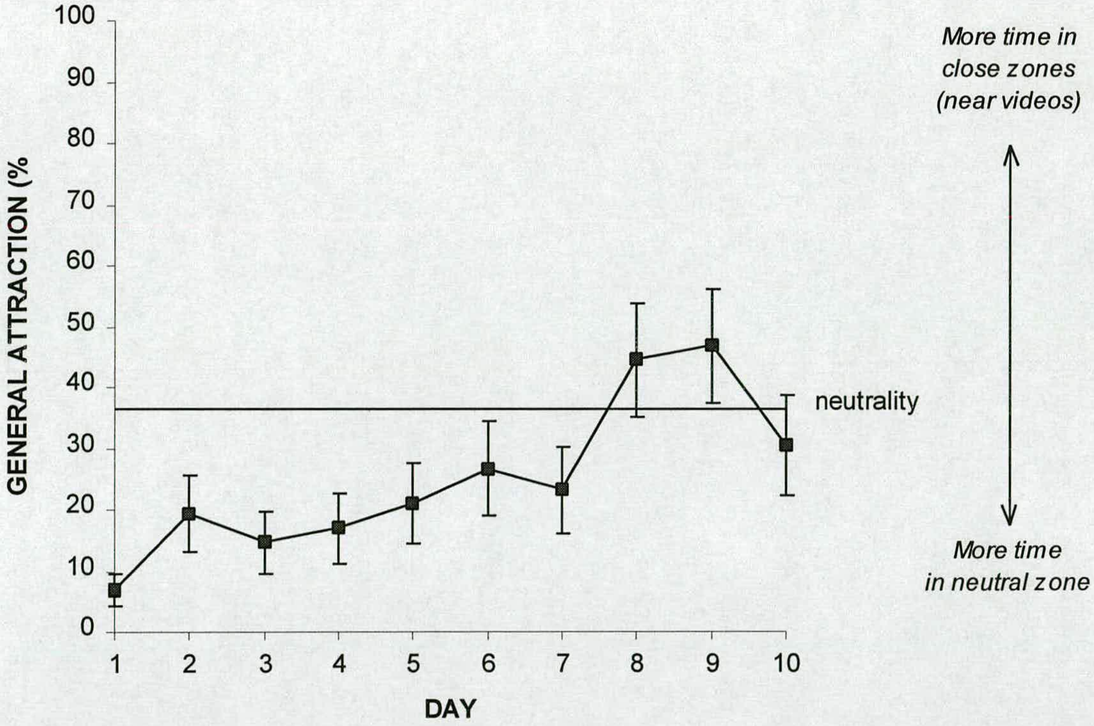


Figure 6.5

Chicks' 'general attraction' (GA) scores (time spent near videos as a percentage of the observation period) when moving and still screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

There was no significant effect of the end of the box at which stimuli were presented (i.e. whether the video was shown at the CZ1 or CZ2 end) on GA (Wald statistic = 0.3, *df* = 1, $F_{1,17} = 0.3$, $p > 0.1$).

The overall GA was significantly less than 36.36% (back-transformed mean ± standard error of 23.0 ± 4.0%; $t = -2.90$, $df = 17$, $p < 0.01$) thus indicating that chicks spent more time in the neutral zone overall than in the close zones near the videos. However, although statistical comparisons across experiments are precluded, the overall GA was numerically greater here than that scored by chicks in Experiment 1 in which no videos were presented (13.2 ± 2.5%). This finding suggests that chicks may spend longer in the close zones when video images are present than they would otherwise.

The analysis revealed a significant increase in GA with repeated exposure (Wald statistic = 35.3, *df* = 9, $F_{9,17} = 3.92$, $p < 0.01$). Within-day comparisons showed that GA remained significantly below 36.36% until day 5 (*t* always < -2.17, *df* = 17, $p < 0.05$) but that there was no significant deviation from neutrality thereafter (Figure 6.5).

The present finding that chicks were more attracted to a moving rather than a still screensaver video image are consistent with those of previous studies in which moving imprinting objects were preferred to stationary ones (Sluckin, 1972; Hoffman, 1978; Eiserer, 1980; Ten Cate, 1989). It could be argued that the still image used here (a paused video frame) was not strictly static in that the chicks may have been able to perceive screen flicker (see **Chapter 1** for further details). Any attraction to flicker may have weakened the chicks' interest in the moving image but this renders the results conservative. The fact that the chicks spent more time near the moving than the still video overall suggests that they perceived sufficient difference between them to make a choice.

6.5 Experiment 3 - Bright vs. dull images

When given a choice, chickens are thought to prefer brightly-lit environments to dull ones. For example, laying hens generally preferred brighter (20 lux) nest-boxes as opposed to darker (5 lux) ones (Appleby et al., 1984) and two-week-old layer chicks spent longer in a chamber where the light intensity was 200 lux compared to compartments lit at 6, 20 and 60 lux (Davis et al., 1998). There is also evidence that preference for projected images was positively associated with the brightness of the stimulus, at least in laboratory monkeys (Humphrey, 1972). Therefore, it is conceivable that chicks may be differentially attracted to bright rather than dull video images. This possibility was examined here by comparing chicks' responses to a bright vs. a dull Fish screensaver video image (SS) or to a bright vs. dull blank, lit television (B). The latter treatment was included to determine chicks' responses towards stimuli differing in brightness but that, unlike the Fish SS videos, incorporated no discernible shapes, colour or movement. In both test conditions, the stimuli were presented to the chicks at opposite ends of their home box for five minutes on each of 10 consecutive days.

6.4.1 Treatments and testing

Eighteen groups of three chicks were randomly assigned to one of two paired-test conditions, i.e., nine groups were exposed to the bright vs. dull SS stimuli and the other nine to the bright vs. dull B ones.

The bright and dull B stimuli were produced by switching the brightness control of two blank televisions to the highest and lowest level, respectively, before they were presented to the chicks. The bright and dull SS stimuli were prepared in the same way, except that the television monitors were showing the 'standard' Fish screensaver video (see Experiment 2). The colour and contrast levels on the television monitors remained on the standard settings for human vision. The bright and dull SS and B stimuli emitted 38.4, 18.8, 15.6 and 10.6 lux, respectively; these estimations were averages of measurements made at 18 different points along the length of the home box. The order of behavioural observations of the boxes was randomized daily, as was the end of the box at which the bright and dull stimuli were presented. The test procedures, behaviours measured and statistical analyses were as described in the Materials and Methods (Section 6.2). Specific attraction (SA) and general attraction (GA) scores were calculated as follows:

$$SA = 100\,[\,B / (B + D)\,]$$

and

$$GA = 100\,[\,(B + D) / 300\,]$$

where B = time (in seconds) spent in the close zone nearest the bright stimulus

D = time (in seconds) spent in the close zone nearest the dull stimulus

Therefore, if the SA score was larger or smaller than the neutral value of 50% it would indicate more or less time, respectively, spent near the bright than the dull stimulus. If the GA score was larger or smaller than the neutral value of 36.36% it would denote more or less time, respectively, spent in the close zones than in the neutral zone.

6.4.2 Results and discussion

The REML analysis revealed a significant effect of the end at which the stimuli were presented (Wald statistic = 5.9, *df* = 1, $F_{1,16} = 5.9$, $p < 0.05$); regardless of whether they were shown videos or only blank screens chicks' SA scores were higher when the bright stimulus was presented at the CZ1 end of the box rather than the CZ2 end (88.4 ± 3.9 % and 79.1 ± 6.7 %, back-transformed means ± standard errors). Therefore, even though stimulus presentation was randomized, the chicks showed a preference for one side of the box. There are no obvious explanations for this finding because the box appeared symmetrical and there were no obvious external cues. Despite such asymmetry, when the bright stimulus was presented in CZ2, i.e., the least preferred end of the box, the SA score (79.1 ± 6.7 %) was still significantly greater ($t = 3.94$, $df = 16$, $p < 0.01$) than neutrality (50%).

The analysis also revealed a significant effect of test condition (Wald statistic = 9.3, *df* = 1, $F_{1,16} = 9.3$, $p < 0.01$); B chicks spent longer near the bright stimulus than SS ones (back-transformed means ± standard errors of 91.3 ± 3.9 % and 69.9 ± 9.2 %, respectively). However, both SS ($t = 2.62$, $df = 8$, $p < 0.05$) and B ($t = 7.27$, $df = 8$, $p < 0.001$) chicks showed significantly greater attraction (i.e., SA > 50%) to the bright stimuli than would have been expected by chance.

There were no significant effects of day (Wald statistic = 16.1, *df* = 9, $F_{9,16} = 1.88$, $p > 0.1$) or day/test condition interactions (Wald statistic = 6.7, *df* = 9, $F_{9,16} = 0.74$, $p > 0.1$) on SA. Within-day tests of the null hypothesis revealed that apart from day 1, B chicks showed significantly higher SA scores than would be expected by chance on each of the test days (t always > 2.36, $df = 8$, $p < 0.05$). SS chicks only deviated significantly from neutrality on days 5 ($t = 3.11$, $df = 8$, $p < 0.02$) and 6 ($t = 2.83$, $df = 8$, $p < 0.03$) (Figure 6.6).

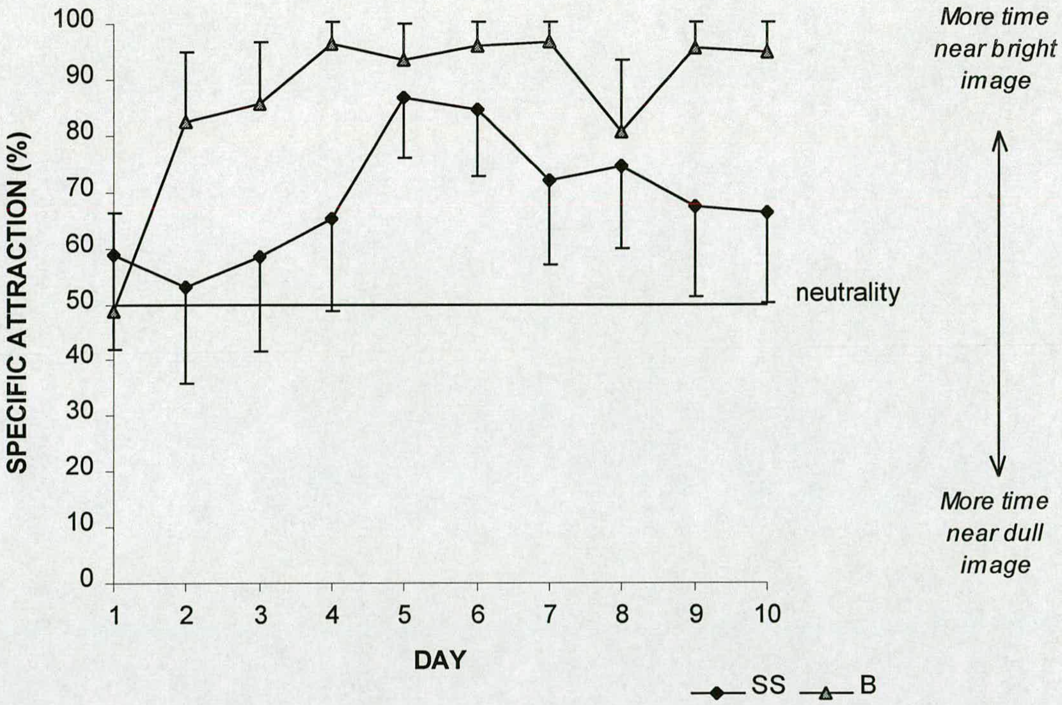


Figure 6.6

Chicks' 'specific attraction' (SA) scores (time spent near bright stimulus as a percentage of the total time spent near bright + dull) to a bright vs. dull screensaver video (SS) or a bright vs. dull blank television (B) when these were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 9.

These results suggest that the chicks found a bright blank screen more attractive than a dull one, although this preference for brightness was more pronounced when they were exposed to blank television screens than to video images.

There was no significant effect of the end at which stimuli were presented (Wald statistic = 0.7, *df* = 1, $F_{1,16} = 0.7$, $p > 0.1$) on GA.

Chicks were more attracted to the television screens overall if they displayed video images than if they were blank but lit (GA scores for SS and B chicks = 37.0 ± 6.6% and 20.3 ± 4.7%, respectively; back-transformed means ± standard errors) and this effect of test condition only narrowly missed significance (Wald statistic = 4.0, *df* = 1, $F_{1,16} = 4$, $p < 0.06$). The overall GA score of SS chicks did not deviate significantly ($t = -0.09$, *df* = 8, $p > 0.2$) from neutrality (36.36%) whereas B chicks showed a significantly lower overall GA score than 36.36% ($t = -2.80$, *df* = 8, $p < 0.05$). In other words, SS chicks spent as much time near the videos as in the neutral zone and B ones spent more time in the neutral zone. However, although not statistically comparable, the overall GA scores for both SS (37.0 ± 6.6%) and B chicks (20.3 ± 4.7%) were numerically greater than that of the chicks in Experiment 1 (13.2 ± 2.5%) in which there was no video stimulation.

The analysis also revealed a significant effect of day (Wald statistic = 93.8, *df* = 9, $F_{9,16} = 10.4$, $p < 0.01$) with the pooled GA for SS and B increasing with repeated exposure from 2.4 ± 1.0% (back-transformed mean ± standard error) on day 1 to 50.3 ± 9.4 % on day 10.

Although there were no significant day/test condition interactions (Wald statistic = 4.4, *df* = 9, $F_{9,16} = 0.49$, $p > 0.1$), B chicks showed GA scores that increased with repeated exposure but that, apart from day 2, were significantly less (t always $< - 2.77$, *df* = 8, $p < 0.05$) than expected by chance (36.36%) until day 6 (Figure 6.7); thereafter, they did not differ significantly from neutrality (t always < 1.50, *df* = 8, $p > 0.1$). Similarly, SS chicks showed increasing GA over time. The score was significantly less ($t = -7.77$, *df* = 8, $p < 0.001$) than expected by chance (36.36%) on day 1, surpassed neutrality on day 5, and from day 8 onwards was significantly greater than expected by chance (t always > 2.38, *df* = 8, $p < 0.05$).

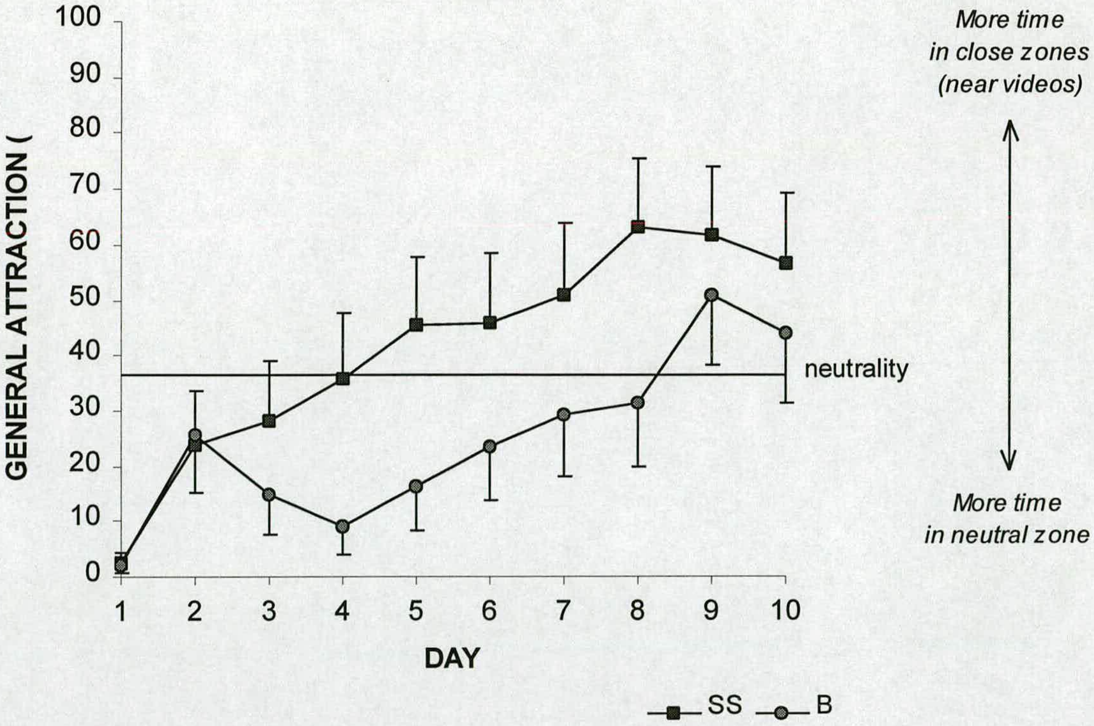


Figure 6.7

Chicks' 'general attraction' (GA) scores (time spent near both stimuli as a percentage of the observation period) when bright and dull screensaver videos (SS) or bright and dull blank televisions (B) were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 9.

Collectively, these results suggest that chicks were more attracted to a bright visual stimulus than a dull one, regardless of whether the screens were blank but lit or if they displayed videos of a SS programme. This preference was more apparent among the chicks exposed to blank, lit televisions. Increasing the brightness of a television monitor can increase the amount of screen flicker perceived (Landis, 1954; Powell, 1967; D'Eath, 1998; see **Chapter 1** for further details). Therefore, because chicks are attracted to flicker (James, 1959; Bateson and Reese, 1969), their preference for brighter screens may have reflected this phenomenon.

The stronger preference for the bright rather than dull screen shown by B than SS chicks may signify that screen brightness acquires greater relevance in the absence of other features such as colour and moving shapes.

Overall, chicks in both treatment groups spent progressively more time near the televised stimuli upon repeated exposure, regardless of brightness. However, SS chicks showed a strong tendency to spend more time near their stimuli than B ones. These findings are consistent with those of Jones et al. (1998) who found that socially reared chicks showed progressively more attraction when a Fish screensaver was presented at one end of their home box on each of 9 days than did those exposed to a blank, lit television. As Jones et al. (1998) suggest, it is possible that blank screens (being absent of other features such as colour and moving shapes) may not be sufficiently interesting to elicit strong attraction, particularly in the potentially competing presence of social companions.

6.6 Experiment 4 – Coloured vs. black & white video

Chickens have good colour vision which ranges from the infrared to ultraviolet regions of the spectrum (Varela et al., 1993; Bennett and Cuthill, 1994; Rogers, 1995) and there is compelling evidence that they exhibit strong colour preferences (Schaefer and Hess, 1959; Berryman et al., 1971; Salzen et al., 1971; Bolhuis, 1991; van Kampen and de Vos, 1991; Roper and Marples, 1997). However, there has been little agreement as to which colours chickens prefer and it appears that their preferences can vary according to previous experience, the medium of presentation and the context in which the colour preferences are tested (Kovach, 1971; Salzen et al., 1971; Jones and Carmichael, 1998). Firstly, for example, chicks ate brown-painted mealworms more readily than red-painted ones but the preference was reversed when chicks were reared in red cages (Roper, 1990). Secondly, chicks ate red food crumbs more readily than black ones when they were placed on the floor of the cage but this preference was reversed when the food was offered in dishes (Roper and Marples, 1997). Thirdly, chicks drank black water more readily than red (Roper and Marples, 1997). Fourthly, naïve chicks accepted mealworms painted green but avoided those painted with a common 'warning colouration' (the conspicuous patterns of noxious prey animals) of yellow and black stripes (Schuler and Hesse, 1985). Fifthly, red and blue imprinting stimuli elicited more approach than green, yellow or orange ones (Schaefer and Hess, 1959; Salzen et al., 1971; Kovach, 1971; Sluckin, 1972; Bolhuis, 1991; van Kampen and de Vos, 1991). On the other hand, adult laying hens and chicks do not peck readily at blue objects (Wood-Gush, 1971; Andrew et al., 1981). Indeed, adult hens pecked much more at white or yellow bunches of string than at blue or orange ones; these colour preferences were relatively stable (Jones and Carmichael, 1998).

Although there is no consensus of opinion concerning colour preferences, I consider colour to be a potentially important feature of screensaver images, particularly in the context in which I have used them. Because chickens have such well-developed colour vision they could show differential responses to coloured vs. monochrome video images. Indeed, chicks are thought to show greater attachment to coloured imprinting stimuli than to black, white or grey ones (Schaefer and Hess, 1959).

It has been argued that video images may not be suitable for experiments designed to establish animals' responses to different colours (D'Eath, 1998; Fleishman et al., 1998) because colour televisions are designed for human vision and some animals, including chickens, have a different spectral sensitivity to us (Bennett and Cuthill, 1994; D'Eath, 1998; Fleishman et al., 1998; Prescott and Wathes, 1998; 1999). On the other hand, chickens successfully discriminated between the video images of different coloured food dishes (McQuoid and Galef, 1993; 1994) and of coloured cards (Patterson Kane et al., 1997). I make no presumptions concerning chickens' perception of the colours shown on screen: this experiment was simply designed to ask if chicks would prefer a video image that a human observer perceives as multicoloured to one that a human observer sees as black & white. The chicks were simultaneously exposed to a coloured and a black & white ('greytone') video image of the 'Fish' screensaver at opposite ends of their home boxes for five minutes on each of 10 consecutive days.

6.6.1 Treatments and testing

The coloured Fish stimulus was the 'standard' one (see Experiment 2), presented on a television monitor on which the colour level was set at standard for human vision. The black & white ('greytone') stimulus was produced by turning the colour setting of a television monitor showing the standard Fish video to zero. The brightness and contrast levels on both of the monitors remained on the standard settings, i.e., apart from colour, the settings on each monitor were the same.

Eighteen groups of three chicks were used but the responses of just one marked focal chick per group were recorded. The order in which the boxes were observed was randomized daily, as was the end of the box at which the coloured and black & white video images were presented. The test procedures, behaviours measured and statistical analyses were as described in the Materials and Methods (Section 6.2). This time, specific attraction (SA) and general attraction (GA) were calculated using the following formulae:

$$SA = 100\,[\,C / (C + BW)\,]$$

and

$$GA = 100\,[\,(C + BW) / 300\,]$$

where C = time (in seconds) spent in the close zone nearest the coloured Fish video

BW = time (in seconds) spent in the close zone nearest the black & white Fish video

Therefore, if the SA score was larger or smaller than the neutral value of 50% it would indicate more or less time, respectively, spent near the coloured than the black & white video. If the GA score was larger or smaller than the neutral value of 36.36% it would denote more or less time, respectively, spent in the close zones (near the videos) than in the neutral zone.

6.6.2 Results and discussion

There was no significant effect of day (Figure 6.8) on SA scores (Wald statistic = 3.7, $df = 9$, $F_{9,17} = 0.41$, $p > 0.1$). The finding that the mean of the daily SA scores (66.7 ± 3.7%, back-transformed mean ± standard error) was significantly greater than the neutral value of 50% ($t = 4.14$, $df = 17$, $p < 0.001$) suggests that chicks spent more time near the coloured Fish stimulus than the black & white one overall.

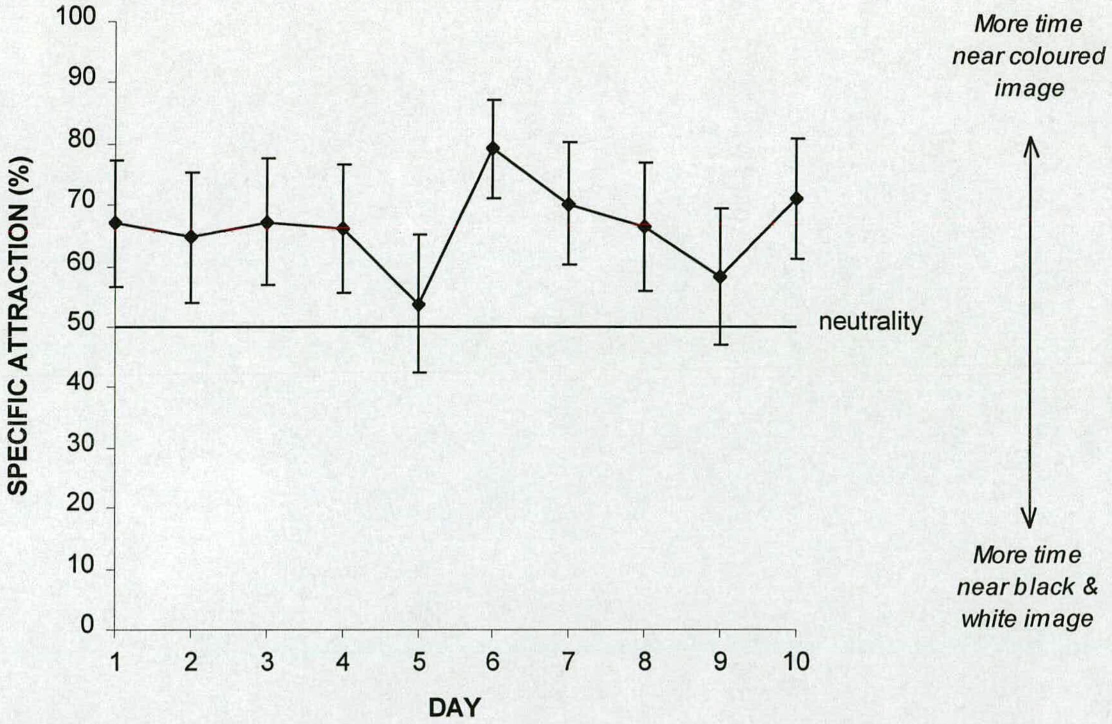


Figure 6.8

Chicks' 'specific attraction' (SA) scores (time spent near coloured video as a percentage of the time spent near both videos) when coloured and black & white screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

The REML analysis revealed a significant effect of the end of the box at which the stimuli were presented (Wald statistic = 8.3, *df* = 1, $F_{1,17} = 8.3$, $p < 0.05$); chicks showed significantly higher SA scores when the coloured image was presented in CZ2 rather than CZ1 (75.8 ± 4.2% and 56.1 ± 5.5%, respectively, back-transformed means ± standard errors). This suggests that although video stimuli presentation was randomized, the chicks had established a preference for one side of the home box. As with Experiment 3, there are no obvious explanations for this preference. The boxes appeared to be symmetrical and there were no other obvious external cues that may have affected the chicks' choice. When the coloured stimulus was presented at the preferred (CZ2) end, SA (75.8 ± 4.2%) was significantly greater than 50% ($t = 4.98$, $df = 17$, $p < 0.001$) but it did not significantly differ from neutrality ($t = 1.07$, $df = 17$, $p < 0.2$) when the coloured stimulus was shown in CZ1 (56.1 ± 5.5%). This suggests that chicks' overall preference for the coloured image (see above) may have been weakened by their preference for one end of the box over the other. However, this renders the results conservative.

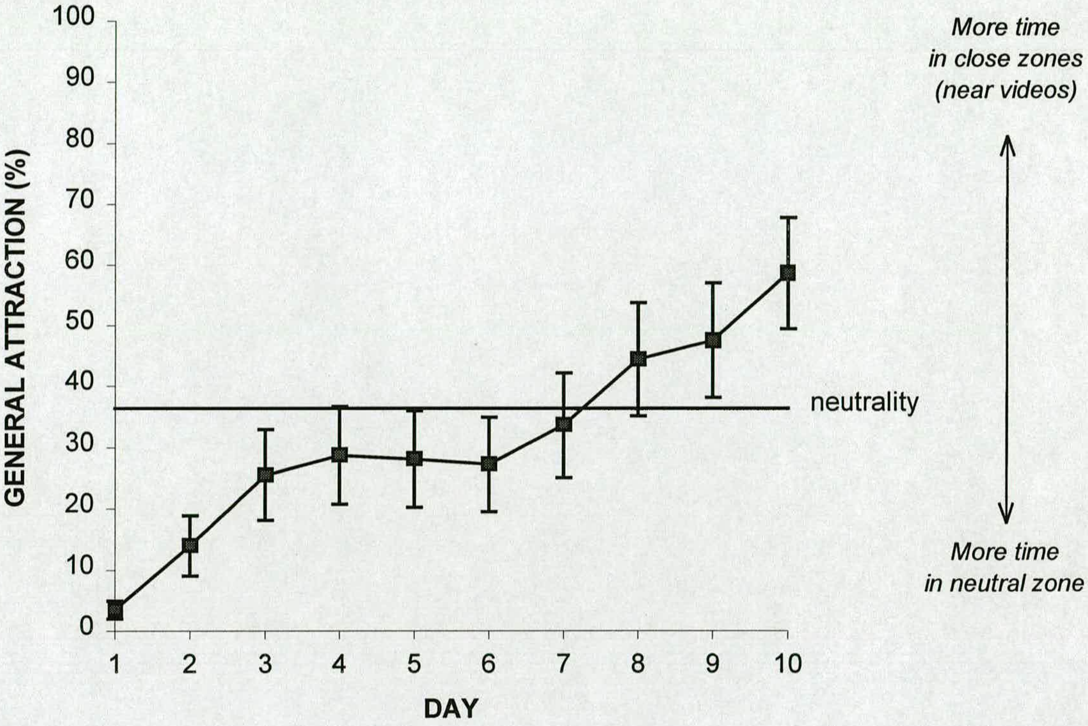


Figure 6.9

Chicks' 'general attraction' (GA) scores (time spent near both videos as a percentage of the observation period) when coloured and black & white screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

There was no significant effect of the end of the box at which stimuli were presented (Wald statistic = 0, $df = 1$, $F_{1,17} = 0$, $p > 1.0$) on GA. The overall GA (27.5 ± 5.0%, back-transformed mean ± standard error) did not differ significantly ($t = -1.62$, $df = 17$, $p > 0.1$) from neutrality (36.36%), suggesting that chicks spent as much time near the videos as in the neutral zone. Additionally, overall GA was greater than that of chicks that received no televised stimuli (13.8 ± 4.7%; Experiment 1).

The analysis revealed that GA increased significantly (Wald statistic = 74.4, *df* = 9, $F_{9,17} = 8.3$, $p < 0.01$) with repeated exposure (**Figure 6.9**). Within-day comparisons showed that GA was significantly less than expected by chance (36.36%) until day 2 ($t < -3.17$, $df = 17$, $p < 0.01$), had surpassed neutrality by day 8 and was significantly greater than expected by chance on day 10 ($t = 2.29$, $df = 17$, $p < 0.05$). Therefore, the chicks became increasingly attracted to the video images *per se*, regardless of their preference for one over the other.

Consideration of the overall results showed that chicks were more attracted to a coloured screensaver video image than to a black & white one. This result is consistent with that of a previous study that compared responses to coloured vs. achromatic imprinting stimuli (Schaefer and Hess, 1959).

It has been argued that comparisons of animals' responses to coloured and greytone video images may be difficult to interpret because of potential differences in brightness and contrast as well as in colour (D'Eath, 1998; Fleishman et al., 1998). Previous studies have mainly used such images to establish whether colour is important for individual discrimination in Bengalese finches (Watanabe et al., 1993) and *Anolis* lizards (Macedonia and Stamps, 1994), for mate choice in female sticklebacks (Rowland et al., 1995b) or whether it affects aggression in male sticklebacks (Rowland et al., 1995a; Bolyard and Rowland, 1996). In such studies of responses to different coloured videos of conspecifics, subtle changes in brightness may confound interpretation of the results. However, the current experiment was simply designed to determine whether chicks preferred an abstract video image that humans perceive as coloured to a greytone one. Of course, the possibility that the chicks' preferences reflected greater attraction to certain levels of brightness and contrast as well as or rather than the colours cannot be ruled out. Therefore, in future studies, it would be prudent to measure the colour/brightness output of the video images using specialized equipment, such as a spectroradiometer (Shepherd, 1997; D'Eath, 1998), that can take account of the chickens' spectral sensitivity (see **Chapter 1** for further details). Alternatively, chicks' preferences for coloured images could be more rigorously tested over a wide range of brightness conditions, as suggested by Fleishman et al. (1998).

6.7 Experiment 5 – Complex vs. simple image (1)

It has been suggested that complexity is a potentially important component of environmental enrichment; for example, long periods of inactivity are believed to be indicative of poor health (Chamove, 1989) and there is evidence that activity is positively correlated with environmental complexity (Tripp, 1985). Furthermore, it has been suggested that complexity encourages interaction between the animal and its environment (Dember et al., 1957; Chamove, 1989; Chamove and Anderson, 1989). Animals have also shown preferences for complex stimuli over simple ones. For example, laboratory rhesus monkeys that could press a button to see one of two projected images differing in complexity preferred to view the more complex one (Humphrey, 1972). More specifically, when chicks aged 6 days or more were given a choice between two unfamiliar, two-dimensional stimulus cards they approached one with a complex pattern rather than a plain or simply patterned one (Dutch, 1969; Berryman et al., 1971). Furthermore, chicks presented with complex images like the Fish or Flying Toaster screensaver video images in their home box showed more approach towards their respective stimuli than did those that were only exposed to a simple, blank lit television screen (Jones et al., 1996a; 1998). This apparent preference for complexity was further examined in the present experiment. Here, I investigated chicks' responses when they were simultaneously presented with a simple screensaver depicting a lime-green bouncing square (see **Chapter 2**) and the more complex Fish screensaver video image at opposite ends of their home boxes for five minutes on each of 10 consecutive days.

6.7.1 Treatments and testing

Dutch (1969) defines complexity as "the number of elements constituting each stimulus". This definition was applied in the present experiment and the 'standard' Fish screensaver stimulus (see Experiment 2) differed from the Square one not only in the variety of colour and moving objects, but also in the number and size of images on the screen. The Fish screensaver contained 12 fish (each one approximately 2.5 cm in length) on the screen at any one time whereas the Square screensaver depicted one 4.5 × 4.5 cm square (roughly the same size as 4 or 5 fish). The brightness emitted by both stimuli was similar (Fish, 24 lux; Square, 19 lux, averages of 18 measurements taken over the length of the home box) and the brightness, colour and contrast levels on each television monitor remained on the standard settings.

Eighteen groups of three chicks were used but the responses of just one focal chick in each group were measured. The order of behavioural observations of the boxes was randomized daily, as was the end of the box at which the Fish and Square videos were presented. The test procedures, behaviours measured and statistical analyses were as described in the Materials and Methods (Section 6.2). Specific attraction (SA) and general attraction (GA) were calculated using the following formulae:

$$SA = 100 \left[F / (F + SQ) \right]$$

and

$$GA = 100 \left[(F + SQ) / 300 \right]$$

where F = time (in seconds) spent in the close zone nearest the Fish screensaver video

SQ = time (in seconds) spent in the close zone nearest the Square screensaver video

Therefore, if the SA score was larger or smaller than the neutral value of 50% it would denote more or less time, respectively, spent near the Fish than the Square video. If the GA score was larger or smaller than the neutral value of 36.36% it would indicate more or less time, respectively, spent in the close zones (near the videos) than in the neutral zone.

6.7.2 Results and discussion

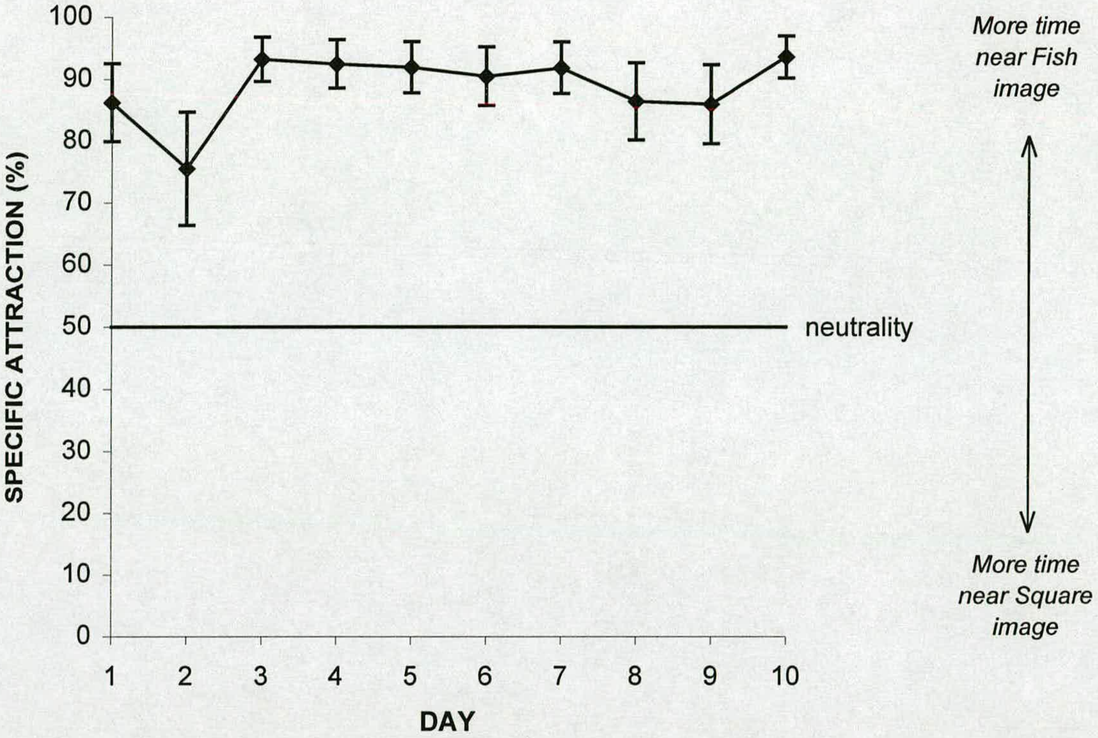


Figure 6.10

Chicks' 'specific attraction' (SA) scores (time spent near Fish as a percentage of the total time spent near Fish + Square) when complex (Fish) vs. simple (Square) screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

There was no significant effect of the end at which the stimuli were presented (Wald statistic = 3.9, *df* = 1, $F_{1,17} = 3.9$, $p > 0.1$) or of day (Wald statistic = 10.2, *df* = 9, $F_{9,17} = 1.13$, $p > 0.1$) on SA.

The overall SA (89.6 ± 2.1%, back-transformed mean ± standard error) was significantly greater than expected by chance ($t = 9.65$, *df* = 17, $p < 0.001$) and this was true on each of the separate test days (Figure 6.10; *t* always > 2.21, *df* = 17, $p < 0.05$). Therefore, the chicks showed a consistent and significant preference for the complex (Fish screensaver) video stimulus rather than the simple (Square screensaver) one.

There was no significant effect of the end at which the stimuli were presented (Wald statistic = 0.1, *df* = 1, $F_{1,17} = 0.1$, $p > 0.1$) on GA. However, the analysis revealed a significant (Wald statistic = 111.8, *df* = 9, $F_{9,17} = 12.4$, $p < 0.01$) day effect. GA increased markedly with repeated exposure (Figure 6.11); on day 1 it was significantly less than 36.36% ($t = -6.91$, $df = 17$, $p < 0.05$), but it surpassed neutrality on day 4 and, from day 7 onwards, GA was significantly ($t > 3.11$, $df = 17$, $p < 0.01$) higher than expected by chance. Thus the chicks initially spent longer in the neutral zone but, with repeated exposure, they showed increasing approach towards the video stimuli and spent more time near them regardless of type.

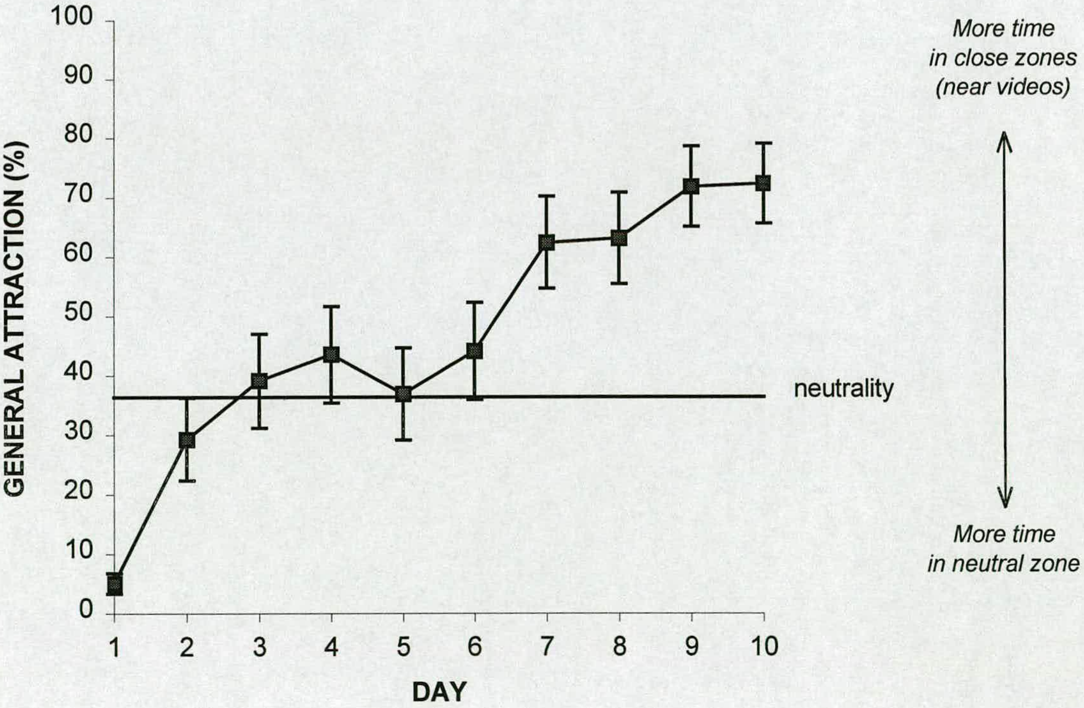


Figure 6.11

Chicks' 'general attraction' (GA) scores (time spent near videos as a percentage of the observation period) when complex (Fish) and simple (Square) screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

Collectively, the present results suggest that chicks are more attracted to complex rather than simple video images, and that they become increasingly attracted to both videos with repeated exposure. These findings are consistent with those of other studies where complex stimuli were preferred to simpler ones (Dutch, 1969; Berryman et al., 1971; Humphrey, 1972; Jones et al. 1996a; 1998). However, it is not possible to reach firm conclusions concerning the basis of the chicks' preference for the Fish screensaver video. It may have been due to the fact that the Fish stimulus had more moving images on the screen at any one time (see Experiment 2) or because it incorporated lots of colours rather than just one (see Experiment 4). It is also possible that the chicks were more attracted to the Fish screensaver because it depicted lots of smaller stimuli, rather than one large one (Square screensaver). For example, chicks are known to peck more at 0.5-cm diameter spheres than at 1.3- and 3.7-cm ones (Clifton and Andrew, 1983). Of course, it is also conceivable that the Fish screensaver stimulus was more attractive than the Square one because it contained a combination of all of the aforementioned elements.

6.8 Experiment 6 – Complex vs. simple image (2)

It has previously been shown that laboratory rhesus monkeys placed in an operant chamber would press a key in order to watch 8-mm cine-films showing Walt Disney cartoons (Humphrey, 1972). Captive zoo monkeys that were regularly exposed to televised images also showed a preference for cartoons over other off-air television programmes (from television documentary entitled 'Molly's Zoo', British Broadcasting Corporation, 1998). Cartoon images are also considered to be abstract (see **Chapter 2** for definition) but they are much more complex than the Fish screensaver image in that they include frequently changing scenes, characters and backgrounds as well as much more movement and colour, at least to the human eye. Therefore, this experiment further examined chicks' responses to simple vs. complex video images by presenting them simultaneously with an excerpt from an episode of a cartoon programme (complex stimulus) and the Fish screensaver video (simple stimulus) at opposite ends of their home boxes for five minutes on each of 10 consecutive days.

6.8.1 Treatments and testing

The cartoon stimulus chosen was an excerpt from an episode of The Simpsons™ (see **Chapter 2** for a detailed description). Although The Simpsons™ video was much more complex than the Fish screensaver, both video images had similar brightness levels (28 and 24 lux, respectively, averaged over 18 measurements along the home box). Despite this similarity, the brightness, colour and contrast settings for both monitors on which the stimuli were presented were standardized.

Eighteen groups of three chicks were used in the experiment but only the responses of one focal chick in each group were recorded. The order of behavioural observations of the boxes was randomized daily, as was the end of the box at which The Simpsons™ and the Fish videos were presented. The test procedures, behaviours measured and statistical analyses were as described in the Materials and Methods (Section 6.2). Specific attraction (SA) and general attraction (GA) scores were calculated as follows:

$$SA = 100\ [\ TS / (TS + F)\ ]$$

and

$$GA = 100\ [\ (TS + F) / 300\ ]$$

where TS = time (in seconds) spent in the close zone nearest The Simpsons™ video

F = time (in seconds) spent in the close zone nearest the Fish screensaver video

Therefore, if the SA score was larger or smaller than the neutral value of 36.36% it would denote more or less time, respectively, spent near The Simpsons™ cartoon than the Fish video. If the GA score was larger or smaller than the neutral value of 36.36% it would indicate more or less time, respectively, spent in the close zones (near the videos) than in the neutral zone.

6.8.2 Results and discussion

There was no significant effect of day (Wald statistic = 12.8, *df* = 9, $F_{9,17}$ = 1.42, $p > 0.1$) on SA (Figure 6.12). The finding that the overall SA (57.9 ± 3.0%, back-transformed mean ± standard error) was significantly greater than expected by chance ($t = 2.62$, *df* = 17, $p < 0.02$) clearly showed that the chicks spent more time near the cartoon than the screensaver.

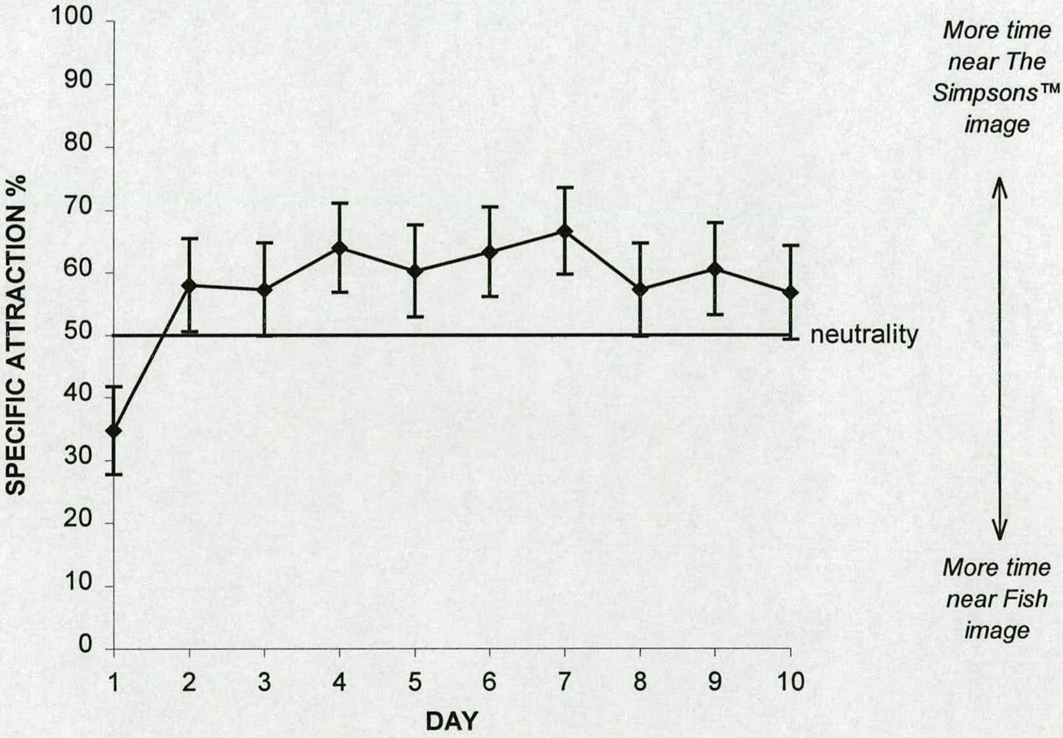


Figure 6.12

Chicks' 'specific attraction' (SA) scores (time spent near The Simpsons™ as a percentage of the total time spent near The Simpsons™ + Fish) when a complex cartoon (The Simpsons™) and a simple screensaver video (Fish) were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

The analysis also revealed a significant effect of the end at which the video stimuli were presented (Wald statistic = 6.2, *df* = 1, $F_{1,17}$ = 6.2, $p < 0.05$); the chicks spent more time in CZ1 when the The Simpsons™ cartoon was presented at that end of the box than when it was shown at the CZ2 end (63.7 ± 3.6% and 52.0 ± 3.9%, respectively; back-transformed means ± standard errors). This suggests that, despite the randomization of the video stimuli presentation, the chicks showed a preference for one side of the seemingly symmetrical home box. As before (Experiments 3 and 4), there are no obvious explanations for this preference. The SA score was significantly greater than neutrality (50%) when the cartoon was presented at the CZ1 end of the box (63.7 ± 3.6%; $t = 3.59$, $df = 17$, $p < 0.01$) but not when it was shown in CZ2 end (52.0 ± 3.9%; $t = 0.51$, $df = 17$, $p < 0.2$). This suggests that the chicks' overall preference for The Simpsons™ cartoon may have been weakened by their preference for one end of the box, thus rendering the results conservative.

On the other hand, there was no significant overall effect (Wald statistic = 0.2, $df = 1$, $F_{1,17} = 0.2$, $p > 0.1$) of the end of the home box at which the stimuli were presented on GA, though there was a significant interaction between day and end of presentation (Wald statistic = 31.1, $df = 9$, $F_{9,17} = 3.4$, $p < 0.02$). This reflected the fact that on day 1, chicks spent more time in the close zones than in the neutral zone when the cartoon was presented at CZ2 (back-transformed means ± standard errors of 40.1 ± 8.8% and 8.3 ± 3.1%, respectively; $t = -4.41$, $df = 17$, $p < 0.001$) whereas GA was greater on day 4 when it was at the CZ1 end (63.3 ± 8.5% and 37.59 ± 8.6%, respectively; $t = -2.32$, $df = 17$, $p < 0.05$). Because there was no logical pattern of response, these results were considered likely to simply reflect chance effects.

The analysis also revealed that GA increased significantly with repeated exposure (Wald statistic = 75.6, $df = 9$, $F_{9,17} = 8.4$, $p < 0.01$) (Figure 6.13). Within-day analysis showed that GA was significantly less than the neutral value of 36.36% on day 1 ($t = -2.73$, $df = 17$, $p < 0.02$); it then increased progressively, surpassed neutrality on day 3, and from day 5 onwards, it was significantly greater (t always > 2.59, $df = 17$, $p < 0.02$) than expected by chance. Therefore, the results suggest that, like Experiments 2, 3, 4 and 5, the chicks initially spent more time in the neutral zone of the box but became increasingly more attracted to the video stimuli with repeated exposure, regardless of preference for one particular stimulus over the other.

These results, which suggest that a complex video image is more attractive than a simple one and that both the simple and complex images became increasingly attractive to chicks are consistent with those reported in Experiment 5 and in previous studies of chicks' responses towards simple (blank screen) and complex (screensaver) videos presented at the front of their home boxes (Jones et al., 1996a; 1998).

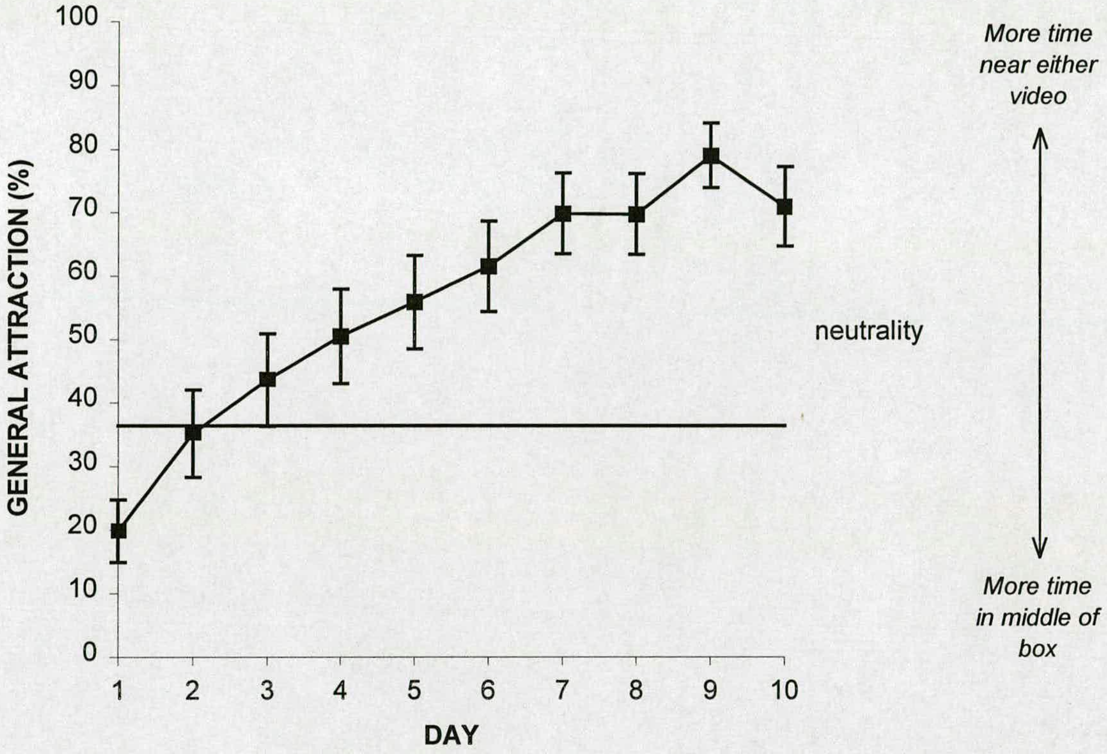


Figure 6.13

Chicks' 'general attraction' (GA) scores (time spent near both videos as a percentage of the observation period) when complex (The Simpsons™) and simple (Fish) screensaver videos were simultaneously presented at opposite ends of their home box for 5 minutes on each of 10 consecutive days; back-transformed means ± standard errors; n = 18.

As in Experiment 5, it is not possible to reach definite conclusions regarding the reasons for the chicks' preferences for The Simpsons™ image rather than the screensaver. It may have been due to its greater movement (see Experiment 2) and colour (see Experiment 3), the rapid change of scenes or a combination of all these features.

It could be argued that the chicks associated the animations of humans in the cartoon with the experimenter and that their preference reflected a covert attraction to me. However, this is unlikely because the cartoon characters are very simplistic and have few features in common with their real life counterparts. Furthermore, to the best of my knowledge there is no evidence that chickens can generalise between people and video images in this way.

6.9 Discussion

When simultaneously presented with two video images at opposite ends of their home box daily for ten consecutive days, chicks spent significantly more time near moving rather than still, bright rather than dull, coloured rather than black & white, and complex rather than simple images. These findings are consistent with those from studies of chicks' responses to various imprinting stimuli. For example, moving objects elicited more approach than static ones (Sluckin, 1972; Hoffman, 1978; Bolhuis, 1991; 1999) and a flickering light source attracted chicks (James, 1959; Bateson and Reese, 1969). Coloured imprinting stimuli were also more attractive to chicks than black, white or grey ones (Schaefer and Hess, 1959) and they preferred complex two-dimensional patterned cards to simple ones (Dutch, 1969; Berryman et al., 1971).

It is interesting to note that the strongest preferences were seen when chicks were given the choice of complex versus simple images (Experiments 5 and 6). The complex videos used in these experiments incorporated all the features that had been identified as attractive in Experiments 2 – 4, i.e. movement, colour and brightness. Therefore, it is tempting to speculate that the most attractive video image is likely to incorporate a combination of all these features. However, despite the fact that the more complex cartoon video (The Simpsons™) was preferred to the simple (Fish) one overall (Experiment 6), no significant preferences were seen on any of the individual test days. On the other hand, chicks showed a clear preference for the Fish video rather than the simple one of a green square on each of the test days (Experiment 5). Though it is not possible to make a statistical comparison across the two experiments, these results suggest that the chicks' preference for The Simpsons™ over Fish was not as strong as that for Fish over the Square stimulus. Therefore, it is possible that there may be a 'cut off' point i.e., increasing the complexity of a symbolic video stimulus beyond a certain level may not increase its attractiveness to chicks.

In experiments where chicks were exposed to televised images (Experiments 2 – 6), they initially spent most of the observation period in the neutral zone of the box but they all showed progressively more approach towards the stimuli, regardless of their nature, following repeated exposure. Though the GA scores of chicks shown moving vs. still videos (Experiment 2) or bright vs. dull blank televisions (Experiment 3) only reached neutrality, those exposed to bright vs. dull Fish screensavers (Experiment 3), coloured vs. black & white (Experiment 4) and simple vs. complex videos (Experiment 5 and 6) showed significantly more approach towards both video stimuli than would be expected by chance. Moreover, although no direct comparisons can be made, the chicks in Experiments 2 – 6 spent much longer in the close zones than did those that received no video stimulation (Experiment 1). The latter birds were still spending the majority of the observation period in the middle of the box (neutral zone) even at day 10. These findings are consistent with those of previous studies (Jones et al., 1996a; 1998) in which chicks became increasingly attracted to video images presented daily at one end of their home box.

Despite the fact that chicks tend to show low levels of fear on the first two days after hatching (Andrew and Brennan, 1983; 1984; Rogers, 1995), my finding that the chicks in the present studies initially spent most of their time in the neutral zone may have reflected initial avoidance of the video stimuli because of their novel and thereby potentially frightening properties (Jones, 1987a). Alternatively, though less likely, chicks of that age may simply have been more interested in the food and water dishes that were situated in the centre of the home box. Because chicks are thought to show an increase in exploratory behaviour from 5 days of age onwards (Workman and Andrew, 1989; Rogers, 1995; Vallortigara et al., 1997) it might be argued that they became more willing to explore the ends of the boxes as they got older. However, chicks that received no stimulation would then also have been expected to move away from the middle of the box and to spend more time investigating the close zones during the latter days of the experiment; this was not the case. Therefore, the current results suggest that presenting the chicks with video images or with blank, lit televisions at either end of the home box encouraged them to utilise areas of the box that they may not otherwise have done. This notion is consistent with previous reports that broiler chickens were more motivated to enter and spent more time in peripheral space if it contained novel objects than if it was empty (Newberry, 1999). Collectively, these findings clearly support the hypothesis that animals seek opportunities to explore novel stimuli (Wood-Gush and Vestergaard, 1991; Mench, 1994; Jones, 1996; 1997). The existence of such motivation is a powerful argument for the provision of environmental enrichment.

Why should chicks show preferences for one component of an abstract video image over another? Newly hatched chicks rapidly form a social preference for a conspicuous stimulus to which they are exposed (van Kampen, 1996; Bolhuis, 1999). Therefore, it could be argued that in the present studies, chicks' responses to the videos might simply have been a result of imprinting. For example, van Kampen (1993) reported that when a chick is exposed to two artificial objects simultaneously, and the objects are relatively far apart (about 20 cm), the bird becomes strongly attached (imprinted) to only one or other of these and shows no attachment to the alternative object, a phenomenon referred to as "overshadowing". However, the birds in the present studies were reared in groups of three and were only exposed to the video stimuli for 5 minutes per day from 2 days of age onwards. Chicks that are reared socially are very likely to imprint onto one another (Guiton, 1959; Sluckin, 1972; Bolhuis, 1991; van Kampen and de Vos, 1995). Furthermore, attachment to a novel object is impaired when it is presented together with an object to which a chick has been imprinted previously (van Kampen and de Vos, 1995; van Kampen, 1996), a phenomenon known as "blocking". In the present cases, this would likely have been one or more of the conspecifics with which the chick was housed. Therefore, the chicks' responses observed here are more likely to have reflected an intrinsic attraction to specific features of the paired video images, rather than imprinting to one or other of them.

It has also been suggested that when chicks are exposed to a novel compound stimulus, their attraction increases when it has many features in common with a familiar one and vice versa (Bateson and Horn, 1994). Furthermore, object preference may be rooted in evolved strategies reflecting animals' behavioural ecology (Sambrook and Buchanan-Smith, 1997) and intrinsic perceptual preferences may ensure that the young animal directs its attention to a particular class of objects (Bolhuis, 1999), such as conspecifics (Sluckin, 1972). Therefore, chicks in the present studies may have preferred those video stimuli that contained more of the elements resembling features of their siblings, e.g. movement, colour, complexity.

Preference tests can have limitations, including the difficulty in determining short versus long-term preferences (Mench, 1994). However, the current methodology was employed to simply provide basic information concerning chicks' differential attraction towards contrasting video images presented in their home environment. Of course, the birds were only exposed to these stimuli for 5 minutes per day for 10 days so it is not yet known if the observed preferences would have remained stable over longer exposure periods. However, chicks' responses to video images of conspecifics and their attraction to abstract video images presented outside their home environment were paralleled in adult laying hens (**Chapter 3**; **Chapter 5**; Clarke and Jones, 1999b). Therefore, it is conceivable that chicks' preferences for features of symbolic video stimuli seen in the present experiment may also continue into adulthood.

Because television monitors are designed for human vision, one of the main concerns in using video playback to study animal behaviour is that the subjects may not perceive images on a television screen as we do. For example, some animals, including chickens, can perceive screen flicker and/or have a different spectral sensitivity to humans (D'Eath, 1998; Prescott and Wathes, 1999). Increasing the brightness of a television image can increase the amount of screen flicker an animal perceives (D'Eath, 1998) and turning off the colour on a television monitor so that it appears greytone to a human observer may lead to subtle changes in brightness (D'Eath, 1998; Fleishman, 1998). This can cause interpretational problems, e.g. I cannot be certain that the chicks' preferences were based solely on colour rather than brightness or a combination of the two. Potential solutions were discussed earlier (Experiment 4). However, in the current context it does not necessarily matter if chicks do not perceive video images in the same way as humans, especially if the information is to be used primarily in the development of environmental enrichment programmes. Differential responses to video stimuli, like those seen in each of the present experiments, still allow us to attach understandable labels to chicks' preferences. It is also important to recognize that people, and not chickens, will ultimately make the decisions concerning the design of environmental enrichment (Jones and Carmichael, 1999b). The current methodology also has the added advantage that video stimuli can be easily manipulated. Because it allows us to dissect, amplify or reduce selected features of a visual image, this facility may represent a powerful tool for identifying the most attractive ones.

The present findings, together with those described in **Chapter 5** and elsewhere (Jones et al., 1996a; 1998), also clearly demonstrate that both young chicks and adult laying hens became readily attracted to abstract video images presented outside their home environments. Therefore, they further support the notion that it is important to consider enriching the environment outside as well as inside the cage (Newberry, 1995; Jones, 1996). The potential strategic relevance of this work is further discussed in **Chapter 7**.

CHAPTER 7

General Discussion

This project had five main objectives. Firstly, I asked if chickens would readily approach video images of conspecifics. This question has important implications for the use of video images as alternatives to live animals in various types of behavioural experiments. Secondly, I asked if chicks were attracted to familiar video images of abstract stimuli (screensavers) when these were presented in an otherwise novel environment (open field). Thirdly, I determined if regular exposure to these abstract video images would reduce chicks' fear of the open field even in the absence of the videos. Fourthly, I addressed the question of whether video images presented outside their home cages would attract and sustain the interest of adult laying hens over lengthy periods. Finally, I systematically compared chicks' responses to the component features (movement, brightness, colour, complexity) of selected abstract video stimuli in order to determine which of them were effective in eliciting and sustaining attraction. Collectively, my studies allowed me to further assess the value of video playback as a tool for probing the behaviour of chickens. The results of each experiment have been discussed in detail in the previous chapters. In this chapter, these findings are briefly recapped and I discuss some of their fundamental (Section 7.1) and strategic (Section 7.2) implications in greater depth. My conclusions are outlined in Section 7.3.

7.1 Video playback: fundamental implications

7.1.1 Chickens' responses to videos of conspecifics

I found that video images of feeding conspecifics readily elicited approach along a runway in both chicks and adult hens, regardless of whether the corresponding soundtrack was played or not (**Chapter 3**). This suggests that the visual and auditory components of the stimulus did not exert additive effects and that the visual features of the video images were the most important in eliciting approach. These findings provide further support for the growing evidence that video images of conspecifics can modulate chickens' behaviour in contexts as varied as feeding, dustbathing and predatory encounters (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b; Keeling and Hurnik, 1993; McQuoid and Galef, 1993; 1994; D'Eath and Dawkins, 1996; Lundberg and Keeling, 1997).

Furthermore, it has been suggested that video technology could be a useful means of determining the relative importance of various characteristics of a compound stimulus in eliciting a response (Evans and Marler, 1991; Evans and Evans, 1999). For example, it may be possible to systematically explore the interaction between the visual and acoustic signals that may be given by a live animal using video playback to manipulate these signals independently (Evans and Evans, 1999). Using this technique, Evans and Marler (1991) showed that a cockerel gave more alarm calls when it was exposed to a video image of an audience hen with the accompanying soundtrack rather than a silent video of that hen. The former stimulus was also more effective in eliciting alarm calls than a video image of an empty cage with the sounds of the hen, or a silent video of the empty cage. McQuoid and Galef (1993) also found that only chicks that had experienced a video of a feeding conspecific incorporating the appropriate soundtrack showed a significant preference for the food dish that they had seen being used by that conspecific. Unlike the above reports, I found that the addition of a soundtrack was not necessary to elicit approach towards the video of feeding conspecifics. Furthermore, adding the soundtrack of feeding conspecifcs to the video image of an empty goal box failed to make it as attractive as a silent video of conspecifics, or more attractive than the video of the silent goal box. In other words, the visual and auditory components of the stimulus did not exert additive effects and the visual component of the conspecific videos was the most important feature in eliciting approach. This apparent inconsistency might reflect the fact that various call systems seem to have quite different properties (C.S. Evans, personal communication, 1999) or may simply be due to differences in methodology and/or the genetic strain of bird used. In other words, it is conceivable that my findings may be specific to the context in which the tests were conducted, i.e. the video image of feeding conspecifics presented at one end of a runway. However, my findings still support the suggestion that video playback may be exploited to identify the effective components of audio-visual stimuli and/or to assess the relative importance of auditory and visual signals.

To the best of my knowledge, there are only two reports claiming that video images of conspecifics did not represent good substitutes for real chickens as test stimuli. Firstly, hens failed to discriminate between video images of familiar conspecifics or strangers in a runway test (D'Eath and Dawkins, 1996) and secondly, hens did not distinguish between video images of conspecifics and basketballs in a Y-maze test (Patterson-Kane et al., 1997). These results are somewhat surprising, especially as many studies have shown that video images of conspecifics can successfully elicit appropriate social behaviour in chickens (Evans and Marler, 1991; 1992; Evans et al., 1993a; 1993b; Keeling and Hurnik, 1993; McQuoid and Galef, 1993; 1994; Lundberg and Keeling, 1997). However, D'Eath and Dawkins (1996) suggested that their negative findings might simply have been a result of the limitations of video technology. For example, they proposed that colour information in televised images may be insufficient to allow social discrimination because chickens' colour perception differs from that of humans (D'Eath and Dawkins, 1996). They also make the points that video images lack certain important features of live animals, e.g., olfactory or tactile signals and interactive properties, that the resolution of many screens may be too poor to preserve fine visual detail, and that all of these factors may be necessary to facilitate individual recognition. On the other hand, it has been shown that pigeons and Bengalese finches were quite capable of distinguishing between video images of familiar and unfamiliar conspecifics (Watanabe, 1992; Watanabe and Jian, 1993; Watanabe et al., 1993; Watanabe and Furuya 1997; Jitsumori et al., 1999). The pigeon and finch studies involved training birds in an operant system whereas D'Eath and Dawkins' (1996) simply used chickens' latencies to approach and feed from a dish placed next to a video of a familiar or unfamiliar bird as a measure of social recognition; hens are known to approach live birds faster if they are familiar (Grigor et al., 1995). It might be argued that chickens also require training before they can discriminate between the different conspecific video images. For example, Patterson Kane et al. (1997) trained hens to discriminate between a brown basketball and a live brown hen or between video images of these two stimuli in a Y-maze. Hens presented with real-life stimuli quickly learned to discriminate, only taking a mean of 5 sessions to reach 90% accuracy. On the other hand, hens exposed to the video images required 16.5 sessions to reach the same level. It was suggested that video images were poor substitutes for real-life stimuli, at least in this context. However, the fact that the birds did learn to make the discrimination indicates that the video images were simply not as powerful as real-life stimuli. Therefore, further work using more rigorous approaches needs to be conducted before chickens' ability to recognise individual conspecifics from video images can be fully judged. For example, the use of 'High-vision' (high-resolution) cameras and televisions might improve discrimination by retaining much of the fine visual detail that may be important for individual recognition. Unfortunately, this equipment is currently only available in Japan.

7.1.2 Chickens' responses to abstract video images

Enforced exposure to an unfamiliar environment elicits fear in chicks (Jones, 1987b; 1996) and it is widely recognized that they are attracted to familiar companions, objects, drawings and odours in otherwise novel situations (Bateson, 1964; Jones, 1977b; Jones, 1987a; Bolhuis and Honey, 1994; Jones and Roper, 1997; Jones and Carmichael, 1999a). I found that a familiar screensaver video image was readily approached by chicks when they were placed individually in an otherwise novel environment (open field) and they spent much of the test period close to it (**Chapter 4**; Clarke and Jones, 1999a). These findings are consistent with those of previous studies in which chicks were exposed to familiar screensavers at one end of a runway (Jones et al, 1996a; 1998). It also strongly suggests that chicks' documented attraction to familiar objects and odours in novel environments (see above) generalizes to include video images. I also found that chicks that had received regular exposure to videos of screensaver during the first week of life showed significantly shorter durations of freezing (a high intensity fear behaviour) were more active and tended to vocalise sooner than those that had received no such stimulation. This suggests that regular exposure to abstract video images decreased chicks' fear responses when they were subsequently placed in an open field, even in the absence of such videos (**Chapter 4**; Clarke and Jones, 1999a). However, the interpretation of avian open-field behaviour has caused some controversy (Gallup and Suarez, 1980; Jones, 1987b; 1989); it has been discussed in terms of social motivation, predator defence, arousal, and exploration as well as fear (Gallup and Suarez, 1980; Suarez and Gallup, 1981; 1982; 1983b; Jones, 1989; 1996). For example, it was argued that open-field behaviour can be viewed as a compromise between opposing tendencies to reinstate contact with their companions and to evade predation by remaining still and silent (Gallup and Suarez, 1980, Suarez and Gallup, 1983b). However, social reinstatement and exploratory behaviours can only be expressed when the inhibitory effects of fear have waned sufficiently (Jones, 1987b; 1989). Furthermore, many of the effects of environmental, social, pharmacological and genetic manipulations are consistent with an interpretation of open-field behaviour based on fear (Faure et al., 1983; Jones, 1987b; 1989; 1996). Nevertheless, it has been suggested that there is no single, straightforward method of measuring general fearfulness and that the use of a number of tests and the measurement of a wide variety of behaviour patterns is advisable in attempting any such assessment (Jones and Mills, 1983; Mills and Faure, 1986). Therefore, I believe that it would be advisable to carry out additional tests of fear, e.g., tonic immobility, emergence, and approach/avoidance responses to novel objects or people (Jones, 1987b; 1996), before drawing firm conclusions concerning the potential fear-reducing properties of video stimulation. If the results of such studies were encouraging, attention could then be profitably focused on determining whether the degree of fear-reduction was dependent on the duration of exposure to video stimulation, its contents, the developmental stage at which it was applied and/or the birds' genetic background.

I also showed that video images of screensavers presented in front of the home cage for 10 minutes on 20 consecutive days reliably attracted and sustained the interest of individually housed laying hens for as long as 8 days (**Chapter 5**; Clarke and Jones, 1999b). Thereafter, interest waned gradually but it was fully reinstated when a new screensaver was shown on day 21 (**Chapter 5**; Clarke and Jones, 1999b). These responses resemble those shown by chicks that were repeatedly exposed to similar videos in their home boxes (Jones et al., 1996a; 1998). Collectively, these findings suggest that, like their responses to videos of conspecifics described in **Chapter 3**, chickens' attraction and interest in abstract video images is not dependent on the stage of development. The fact that chickens show strong interest in video images presented outside their cages also supports the hypothesis that animals are motivated to explore novel stimuli (Wood-Gush and Vestergaard, 1991; Mench, 1994; Jones, 1996; 1997; Newberry, 1999) and therefore could have important practical implications (see Section 7.2.2).

Hens' positive responses to video images outside their cages merits more detailed investigation in order to provide valuable information regarding chickens' motivation to explore novel (and easily changed) stimuli and to gather information, as well as their rates of habituation to selected visual images. For example, in the present project, birds were only exposed to the stimulus for 10 minutes per day. Future studies could ask the following questions: would hens' interest in the video images wane much more rapidly if they were subjected to a longer period of exposure every day or even continuously? Would interest be sustained at a steady level if the video images were changed every few days or might it even be increased? Answers to these questions might also provide information that could also help in the design of environmental enrichment programmes (see Section 7.2.2).

As mentioned in Section 7.1.1, it should be possible to systematically determine whether the components of a compound stimulus exert additive or interactive effects by means of video playback experiments in which these components are manipulated independently (Evans and Marler, 1991; Evans and Evans, 1999). Therefore, a video image (like the Fish screensaver) that was known to reduce fear and/or to elicit approach and interest could be dissected into its separate components in order to determine which were most effective in triggering those responses. I applied this approach in my final series of experiments (**Chapter 6**). Here, I found that when chicks were simultaneously presented with two video images at opposite ends of the home cage for brief periods on each of 10 consecutive days, they spent more time near bright rather than dull, moving rather than still, coloured rather than black & white, and complex rather than simple images (**Chapter 6**). These findings suggest that chicks have intrinsic preferences for specific features of abstract videos. Interestingly, complex images (i.e. Fish screensaver, cartoon) elicited particularly strong responses. These particular videos incorporated all the components that I had previously identified as attractive, i.e. movement, colour and brightness.

The preference tests conducted in the studies outlined in **Chapter 6** involved simultaneously presenting chicks with two video stimuli differing only in one specific feature at each end of the home box and recording approach/avoidance behaviour. This method provided basic information regarding chicks' differential attraction towards contrasting video images presented in their home environment. However, alternative interpretations have to be considered when using techniques like this, e.g, that the results actually reflected chicks' aversion to or fear of dull, still, black & white, and simple stimuli rather than their attraction towards bright, moving, coloured, and complex ones, respectively. However, this alternative interpretation is considered unlikely because if one of the paired images was aversive or frightening then, intuitively, we would not expect the chicks to spend time near it. This was never the case; on average, chicks spent at least 5.6% of the test period near the least preferred image. In future, it may be possible to test chickens' preferences for certain aspects of selected video images more rigorously, e.g., by means of operant techniques. Of course, some of the criticisms of preference testing, such as the difficulties in determining if short-term preferences will translate to long-term ones (Duncan, 1978; van Rooijen, 1982; Mench, 1994), may also apply to operant procedures. However, such techniques could allow chickens to choose the type and duration of exposure to various video images by pecking appropriate keys and thereby provide some indication of their willingness to work to view a specific video image. This methodology has already been successfully used to study pigeons' and finches' responses to video images of conspecifics (Watanabe, 1992; Watanabe and

Jian, 1993; Watanabe et al., 1993; Watanabe and Furuya 1997; Adret, 1997; Jitsumori et al., 1999) but it can be time-consuming and labour intensive.

Collectively, the findings described in **Chapters 4, 5** and **6** support previous reports that chickens are highly responsive to video images of abstract stimuli (Jones et al., 1996a; 1998). They also suggest that chickens remember and are readily attracted to such images, and that they can distinguish between two differing abstract video stimuli. This, in turn, suggests that video stimuli can be used to investigate chickens' perception of and regulation of their visual world. For example, imprinting is a powerful form of learning in the chick (Bolhuis, 1991; Rogers, 1995) and this phenomenon has been used to investigate the neural bases of memory formation and recognition (Horn, 1990). Video technology could be a particularly useful way of presenting easily manipulable stimuli in studies of imprinting and/or memory in chicks. For example, it is possible to use image-processing software to produce biologically impossible chimera (Watanabe and Jian, 1993); these could be exploited to further investigate those features of a conspecific (e.g. head, neck) that were most influential in imprinting/recognition. Abstract images, like the screensaver videos used in this project, have the added advantage that they bear no connotations of social attraction, feeding or predation. Therefore, they could be used to investigate chickens' responses to potentially influential variables such as stimulus structure, complexity, novelty, etc., without the potentially confounding effects of social motivation, hunger or predator evasion (Jones et al., 1996a).

7.2 Video playback: strategic implications

7.2.1 Tests requiring voluntary locomotion

Some behavioural tests require chickens to walk voluntarily along a predetermined path. Firstly, for example, runway and treadmill tests are often used to assess social reinstatement behaviour, and thereby illuminate individual differences in underlying sociality, as well as to investigate social discrimination. Both tests usually require a chicken to traverse a 'corridor' of variable length in order to establish contact with and/or to remain in close visual proximity to a group of conspecifics placed in a 'goal box' but, as the name suggests, a treadmill test requires the chick to work to remain close to the goal box (Launay et al., 1991; Jones et al., 1996b; Carmichael et al., 1998). Secondly, by analyzing the chickens' gait we can assess the incidence and severity of leg problems. A particularly promising technique involves placing conspecifics at one end of a corridor to encourage a chicken at the opposite end to walk along a pedobarograph (S.A. Corr, personal communication, 1997). This apparatus records the pressure placed on different parts of the feet and can thereby provide useful information concerning the bird's gait and, ultimately, any leg problems it may have (Corr et al., 1998). Thirdly, approach/avoidance tests are often used to assess fear (Jones, 1987b; 1996) because cautious investigation of a stimulus is thought to appear as induced fear levels begin to wane (Salzen, 1979; Jones, 1987b). For example, the disinhibition of fear-induced immobility in broiler chickens was examined by recording the birds' latencies to move down a 2-m runway towards familiar conspecifics after they had been exposed to a flashing light and sudden noise (Nicol and Scott, 1990).

However, the interpretation of the results of the above types of experiment could be confounded by the fact that the behaviour of the stimulus birds can influence that of the subject (Jones, 1987a; Regolin et al., 1994; Carmichael et al., 1998). For example, domestic chicks prefer to approach birds which are pecking at the environment and emitting pleasure calls rather than those showing escape behaviour and distress calling (Sigman et al., 1978). Unfortunately, the behaviour of stimulus birds is both uncontrollable and unpredictable. However, the fact that chicks and adult hens readily approach video images of feeding conspecifics (**Chapter 3**) provides encouragement. A controllable and easily manipulated video playback procedure could provide a controllable, standardized alternative to live stimulus animals.

My studies of responsiveness to video images of conspecifics only used birds of a laying strain (**Chapter 3**). However, gait analysis studies have been directed mainly at broiler chickens because of the major concern over the incidence of leg problems in meat-type birds (Kestin et al., 1992; Thorp, 1994; Corr et al., 1998). Clearly, future studies should determine if broiler chickens will also readily approach video images of conspecifics.

7.2.2 Environmental enrichment

Captive animals are often kept in barren, impoverished conditions (Chamove and Anderson, 1989; Mench, 1994; Platt and Novak, 1997) that rarely provide an opportunity for the animal to carry out important activities, such as foraging or exploratory behaviours (Chamove and Anderson, 1989; Mench, 1994; Petherick and Rushen, 1997). A lack of environmental stimulation can also lead to behavioural problems that may, in turn, compromise the animal's welfare and/or performance. For example, self-mutilation, cannibalism, coprophagy, aggression, bar biting, pacing and prolonged inactivity have been recorded in numerous farm, laboratory, zoo and domestic animals, including primates, horses, cattle, pigs, cats, dogs, mice and rodents (Chamove, 1989; Chamove and Anderson, 1989; Mason, 1991; Wemesfelder, 1990; Fraser and Broom, 1997). More specifically, chickens reared in non-enriched environments are more fearful than their 'enriched' counterparts; they are thereby more likely to show intense and inappropriate fear responses, such as panic and escape, when disturbed and these can injure or even kill the birds or their companions (Jones, 1987a; Jones, 1996; 1997). Fear can also have an extremely detrimental effect on productivity (Jones, 1997; 1997). For instance, it has been reported that fearful chickens show poor egg production (Hemsworth and Barnett, 1989; Barnett et al., 1992). Additionally, frightening or stressful procedures, such as handling or translocation from one environment to another, can result in retention of the egg, which, in turn, can result in abnormal, misshapen eggs with poor quality shells (Appleby et al., 1992; Jones, 1996). Birds laying abnormal eggs are more fearful than their "normal" counterparts (Jones, 1996). Furthermore, panic and hysteria in chickens has often been associated with reduced growth rate and food conversion efficiency (Mills and Faure, 1990b; Jones, 1996; 1997). Chickens kept in non-enriched environments may also suffer from boredom (Wemesfelder, 1990) which, in turn, could result in the development of abnormal and undesirable behaviours, such as feather pecking and cannibalism (Wemesfelder, 1990; Mench, 1992, Jones, 1996; 1997, Newberry, 1999).

Environmental enrichment (EE), which usually involves increasing the complexity of the home environment by incorporating manipulable and/or conspicuous inanimate objects, drawings etc., is often proposed as a remedial measure. Indeed, it has been suggested that EE should fulfil a number of specific aims. These include: decreasing abnormal behaviours (see above), increasing the behavioural repertoire, facilitating a more 'normal' temporal patterning of behaviour, helping satisfy animals' need for stimulation and enabling the animal to cope with challenges in a more normal way (Chamove, 1989; Chamove and Anderson, 1989; Mench, 1994; Newberry, 1995; Jones, 1996; Burghardt, 1999; Coppinger and Zuccotti, 1999; Galef, 1999). Encouragingly, EE reduced the incidence of many undesirable behaviours exhibited by a variety of captive animals, including primates, pigs, cats, dogs, mice and rodents (Wemesfelder, 1990; Bayne et al., 1991; Platt and Novak, 1997; Durrell et al., 1997; de Monte and le Pape, 1997; Wurbel et al., 1998; Mench et al., 1998). More specifically, EE reduced underlying fearfulness (Broom, 1969; Jones, 1982; Jones and Waddington, 1992; Jones, 1996), feather pecking and cannibalism (Yasutomi and Adachi, 1987; Vestergaard, 1989; Vestergaard et al., 1993; Jones, 1996), increased growth, food conversion efficiency and egg production (Jones, 1985; Gvaryahu et al., 1989; 1990; Nicol, 1992; Bell et al., 1998), and improved plumage and foot condition (Braastad, 1990) in chickens.

In my studies, I also showed that exposing chicks regularly to videos of abstract images subsequently reduced their fear of an otherwise novel environment (**Chapter 4**; Clarke and Jones, 1999a). Similar videos also attracted and sustained the interest of young chicks and adult laying hens (**Chapters 5** and **6**; Clarke and Jones, 1999a). Furthermore, presenting chicks with videos of abstract images at both ends of their home box increased their use of peripheral space within that environment (**Chapter 6**). These findings strongly suggest that videos of abstract images may have functioned as a form of environmental enrichment, at least in the context of my experiments.

There are potential problems associated with some forms of EE. For example, the types of environmental enrichment devices used in laboratory studies of chickens (see below) could be easily lost in the litter or destroyed (e.g. through pecking by large numbers of birds) in a commercial poultry house (Jones, 1996). Furthermore, not all birds may get access to the device and those that do may rapidly lose interest (Jones, 1996). Indeed, like most animals, chickens often habituate (learn not to respond) rapidly upon the repeated presentation of a stimulus (Appleby et al., 1992; Rogers, 1995; Jones, 1996). For example, hens ceased to peck at coloured cylindrical 'pecking objects' introduced into their cages (Sherwin, 1991) or at a key which activated a rotating T-shaped device with a bell attached to one end of the 'arm' and a plastic rectangle to the other (Sherwin, 1993). Mench (1994) also pointed out that "unfortunately….it sometimes appears that the selection of enrichment devices depends more on their durability, availability, cost, or appeal to the investigator (or to the company marketing them) than for any properties relevant to the animal". Indeed, the catalogue of enrichment objects is catholic. For example, children's toys, rods, hose pipes, chains, tyres, chairs, corks, tubing, shoe laces, aluminium foil, plastic bottles, balls, baubles, leg bands, straw and string have all been used (Reed et al., 1993; Lindberg and Nicol, 1994; Newberry, 1995; 1999; Jones, 1996; Mench et al., 1998; Jones and Carmichael, 1998; 1999b, Sherwin et al., 1999). Mench (1994) pointed out that "an understanding of animals' information-gathering needs is an important element in the design of environmental enrichment programs". It has also been suggested that EE procedures would intuitively be more effective if they incorporated stimuli that were known to attract animals', including chickens', interest (Newberry, 1995; Jones, 1996; 1997). Jones (1997) suggests that when determining the sorts of stimuli that chickens find attractive, the following questions should be borne in mind: are there unlearned preferences, are movement and change important, is physical interaction with the enrichment stimuli essential, and at what rates of introduction and stages of the bird's development would enrichment be most beneficial? I have provided answers to some of these questions. We now know that chicks show intrinsic preferences for specific features of abstract video images (**Chapter 6**), that moving, bright, coloured and complex abstract video images were more attractive than still, dull, black & white and simple ones (**Chapter 6**), that changing the abstract video image reinstated waning interest (**Chapter 5**), that physical interaction with an abstract video stimulus was not essential for the birds to retain interest in it (**Chapter 5**) and that their responses towards videos of conspecifics (**Chapter 3**) or of abstract video images (**Chapter 5**) was not dependent on their stage of development. The results support the suggestion that, due to the tight control and easy manipulation of selected attributes that it offers, video playback could be a useful research tool for identifying the features of visual stimuli that hens' find particularly attractive, interesting or reassuring (Jones, 1996). Indeed, my findings have provided valuable insights into chickens' preferences for specific types and features of visual stimuli. Such information is important in the design of more effective EE devices/programmes. For example, I can conclude that a moving stimulus that was changed regularly is likely to be more attractive than a static, permanent one.

It has recently been suggested that video technology could be used as a form of EE *per se* for laboratory primates (Washburn and Rumbaugh, 1992; Andrews and Rosenblum, 1993; Lincoln et al., 1994; Platt and Novak, 1997; Harris et al., 1999). For example, Platt and Novak (1997) found that both socially and individually housed rhesus monkeys readily watched videos of conspecifics and humans; exposure to these stimuli made them more active and they slept less during exposure to videos than to a blank monitor. Additionally, both paired and singly caged chimpanzees spent more time watching television than playing with a ball or a mirror, even when all these stimuli were available for up to 6 hours a day over a number of years (Brent and Stone, 1996); the greater attraction to the televised stimulus was probably due to its changeable nature. Televised images are currently being used as a form of environmental enrichment for primates kept at Twycross Zoo, Warwickshire, UK (documentary entitled 'Molly's Zoo', British Broadcasting Corporation, 1998). Video stimulation is also used as a form of environmental enrichment for pet cats. Indeed, specially produced videos, like 'Video Catnip' (PetAVision Inc., Morgantown, WV, USA) and 'Cat TV' (Global Video Inc., d.b.a. Media West Home Video, Lake Grove, OR, USA), are now commercially available. These contain edited compilations of animals, such as birds, squirrels, chipmunks and fish. Both companies claim that the videos are "designed to entertain cats" and anecdotal evidence suggests that 'Video Catnip' is "most effective on indoor cats" and that "the cats least impressed were [those] that spent most of their lives outdoors" (see http:/www.cattv.com/main.htm, the PetAVision Internet website). It should be noted that there have been some suggestions that non-interactive stimulation, e.g. visual complexity, is a less 'effective' form of enrichment than manipulable ('controllable') objects, e.g. toys (Schapiro and Bloomsmith, 1995; Sambrook and Buchanan-Smith, 1996; 1997). For example, singly-housed rhesus monkeys used "physical enrichment" (various toys, a manipulable mirror and a piece of fleece) and "feeding enrichment" (various food-filled enrichment devices, frozen juice and fresh produce) for up to 21 min per hour, whereas "sensory enrichment" (silent videos of conspecifics engaged in "normal behaviours" placed outside their cages) attracted their interest for less than 2 min per hour (Schapiro and Bloomsmith; 1995). Based on these findings, the video images were deemed "of little benefit" (Schapiro and Bloomsmith; 1995). However, only 12 videos of conspecifics were used and these were presented for approximately 8 hours a day for 3 months. Therefore, it is likely that the monkeys' lack of interest in the stimulus was due to habituation. Indeed, the authors admit that "the repetitive presentations of highly similar tapes may account for part of this lack of [utilization of the enrichment]" (Schapiro and Bloomsmith, 1995). Despite their low interest, the monkeys exposed to the videos still showed increased exploration. Furthermore, the videos were watched more by subjects that were housed in indoor buildings, i.e., not exposed to live interactions between neighbouring groups (Schapiro and Bloomsmith; 1995). This implies that the monkeys were more attracted to the video images when there were no other forms of external visual stimulation and, in turn, suggests that visual stimulation could be used as a form of EE in this context. Indeed, consideration for enriching the external environment of farm and laboratory animals other than primates is receiving growing support (Newberry, 1995). For example, farmed foxes preferred a cage with a platform (Mononen et al., 1993) or one that afforded them an unobstructed view of their surroundings (Mononen et al., 1998). More specifically, hens readily looked through spyholes to view novel objects (McKenzie et al., 1998), broiler chickens readily entered areas peripheral to the home pen when these contained novel objects that were changed daily (Newberry, 1999), and playing the radio made laying hens calmer, less aggressive and more productive (Jones and Rayner, 1999). Additionally, chicks become attracted to abstract video images displayed on a monitor located just outside their cages (Jones et al., 1996a; 1998; **Chapter 6**) and we now know that adult laying hens also show strong interest in abstract video images presented outside their cages (**Chapter 5**; Clarke and Jones, 1999b).

There are a number of benefits of using video stimulation as a form of EE. Firstly, it provides a relatively convenient and safe method of introducing variety into an animal's visual environment. Secondly, its pervasive nature also means that numerous animals can receive such stimulation at any one time (Jones, 1996; Platt and Novak, 1997). Thirdly, video stimuli can be easily changed, thus minimizing the likelihood of habituation that would probably occur with static, unchanging devices. Therefore, using video stimulation as a form of EE could overcome some of the problems encountered with the more traditional forms of enrichment mentioned above. While it is clearly not practicable to introduce television monitors into poultry sheds, it has been suggested that the provision of projected images as a source of visual stimulation and enrichment merits further investigation (Jones, 1996). Animal housing, including many poultry sheds, is often characterised by flat, featureless walls and floors, and an absence of internal structure (Newberry, 1995). Projecting images onto the walls and the ceiling could increase environmental complexity and perhaps provide conspicuous cues (often absent in large commercial poultry houses) that might help the birds to form spatial maps of their environment and thereby facilitate their location of important resources within the poultry shed (Jones, 1996). Encouragingly, this notion has already received positive feedback from some sectors of the poultry industry.

7.3 Conclusions

I have demonstrated that chickens were responsive to both biologically relevant (videos of conspecifics) and biologically neutral (screensavers and cartoon) video images. Firstly, videos of conspecifics elicited approach in both chicks and adult hens. Secondly, chickens remembered and showed increasing attraction towards abstract video images. Thirdly, chicks showed clear preferences for certain features of such abstract videos. These findings may have important strategic implications for certain behavioural studies and for environmental enrichment. They also illustrate that video technology, which offers controllability and ease of manipulation, is a potentially powerful research tool for the study of poultry behaviour.

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