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MIRROR PRESENTATION AND PLAYBACK OF SPECIES-SPECIFIC AGGRESSIVE VOCALIZATIONS AS REINFORCERS IN ADULT DOMESTIC CHICKENS (*Gallus gallus*)

by

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ABSTRACT

The present three experiments, designated as I, II, and III, attempted to establish the positive reinforcing effects of mirror and audio (the playback of recorded crows) presentation, alone and combined, for adult Domestic Chickens. The study also sought to determine if the reinforcing effects of mirror and audio presentation combined are additive.

A review of previous research emphasizes the significance of these stimuli in the study of intraspecific aggression, since they have been shown to be sufficient enough to elicit behavior normally occurring in response to a conspecific. It has been demonstrated as well that mirror stimulation and the playback of conspecific vocalizations can function as positive reinforcers for a variety of species.

The reinforcers were presented separately and in combination in three reinforcement periods which alternated with three extinction periods. A baseline period and a shaping period were also given. The operant response was key pecking and reinforcement was on a CRF schedule. Two Bantam cocks and four Old English Black and Red Gamecocks served as subjects.

In three final sessions of Experiment III, mirror termination was presented as negative reinforcement for the operant response in order to ascertain if the cock would work to terminate the mirror.

Mirror and audio presentation, alone and combined, proved to be effective positive reinforcers for one cock in Experiment II. Moreover, the magnitude of the reinforcing effects of the stimuli presented in combination was greater than that of either stimulus alone. The findings of this experiment are discussed in relation to several topics, including their significance for Seitz's (1940) law of heterogeneous stimulus summation.

However, the stimuli did not act as positive reinforcers in Experiments I and III. Fear and to a lesser extent displacement activities and aggression were exhibited by the cocks in the chamber. Although it is not suggested that they operated systematically, several factors were present in these experiments which might have inhibited operant responding by the subjects. These factors are discussed in some detail.

Mirror termination was not an effective negative reinforcer. But, preliminary evidence indicated that, had a different operant response been required, one the cock was prepared to associate with mirror termination, the subject might have learned to terminate the mirror.

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CHAPTER 1

Several topics related to the purpose of this study are presented in the introduction. First, in order to introduce the subject, the distinction is made between interspecific and intraspecific aggression. Then, some important characteristics of intraspecific aggression and of the stimuli releasing it are mentioned. Seitz's (1940) law of heterogeneous stimulus summation, as it relates to aggression-releasing stimuli, is presented. Following these topics, there is an analysis of avian intraspecific aggression which is examined in terms of two potential aggression-releasing stimuli, mirror presentation and the playback of recorded species-specific vocalizations.

The behaviors elicited by mirror presentation and the playback of species-specific vocalizations and the reinforcement effects of these two stimuli are noted in some detail. Although the extensive references given in the text concerning these two aspects of the stimuli refer primarily to birds, references to other species are also included, specifically in the discussion of the reinforcement effects of mirror presentation. Since the number of species presented with mirror images is limited, the exemption of references other than those to birds might result in a loss of invaluable data.

Because the behavior of the species under investigation can affect an experimental situation (e.g. Breland & Breland, 1972), the agonistic behavioral repertoire of Domestic Chickens, the subjects of this current study, is outlined. The nature of aggressive encounters between Chickens and their aggressive vocalizations are also mentioned.

The final section of the introduction deals with the purpose of the present study.

Interspecific Aggression

In order to survive, individuals and species must cope with environmental conditions. Aggression is one means of adapting to a complex environment.

A distinction must be made between interspecific and intraspecific aggression. While these can have behavioral patterns in common, they are often clearly distinguishable from one another (Barber, 1971; Eibl-Eibesfeldt, 1967, 1970, 1972; Lorenz, 1966, 1970). For example, the method of fighting a conspecific may be different from attacking a predator. The Oryx Antelope (Oryx gazella beisa), among other horned ungulates, never uses its horns to gore a conspecific but will use them against a predator (Eibl-Eibesfeldt, 1970; Matthews, 1964). The motivation, or inner drive, of the predator is also different from that of the animal attacking a conspecific and this difference can be seen in the expressive movements of the animal (Lorenz, 1966).

Predator-prey relationships comprise most interspecific fights. For the predator, the survival value of such encounters, e.g. as a means of obtaining food, is evident.

Interspecific aggression also includes the defensive fighting of the prey (Davis, 1964; Johnson, 1972; Tinbergen, 1970). Aggressive contacts between species occur for other reasons too, e.g. between Blackcaps (*Sylvia atricapilla*) and Whitethroats (*Sylvia communis*) over the same territories (Wynne-Edwards, 1962). Occasionally, "mistaken identity" results in an animal of one species being attacked by an individual of another species as if it were a conspecific rival, because it happens to present some stimuli normally releasing attack in that other species (Tinbergen, 1970).

Intraspecific Aggression

Intraspecific fighting deals specifically with aggressive contacts between conspecifics and this is "aggression in the proper and narrower sense of the word" (Lorenz, 1966, p. 22). Excluding predation, most fights between animals are intraspecific in nature. Moreover, these encounters tend to be confined to the same-sexed members of a species (Tinbergen, 1958, 1970). Only a few animal species do not show some intraspecific fighting, such as schooling Herrings (Eibl-Eibesfeldt, 1967) and worms and oysters which lack a discernable physical means of inflicting injury (Southwick, 1970).

The occupation of a territory is frequently a requisite for the occurrence of intraspecific contacts (Eibl-Eibesfeldt, 1970; Tinbergen, 1970). Other situations can also result in hostile behavior, such as competition for mates or for positions of leadership (Barber, 1971; Cloudsley-Thompson, 1965; Lorenz, 1966, 1970). The violation of an animal's individual space very often releases fighting too (Craig, 1928; Marler, 1956; Willis, 1966). In the laboratory, intraspecific aggression can be elicited by a number of unconditional stimuli, such as electric footshock, intense heat, or a physical blow (Gentry, 1968). However, Mountjoy and Vanderweele (1970) found that pain-elicited aggression, e.g. electric shock to the wings, was infrequent and inconsistent in Chickens. Various reinforcement schedules are also capable of eliciting conspecific aggression, at least in Pigeons (Cherek & Heistad, 1971; Gentry, 1968; Webbe, DeWeese, & Malagodi, 1974). Extinction-induced aggression in primates has been investigated as well (Hutchinson, Azrin, & Hunt, 1968). The attack behavior observed in such studies involves seizure or contact with such force that physical injury can result (Hutchinson, 1972).

Possibly the most important survival function of intraspecific aggression is to ensure that a species is well-distributed over an inhabitable area of land (Barber, 1971; Eibl-Eibesfeldt, 1972; Lorenz, 1964; 1966; Tinbergen, 1970). Among other considerations, this dispersal of animals helps to prevent exhaustion of food resources which could result from overcrowding (Lorenz, 1966, 1970). The distribution of a species through combat is so important that intraspecific aggression appears to have been favored by natural selection (Eibl-Eibesfeldt, 1961; Lorenz, 1966; Southwick, 1970). Generally, the more aggressive individuals of a species have priority in access to food, shelter, and mates (Southwick, 1970).

Remarkably, fights between conspecifics infrequently end in death or serious injury, despite the presence of potentially dangerous weapons, such as claws, hooves, or antlers (Eibl-Eibesfeldt, 1961, 1967, 1970; Johnson, 1972; Matthews, 1964; Southwick, 1970; Tinbergen, 1970). Under natural circumstances, such encounters do not typically develop into true, destructive, or overt fighting (Craig, 1928; Carthy & Ebling, 1964; Johnson, 1972; Tinbergen, 1958). It would not be advantageous in terms of survival for a species to have its members invariably fatally wounded in fights, since the defeated animal is not necessarily less healthy or viable than the winner, possibly just younger and/or inexperienced (Cloudsley-Thompson, 1965; Eibl-Eibesfeldt, 1961; Matthews, 1964). Also, the reserve of animals in a species needed to replenish losses incurred by predation, accidents, or natural death would dwindle if one animal died or was severely wounded in every combat (Eibl-Eibesfeldt, 1972). On the other hand, in certain situations intraspecific killing could conceivably promote a species survival. For example, it could reduce a large population to prevent further destruction of necessary resources (Skinner, 1969). However, overt fighting among conspecifics is generally limited to unusual circumstances, such as in captivity when the animals are confined, or in intergroup conflicts when individuals of one social group invade the territory of another group, or because of sudden social disorganization (Southwick, 1970).

As a general rule, therefore, most intraspecific agonistic encounters do not advance to the stage of physical contact (Johnson, 1972). Some constraints upon overt aggression are necessary to prevent the complete disruption of more favorable social interactions, such as mating and care of the young (Southwick, 1970). One constraint results from the fact that in many species destructive fighting has been ritualized into intimidatory or threat displays which are comprised of intention actions derived from actual combat patterns. Consequently, fights are ordinarily no more than tournaments (Barber, 1971; Carthy & Ebling, 1964; Frings & Frings, 1964; Lorenz, 1966; Matthews, 1964; Moynihan, 1955). Thus, ritualized intraspecific aggressive displays have evolved as a means of obtaining certain advantages, e.g. territories, mates, and food, without actually having to fight for them (Moynihan, 1955). Threat displays obviate the risk of physical damage and death (Lorenz, 1966; Moynihan, 1955). Usually, these displays are sufficient to cause an opponent to retreat or flee (Frings & Frings, 1964; Moynihan, 1955). But, they can intensify and become overt attacks if one or the other of the combatants does not submit or withdraw (Frings & Frings, 1964; Moynihan, 1955). Intimidatory displays are not all visual in character; various vocalizations and scent signals have threat functions as well (Tinbergen, 1970), e.g. the choking of the Black-headed Gull (<u>Larus ridibundus ridibundus</u>) (Moynihan, 1955), the staccato shrieks of the shrews of China and India (Barber, 1971), and the scent signals of cats (Lorenz, 1966).

Ritualized fighting is of critical importance in species with potentially dangerous weapons (Eibl-Eibesfeldt, 1961). It has been observed and recorded in a number of animals: in fish such as Cichlids (Cichlidae), in snakes and lizards such as the Rattlesnake (Crotalus ruber) and the Fence Lizard (Lacerta agilis), in birds such as Turkeys (Melegrididae), and in horn-and-antler-bearing hoofed animals such as the Nilgau Bull (Boselaphus trogocamelus) (Eibl-Eibesfeldt, 1967).

Lorenz (1964) emphasized the point that ritualized intraspecific aggression can fulfill its essential survival functions only if the vanquished animal is as effectively and permanently subdued as if it had suffered real physical injury. The loser, he noted, is often completely intimidated and retains the memory of the loss for long periods of time. Among Chickens, once social dominance between two birds has been established, the subordinate individual avoids its superior and retreats if threatened. Reverses in dominance are rare among hens, although more frequent among cocks (Allee, Collias, & Lutherman, 1939).

Submissive and appeasement postures have also been extensively evolved throughout the animal kingdom to end, if not to prevent, confrontations (Eibl-Eibesfeldt, 1967; Matthews, 1964; Moynihan, 1955). If introductory threat displays fail to prevent an aggressive encounter between two wolves, the losing animal ordinarily presents its neck to the other (Eibl-Eibesfeldt, 1961, 1967; Matthews, 1964). This posture is effective in ending combat in most cases because the winning animal cannot generally overcome its inhibitions to bite its opponent.

Animals without weapons or those whose capacity to escape is highly developed tend to have little or no mechanisms inhibiting intraspecific aggression (Eibl-Eibesfeldt, 1967, 1972). After a brief exchange of viscious biting, Hamsters (Cricetus cricetus) can escape from an opponent with a few leaps without being pursued (Eibl-Eibesfeldt, 1967, 1972).

Stimuli Releasing Aggression

Much of the research on intraspecifc aggression has dealt with selected characteristics of individual stimuli eliciting such behavior (Thompson, 1964). Some investigators, e.g. Seitz (1940), have also concerned themselves with the effects of these stimuli presented in combination.

Any behavior, while it may be activated by an internal drive, is normally released by specific stimuli present in the animal's environment (Eibl-Eibesfeldt, 1970; Lorenz, 1966). Each animal can perceive only a limited portion of all the potential stimuli available in its biotope (Eibl-Eibesfeldt, 1970; Hess, 1962). Out of these perceived stimuli, only a few are capable of evoking instinctive or innate reactions (relatively fixed and stereotyped behavioral patterns) (Hess, 1962; Reynolds, 1968). Such stimuli have been called "key" stimuli (Eibl-Eibesfeldt, 1970), "eliciting" stimuli (Lorenz, 1966; Reynolds, 1968), "sign" stimuli, or "releasers" (Hess, 1962).

Those stimuli evoking intraspecific aggression are frequently simple (Eibl-Eibesfeldt, 1970) and come from the rival itself (Eibl-Eibesfeldt, 1967). They are specific to a particular species and are different even in closely related species, especially if they live in the same habitats (Tinbergen, 1970). Various body parts, vocalizations, odors, and behavioral postures are capable of eliciting aggression (Eibl-Eibesfeldt, 1970; Tinbergen, 1970). For instance, the red breast feathers of the English Robin (Erithacus rubecula) release fighting in conspecifics (Lack, 1953). Fish such as Cichlids and many rodents threaten their rivals with vocalizations (Eibl-Eibesfeldt, 1970). Macrosmatic animals, e.g. Guinea Pigs, intimidate opponents with odors (Eibl-Eibesfeldt, 1970). Threat postures of male Three-spined Sticklebacks release fighting in male conspecifics (Tinbergen, 1970).

The law of heterogeneous stimulus summation. Aggressive behavior can be elicited by more than one key stimulus (Eibl-Eibesfeldt, 1970). Keenleyside (1971) found that several key features of conspecifics can release aggression by nest-guarding Longear Sunfish (Lepomis megalotis): relatively deep body, conspicuous opercular patch, black eye with bright red iris patches, and black pelvic fins. Moreover, the combination of key stimuli often evoke a much stronger response. Tinbergen (1951) found that the red belly of a species model released fighting in Sticklebacks, as did the model in the head-down position. Combined, these two cues elicited much more intense aggressive behavior. Seitz (1940) referred to this phenomenon as the law of heterogeneous stimulus summation: *viz.*, two or more releasing stimuli, which can be presented individually, become additive in their effectiveness in eliciting a behavior if they are combined. He found that, in Cichlids (*Astatotilapia strigigena*), the blue coloration, the black mark on the fins, and the behavioral patterns of lateral position, spreading fins, tail beats, and ramming thrusts when presented alone released aggression of varied intensity, but, when combined, evoked a much stronger response. However, it should be noted that stimuli do not always result in the simple additiveness of their effects upon behavior (Eibl-Eibesfeldt, 1970).

Avian Aggression

The visual displays of avian aggression, particularly those which are intraspecific in nature, have received considerable attention. Visual threat displays have been observed and recorded in diverse bird species, from Chaffinches (*Fringilla coelebs*) (Lack, 1941) to Burmese Red Junglefowl (*Gallus gallus spadiceus*) (Kruijt, 1964).

On the other hand, the nature and communicative significance of the vocalizations associated with intraspecific aggression have been examined to a lesser extent and usually in a somewhat cursory manner. The presence of calls in aggressive contexts have been noted in a number of studies. Mason (1940) reported the "growling mew" note of combative Corn-crakes (Crex crex). The crowing of the male Starling (Sturnus vulgaris) and the "rattle" of the female are clearly aggressive (Davis, 1959). The Steller's Jay (Cyanocitta stelleri) has several such calls (Brown, 1964). Aggressive calls have also been heard from Jays (Garrulus glandarius) (Goodwin, 1949), Chickens (Gallus gallus) (Konishi, 1963; Wood-Gush, 1955), Painted Buntings (Passerina ciris) (Thompson, 1965), Gambel Quail (Luphortyx gambelii) (Ellis & Stokes, 1966), Myrtle Warblers (Dendroica coronata) (Ficken & Ficken, 1966), and American Goldfinches (Spinus tristis) (Coutlee, 1967). Meyerriecks and Baird (1968) observed that singing was an integral part of the aggressive behavior of the Blue-winged Warbler (Vermivora pinus) and the Brewster's Warbler (Vermivora leucobronchialis). Vocalizations associated with conspecific fighting have also been recorded in Turkeys (Hale, Schleidt, & Scheen, 1969), in Canaries (Serinus canaria) (Mulligan & Olsen, 1969), in Savannah Sparrows (Passerculus sandwichensis) (Gobeil, 1970), and in Yellow-billed Magpies (Pia nuttalli) (Verbeek, 1972).

Mirror Presentation and Recorded Vocalizations

The study of aggressive behavior in birds has involved the use of models (e.g. Edwards, Hosking, & Smith, 1947; Feekes, 1972; Lack, 1953; Spurr, 1974), mirror presentation, and tape-recorded songs and calls. This current study is concerned with the latter two techniques.

Mirror presentation. The aggressive reactions of different avian species towards their mirror images or towards their reflections in mirror-like surfaces have interested a number of researchers.

"Shadow-boxing" by birds in windows had been described previously by Dickey (1916). He noted that this behavior, which tended to be both vigorous and persistent, was seen to occur in Anthony Towhees (*Pipilo crissalis senicula*), California Linnets (*Carpodacus mexicanus frontalis*), and Western Mockingbirds (*Mimus p. leucopterus*). Ritter and Benson (1934) recorded in more detail the image fighting of Brown Towhees (*Pipilo fuscus petulans*) and cited examples of it in the Cardinal (*Richmondena cardinalis*) and the Robin (*Turdus migratorius*). Buxton (1937) reported that an English Robin repeatedly attacked an image of itself in a silver tray and Smith (1974) observed a Great Spotted Woodpecker (*Dendrocopos major*) pecking at its reflection.

Field studies have also examined the aggressive responses of birds towards their mirror images. Brown (1937), after placing a triple-sided mirror in his garden, observed three species of birds attacking their images: a Pied Wagtail (*Motocilla a. yarrellii*), a Blackbird (*Turdus m. merula*), and a Great Titmouse (*Parus m. newtoni*). Aggressive displays elicited by mirror images were also recorded in Ringed Plovers (Edwards et al., 1947; Smith & Hosking, 1955), in Oyster-catchers (*Haematopus ostralegus occidentalis*) (Edwards *et al*., 1948; Smith & Hosking, 1955), and in Corn-crakes (Mason, 1941, 1951). Andrews (1966a) noted a Cedar Waxwing (*Bombycilla cedrorum*) also interacting intensely with its reflection. Under more controlled conditions, Stout, Wilcox, and Creitz (1969) found that Glaucous-winged Gulls (*Larus glaucescens*) exhibited their full range of aggressive behavior, including postures and vocalizations, towards their mirror images. In the laboratory, Gallup and Capper (1970) showed that House Sparrows (*Passer d. domesticus*) behaved aggressively towards their images.

However, aggressive displays are not the exclusive outcome of mirror stimulation in birds. Smith and Hosking (1955) noted that a Common Sandpiper (*Actitis hypoleucos*) fled fearfully from its reflection whereas Andrews (1966b) observed a Slate-colored Junco (*Junco hymenalis*) which appeared to be quietened by its mirror image. Although Parakeets (*Melopsittacus undulatus*) persistently interacted with their reflections, there was little or no evidence of aggressive behavior (Gallup & Capper, 1970). Chicks restrained briefly before their mirror images showed exaggerated tonic immobility reactions (Gallup, 1972). But, White Plymouth Rock Chicks (*Gallus gallus*) and Turkeys (*Meleagris gallopavo*), when reared with a mirror, preferred to spend more time with their reflections than with same-aged conspecifics (Schulman & Anderson, 1974). Therefore, while aggressive behavior tends to dominate the actions of some bird species towards their mirror images, there are exceptions to this tendency.

Reinforcement effects of mirror presentation. Recently, the reinforcement value of mirror presentation has come under experimental scrutiny. In operant situations, this stimulus has proven to be an effective reinforcer for diverse animal species, including fish, birds, and primates.

When made contingent upon an operant response, mirror image presentation was found to be an effective reinforcer for Red Gavillan cocks (Thompson, 1964), for Siamese Fighting Fish (*Betta splendens*) (Goldstein, 1967; Hogan, 1967; Thompson, 1963), and for Paradise Fish (*Macropodus opercularis*) (Melvin & Anson, 1970). Moreover, prior social experience can affect the reinforcing value of mirror presentation (Baenninger, 1970). This reinforcer was more effective for *Bettas* which had been dominant in a previous pair encounter than for those which had been subordinate. The opportunity to view their mirror images also reinforced operant responses in Pigtailed Monkeys (*Macaca nemestrina*) and in a Rhesus Monkey (*Macaca mulatta*) but not in a Japanese Macaque (*Macaca fuscata*) (Gallup, 1966). In another operant situation, surrogate-reared Rhesus Monkeys preferred their reflections whereas feral animals preferred a conspecific (Gallup & McClure, 1971). While Thompson (1964) reported that mirror presentation maintained lower response rates than a live conspecific, Gallup, Montevecchi, and Swanson (1972) found, on the other hand, that mirror stimulation constituted a more effective reinforcer than a same-aged conspecific in Chicks.

Aggressive displays appear to be the typical outcome of using mirror presentation as an operant reinforcer. Such a consequence has been demonstrated in Siamese Fighting Fish (Baenninger, Bergman, & Baenninger, 1969), in Paradise Fish (Melvin & Anson, 1970), and in Chicks (Gallup, Montevecchi, & Swanson, 1972). But, aggression is not exclusively evoked by this stimulus. Goldfish (*Carassius auratus*) showed no evidence of stereotyped displays towards their mirror images (Gallup & Hess, 1971) whereas male *Bettas* exhibited sexual behavior towards their mirror images (Goldstein, 1973).

Vocalization playback experiments. The results of playback experiments have indicated that recorded songs and calls are sufficient enough to elicit behavior normally occurring in response to another bird (Ickes & Ficken, 1970). Under the appropriate circumstances, recorded vocalizations may evoke aggressive reactions.

Not only do birds respond selectively to species-specific vocalizations when they are played back to them but they also respond to those of particular conspecifics. This has been demonstrated in several species of birds, i.e. in the Eastern Meadowlark (*Sturnella magna*) and the Western Meadowlark (*Sturnella neglecta*) (Falls & Szijj, 1959), the White-crowned Sparrow (*Zonotrichia leucophrys*) (Milligan, 1966), the Green Sandpiper (*Tringa ochropus*) and the Solitary Sandpiper (*Tringa solitaria*) (Oring, 1968), and the Blue-winged Warbler and the Golden-winged Warbler (*Vermivora chrysoptera*) (Ficken & Ficken, 1969). American Redstarts (*Setophaga ruticilla*), Chestnut-sided Warblers (*Dendroica pensylvanica*), and Black-throated Green Warblers (*Dendroica* *virens*) but not Yellow Warblers (*Dendroica petechia*) responded differentially to their two song-types (Ficken & Ficken, 1970).

The response of birds to recorded species' vocalizations appears to depend upon, among other variables, the song or call *per se*, the season, and the circumstances under which it is played back. Using recorded songs to elicit aggressive responses from male Ovenbirds (*Seiurus aurocapillus*) with territories, Weeden and Falls (1959) reported that these birds reacted in the same hostile manner as in a natural encounter with a rival male. Moreover, the responses were quicker and more intense towards songs of non-adjacent males than towards those of neighbouring males. Unmated American Redstarts behaved aggressively towards playbacks of species-specific song in the centre of their territory and to a lesser extent towards those on the periphery (Ickes & Ficken, 1970). After mating, they defended both the centre and periphery of their territories about equally against the recording.

When aggressive calls were presented during mirror presentation, Stout *et al*. (1969) found that the duration of the aggressive responses of Glaucous-winged Gulls towards their mirror images was significantly increased. The combination of the playback of aggressive calls and mirror presentation apparently was additive in their aggression-releasing effects.

Reinforcement effects of conspecific vocalizations. Studies concerned with the reinforcement effects of conspecific (territorial) songs in birds are limited in number. However, research with Chaffinches (Stevenson, 1967; Stevenson-Hinde, 1972) and with White-crowned Sparrows (Dobson & Petrinovich, 1973) have found that conspecific song could serve as positive reinforcement for these birds, although it does not appear to produce a high steady rate of responding, at least under the circumstances of these studies.

The Domestic Chicken (Gallus gallus)

Of the four original wild species of Fowl, the Red Junglefowl (*Gallus bankiva or gallus*), the Gray Junglefowl (*G. sonnerati*), the Ceylon Junglefowl (*G. layfayetti*), and the Javan Junglefowl (*G. varius*), the first is believed to be the chief ancestor of all the modern domestic breeds of Chickens (Jull, 1952; Zeuner, 1963). Because of their pugnacious nature, it is speculated that Fowl were first domesticated and selected for their fighting abilities, then for qualities consonant with religious practices and finally for food production (Jull, 1952; Peters, 1913; Wood-Gush, 1959; Zeuner, 1963).

One of the underlying bases for social organization among Domestic Fowl is aggressive behavior (Allee *et al.*, 1939; Guhl, 1953; Siegel, 1960). The formation of social orders, or peck orders, depends essentially upon the outcome of initial pair contacts (Allee *et al.*, 1939; Guhl, 1953). When a number of strange Fowl are placed together, fights occur between pairs of birds until each bird has engaged all others. The winner of each contest has then earned the right to peck (peck right) the loser, without being pecked in return. Thereafter, the losing bird usually avoids close contact with its superior (s) and, in the event of a "revolt", does not fight back vigorously (Allee et al., 1939). However, some birds submit passively without fighting, perhaps because of lack of aggressiveness, lack of fighting skills, or poor health (Collias, 1943; Guhl, 1945, 1956). A hierarchy of Chickens developed in this manner is called a peck order, a situation in which the social position of each bird is determined by the number of individuals in the flock it pecks (Guhl, 1945; Masure & Allee, 1934). This hierarchy tends to be a straight line in small flocks, is relatively more stable among hens than cocks, and is formative among pullets. Although in mixed flocks all the males tend to dominate all the females, cocks do not generally peck hens (Allee et al., 1939; Collias, 1943; Guhl, 1945, 1953, 1956; Guhl, Collias, & Allee, 1945).

Chickens do not attend to social position per se. They act and react to individuals and according to former pair-contact experience. Each bird develops special habits in relation to every member of its flock (Guhl, 1945). It avoids close contact with some individuals and dominates others. Guhl (1945) and Douglis (1948) suggested that the cumulative effect of the determination of peck orders is the promotion of some degree of integration in the flock which precludes the recurrence of fighting every time two birds meet in a competitive situation. Therefore, "competition at the individual level helps to give rise to an organized group which is better suited to co-operate as a social flock" (Douglis, 1948, p. 175).

Several physiological and psychological factors are known to contribute to achievement of dominance between same-sexed birds. Heredity, greater strength, greater weight, maturity, and physical condition (e.g. slightness of moult) are associated with attainment of dominance (Allee *et al*., 1939; Douglis, 1948; Potter, 1949). Familiarity with the area in which an encounter takes place, presence of flock-mates, previous experience (e.g. high social rank increases the chance for success in meeting with a stranger), and the behavior of the combatants (e.g. a bird intimidated by an apparently unfrightened stranger may submit without fighting) are some psychological factors involved in dominance (Allee *et al*., 1939; Douglis, 1948; Potter, 1949).

A high rank in a flock has definite advantages: precedence at the food trough, roosts, nests, dusting areas, and greater freedom of movement; cocks mate more and sire more offspring although high rank, at least in large flocks, inhibits mating in hens (Guhl, 1945, 1950, 1953, 1956; Long & Godfrey, 1952; Masure & Allee, 1934).

Intraspecific aggressive encounters. The following is a brief composite of descriptions of aggressive encounters between male adult Domestic Chickens. There are two types of aggressive displays, frontal and side (or lateral) threat displays, and both can give way to overt fighting (Feekes, 1972).

During the frontal threat display, the birds orient towards one another. Faces become red and flushed; heads are lowered; necks are stretched horizontally or obliquely; neck hackles are raised continuously or intermittently; tails become more erect; and, wings are drooped (Collias, 1943; Feekes, 1972; Fisher & Hale, 1957). The opponents may jockey for a more favorable position in relation to one another, with each small head movement of one bird followed precisely by the other, one may submit to the other, or they may jump immediately at one another with wings flapping, kicking, and pecking at the other's comb and wattles (Collias, 1943; Fisher & Hale, 1957; Kruijt, 1964). During the side display, the bird tilts its back and tail towards its opponents. In this lateral orientation, tail feathers are spread and the neck ruff may be slightly raised so that the bird appears larger than normal (Feekes, 1972). The displaying bird may circle around the other, or walk parallel to it, or remain in one position (Feekes, 1972).

A fight may last a few seconds or more than an hour (Fisher & Hale, 1957). The losing bird usually retreats and tries to escape from its superior. Its face pales, its feathers become depressed and the bird appears to be confused and panic-stricken (Collias, 1943). Submission may take the form of motionless interaction (McBride, Parer, & Foenander, 1969). In this situation, the loser starts to avoid and then stands still; the dominant cock stands motionless too but it is the first to move away. If a fight has been particularly severe, the winner may make several false starts before actually moving off (McBride _et al_., 1969). If the loser moves first, it is attacked. The winner of the encounter maintains much the same bearing it had during the fight and only gradually does its aggressive posture subside (Collias, 1943). Fighting between hens tends to be less severe than that between cocks (Collias, 1943).

The development of behavior patterns in Chickens has received somewhat less attention and the research done in this area has concentrated particularly on aggression and those factors influencing its expression (e.g. Craig, Biswas, & Guhl, 1969; Dawson & Siegel, 1967; Foreman & Allee, 1959; Kruijt, 1964; McBride, 1958; Mountjoy & Vanderweele, 1970).

Intraspecific aggressive vocalizations. Domestic Fowl have a rich repertoire of intraspecific calls (Konishi, 1963). Of interest here are those calls which are in the nature of threat or challenge.

Collias and Joos (1953) and Konishi (1963) noted the presence of "grumbling" sounds during the sparring matches of two cocks. While these particular aggressive calls were not given during the physical attack itself, they occurred frequently and intensely before and after actual combat.

Crowing, too, functions as a warning or challenging call to other males (Collias & Joos, 1953; Guhl & Fisher, 1969; McBride *et al*., 1969; Wood-Gush, 1955). Males high in the rank order have been observed to attack a subordinate immediately when the latter crowed (Siegel, Phillips, & Folsom, 1965). Unlike the other intimidatory vocalizations, crowing tends to be less harsh sounding (Collias & Joos, 1953) and varies from individual to individual, even in a sample of males that are genetically homogeneous (Konishi, 1963). But, in terms of the individual, crowing is relatively fixed (Konishi, 1963; McBride *et al*., 1969). Behaviorally, "the crowing of the cock is an extremely difficult....trait to interpret" (Wood-Gush, 1959, p. 323). In a study of feral Domestic Fowl, McBride *et al*. (1969) found that crowing occurs in a variety of contexts. "Functionally, the crow is concerned with outgroup avoidance and ingroup attraction" (McBride *et al*., 1969, p. 167). The outgroup effect is emphasized in territorial crows; and ingroup attraction predominates in the "all clear", "mating", "assembly", and "roosting" crows (McBride *et al*., 1969).

Purpose

The preceding review underscores the significance of mirror presentation and the playback of recorded species-specific vocalizations as techniques for investigating intraspecific aggression in birds. Mirror presentation (e.g. Smith & Hosking, 1955) and audio presentation (e.g. Weeden & Falls, 1959) are sufficient to elicit aggressive responses from animals that normally occur in response to a conspecific. Mirror image and live male encounters, and perhaps to some extent audio presentation and live male contacts, result in aggressive displays and, as much as possible, in fight sequences similar to those in encounters between males (Goldstein, 1971). Moreover, mirror presentation (e.g. Thompson, 1963) and audio presentation (e.g. Stevenson, 1967) can serve as positive reinforcers for an operant response.

The primary purpose of this study was to establish the positive reinforcing effects of mirror and audio presentation, alone and combined, for an operant response in adult Domestic Fowl. Thompson (1964) found that mirror presentation could reinforce an operant response in Red Gavillan cocks but its reinforcing effects were not established apart from those of food and water. Even though he presented evidence removing the possibility of responding on the key for mirror presentation resulting from generalization from one key to another or from chaining of responding on the mirror key leading to food and water, only the absence of food and water reinforcement could eliminate any subtle effect (s) they might have on mirror reinforcement. In this investigation, therefore, only one operandum was available in the testing chamber and food and water as reinforcers were not present.

Unlike an earlier study in which he was concerned with both the reinforcing effects and the aggression-eliciting qualities of three visual stimuli (mirror, moving and stationary models) (Thompson, 1963), Thompson (1964) was not directly interested in the aggression-releasing properties of mirror presentation. But, because the reinforcing effects of such stimuli do appear to covary with the degree to which they elicit aggressive displays (Thompson, 1963), this study is concerned with the aggression-eliciting properties of both mirror and audio presentation.

Seitz's (1940) law of heterogeneous stimulus summation states briefly that the magnitude of the effect resulting from the combination of stimuli capable of eliciting aggression is greater than that of any key stimulus alone. The question then arises concerning whether or not a parallel law or corollary exists in terms of the summation of the reinforcing effects of aggression-releasing stimuli. In other words, would the magnitude of the reinforcing effects of the combination of such stimuli, here mirror and audio presentation, be greater than that of either stimulus alone ?

CHAPTER 2

Three experiments were performed and these are designated as I, II, and III. Various factors which arose during the course of the study required changes in some aspects of the experimental procedure, in dimensions and features of the experimental apparatus, and in maintenance variables. Such alterations are noted in the appropriate sections of each experiment.

Experiment I

Method

Subjects. Two experimentally naive adult Bantam cocks (*Gallus gallus*), designated A and B, served as subjects. They were housed in individual cages measuring 48.90 cm x 41.28 cm x 38.42 cm, with both the cages and their occupants kept under conditions of near continuous lighting and ventilation. Water and food were supplied *ad lib*. Their feed consisted of MLM scratch grain, eggshells, granite grit, lettuce, and cod liver oil. During this experiment, one cock required medication in the form of eyedrops (Isopto Fenicol) and terramycin. The subjects were exercised daily when it was possible to do so. The Bantams were purchased from the Fin, Feather, & Fur Shop, Thunder Bay, Ontario.

Apparatus. The experimental space was a Gerbrands' pigeon operant chamber (33.66 cm x 25.58 cm x 32.40 cm). A two-way mirror (29.86 cm x 29.86 cm) set in a fan-cooled metal box (36.84 cm x 20.96 cm x 36.20 cm) was used for mirror reinforcement and a Sony cassette recorder for audio reinforcement. A Gerbrands' control box programmed the occurrence of the reinforcers. A hand control switch provided direct experimenter control of reinforcement. A standard mirror (24.78 cm x 34.94 cm) was used outside of the response-contingent situation. The food delivery system of the chamber was disconnected for the duration of the reported experiments.

The two Plexiglas sides of the chamber were covered with translucent paper. The aluminum side of the testing space contained the operandum, a plastic translucent key-disc illuminated by a red bulb. A 25 w light was secured on top of the chamber.

The mirror box was situated along side of the uncovered wall of the chamber, at right angles to the operandum wall. When lighted from behind with four 60 w bulbs, the mirror acted as transparent glass. But, when these lights were off, a true mirror effect was produced. This effect was enhanced by the house light on top of the chamber. The cassette recorder was placed to the right of the mirror box. One side (60 min) of a C-120 tape contained the audio reinforcement.

An event recorder with two pens recorded the number of reinforced and nonreinforced responses; a counter recorded the total number of responses made on the operandum.

The apparatus was located in a room far removed from where the cocks were housed. This experimental room was not soundproof.

Procedure. The design of the conditioning experiment in the chamber was as follows: one baseline period (2 days), a shaping period (indefinite number of days), and three reinforcement periods (5 days per period) alternating with three extinction periods (2 days per period). Each cock spent 1 hr per day in the chamber between 10 a.m. and 1 p.m. With the exception of the first baseline hour (or session), the subjects were observed in the testing chamber.

The purposes of the baseline period were to measure prereinforcement levels of responding on the operandum and to allow the subjects to become accustomed to the chamber. The purpose of the extinction periods was to measure post-reinforcement responding on the disc.

Prior to the experiment, the shaping period was not fixed in terms of the number of days alloted to it. This flexibility was necessary to allow the individual bird time to learn to key peck and to become accustomed to the experimental area under reinforcement conditions. Both successive approximation and autoshaping techniques were tried in order to induce operant responding by the subjects. The successive approximation method was the first technique tried. Those responses which lead to the desired response, e.g. the bird's head turned towards the operandum and later pecking directed at the chamber's sides, were reinforced by mirror or audio presentation; as the appropriate response, key pecking, was approached, the range of these responses was gradually restricted by allowing those now peripheral to the operant response to extinguish. However, since it became apparent that the Bantams were not learning to key peck by this method, the second technique tried was autoshaping, as outlined briefly by Engberg, Hansen, Welker, and Thomas (1972). A signal, in this experiment the operandum light switched on/off, was followed by nonresponse-contingent reinforcement, mirror or audio presentation. At least 50 autoshaping reinforcements were given to each cock per session. Because of the practical limitations of the experimenter's involvement in this procedure, the cocks' behavioral responses towards the reinforcers were not recorded. When the subject pecked on the operandum during a shaping hour, the session following it was the first hour of the initial reinforcement period. The response-contingent part of the experiment was ended after the shaping period for both cocks.

A response on the operandum during a reinforcement session resulted in 15 sec of reinforcement--mirror, audio, or mirror and audio presentation. During mirror reinforcement sessions, the cassette recorder, connected directly to the operant chamber, was turned off. When the audio reinforcement condition was operative, the mirror box was plugged directly into an outlet rather than into the control box in order to keep the lights on in the mirror box. Reinforcement was on a continuous basis (CRF): every response on the operandum was reinforced with the exception of those responses made during reinforcement. These latter responses did not alter the duration of ongoing reinforcement.

To prevent order effects arising from the reinforcement presentation during the first two reinforcement periods, bird A was assigned mirror presentation first, followed by audio presentation in the second period and bird B was given audio presentation initially, followed by mirror presentation in the second period. Both cocks received mirror and audio presentation in the third reinforcement period.

Outside of the chamber, but in the experimental room, the cocks' behavioral responses, aggressive or fearful, towards their mirror images were recorded in three 1 hr sessions. The birds were free to approach or to avoid their reflections. On one 5 min occasion, the Bantams were placed together in the experimental room and their aggressive and submissive reactions were observed.

The crow of the Bantam cock was chosen as the aggression-associated call to be used as audio reinforcement. To obtain a tape of relatively uninterrupted crowing, crows were first recorded in the home cages and then re-recorded with the interval between crows reduced to a minimum of 2 or 3 sec. This tape was played back to the cocks in their home cages to ensure that they would react aggressively towards it.

Results

The responses of the cocks towards the re-recorded crows were aggressive and consisted of orientation towards the sound source, crowing, and erection of neck feathers.

Baseline period. During this period, no operant responses were recorded for either bird. An analysis of cock A's behavior during the observed session showed the following responses, with the frequency of occurrence of each response noted after it: pecking (6) on all sides of the chamber and grid, calls (17) which consisted of barely audible clucking, beak opening (2), and immobility (5), totaling 36 min. Crowing, preening, and defecation were absent.

An examination of bird B's behavior indicated the following: defecation (1), crowing (11), other calls (9), pecking (7) on all sides of the chamber, beak opening (13), eye closure (1), preening (2), body shaking (3), head shaking (2), tail wagging (1), and immobility (3) totaling 15 min.

Shaping period. Neither cock pecked on the operandum during this period. The total duration of this period was 11 hr for cock A and 15 hr for cock B. The duration of the successive approximation method was 5 hr for cock A and 7 hr for cock B; and, the duration of the autoshaping technique was 6 hr for cock A and 8 hr for cock B.

Bird A's responses towards its mirror image and bird B's reactions towards the audio reinforcement were recorded.

Table 1 indicates the behaviors observed during each session (numerals 1-5 for cock A and numerals 1-7 for cock B) and the total number of times the individual behaviors occurred each session.

Preening (161) was the most frequent behavior performed by bird A during the 5 hr; preening bouts lasted only a few seconds and were confined to breast and neck feathers. Calls (79) followed by immobility (50) and beak opening (11) were the next most frequent behaviors observed. The length of bird A's immobility episodes ranged from a few seconds to 25 min. Body shaking, body stretching, wing stretching, and alert posture were each performed once. Cock A received a total of 239 shaping reinforcements.

The most frequent behavior for cock B was preening (174), generally of a few seconds duration and confined primarily to breast feathers. Pecking (113) was also frequent; immobility was noted 73 times, ranging from a few seconds duration to 10 min. Beak opening occurred 40 times. Neck hackle erection was seen 4 times and head zigzagging twice. The least frequent behavior performed by bird B was yawning (1). The number of shaping reinforcements totaled 222 for this subject.

Autoshaping. This method also failed to induce key pecking in the cocks; bird A had received no fewer than 300 autoshaping reinforcements and bird B no fewer than 400.

Outside of the chamber, the reactions of the Bantams towards their reflections were recorded. Table 2 shows the

TABLE 1

Behaviors Observed and Frequency of Occurrence during the Shaping Sessions

Behaviors Observed	Cock A					Cock B						
	1	2	3	4	5	1	2	3	4	5	6	7
Alert Postures	-	-	-	-	1	5	3	-	1	6	-	1
Beak Opening	-	4	1	3	3	5	3	4	2	10	6	10
Body Quivering	-	-	-	-	-	-	-	-	1	2	-	-
Body Shaking	1	-	-	-	-	1	-	1	3	-	1	-
Body Stretching	-	1	-	-	-	3	-	-	1	2	-	-
Calls	4	18	7	26	24	5	4	2	2	-	3	1
Defecation	-	-	3	1	-	1	-	1	1	1	-	1
Eye Closure	-	-	-	3	4	-	-	-	-	8	7	5
Head Scratching	-	-	-	-	-	-	-	-	1	-	1	1
Head Shaking	-	-	-	2	2	2	2	1	-	3	9	6
Head Zizagging	1	5	-	1	2	-	-	-	-	-	2	-
Immobility	7	19	9	9	6	17	23	4	5	8	6	10
Neck Hackle Erection	-	-	-	-	-	4	-	-	-	-	-	-
Pecking	5	5	1	6	3	17	17	18	19	16	9	17
Preening	18	21	38	27	57	5	8	6	40	41	29	45
Wing Stretching	-	-	-	-	1	-	-	-	-	-	-	-
Yawning	-	-	-	-	-	-	-	-	-	-	-	1

behaviors performed by cocks A and B and the number of times they occurred per session (numerals 1-3), both when the cocks were oriented towards their mirror images and when they were not. The period of non-orientation includes the behaviors observed before and after exposure to the mirror.

Immobility (41) was the most frequently observed behavior when bird A was oriented towards its reflection and one of the least frequent responses (1) when it was not looking at its mirror image. Wing flapping (27, 11) and calls (20, 26) were frequent during periods of orientation and non-orientation towards the mirror. Preening occurred 25 times when the cock was not oriented towards the mirror and 11 times when it was. Pecking (11, 11) was observed during orientation and non-orientation towards the mirror. When cock A viewed its reflection, head scratching (1) and the ruffling of feathers (1) were the least frequent occurring behaviors; when the bird was not looking at its image, beak opening (1), body stretching (1), eye closure (1), and head shaking (1) were the least frequent.

Beak opening (50) followed by immobility (25), eye closure (19), and wing flapping (19) were the most frequent behaviors displayed when bird B viewed its reflection; tail wagging (1), beak clacking (1), and defecation (2) were the least frequent. Alert posture was noted 3 times during mirror orientation. When the subject was not oriented at the mirror, wing flapping (34) and preening (32) were the most frequently performed behaviors; alert posture (1)

TABLE 2

Behaviors Observed and Frequency of Occurrence during Three Sessions outside of the Chamber

Behaviors Observed	Towards the Mirror						Away from the Mirror					
	Cock A			Cock B			Cock A			Cock B		
	1	2	3	1	2	3	1	2	3	1	2	3
Alert Posture	-	-	11	1	6	6	-	-	1	-	-	1
Beak Clacking	5	4	-	1	-	-	7	3	1	-	-	-
Beak Opening	-	3	2	14	14	22	-	-	1	2	1	-
Body Shaking	2	1	-	-	-	-	1	1	-	2	-	-
Body Stretching	2	-	-	1	1	-	1	-	-	2	1	1
Calls	6	9	5	-	6	-	11	11	4	2	2	4
Defecation	2	-	1	1	1	-	1	3	1	2	1	1
Eye Closure	1	3	6	-	6	13	-	1	-	-	-	-
Hackles Raised	-	-	-	3	3	-	-	-	-	-	-	-
Head Scratching	1	-	-	-	-	4	-	-	-	-	1	1
Head Shaking	-	1	3	1	1	5	-	-	-	1	2	1
Head Zigzagging	2	5	-	1	2	-	-	-	-	-	-	-
Immobility	7	2	32	4	6	18	1	-	-	-	-	-
Pecking	1	6	4	-	1	2	2	5	4	1	2	4
Preening	1	5	6	-	5	15	-	-	-	1	11	19
Ruffled Feathers	-	-	1	-	-	-	-	-	-	-	-	-
Tail Spreading	-	-	-	3	-	-	-	-	-	-	-	-
Tail Wagging	-	-	2	-	-	1	1	2	-	3	4	4
Wing Flapping	3	2	22	1	2	17	-	5	6	6	11	17
Wing Stretching	5	-	-	3	-	-	1	3	1	4	2	-
Yawning	-	-	-	-	3	1	2	3	1	1	-	-

and yawning (1) were the least frequently frequently performed. Immobility was not observed when this subject was not viewing its mirror image. Cock B spent less time before the mirror per session, ranging between 30 and 40 min, than did bird A.

When both cocks were placed together in the experimental room, bird A established itself dominant over bird B. Initially, both subjects lowered their heads and raised their neck hackles; however, cock B quickly dropped its aggressive posture and retreated. Cock A pursued B four times but veered off each time before reaching its opponent. Bird A finally charged cock B, jumping at and pecking the retreating bird. After this, cock A walked around the room, pecking at but not eating seeds; cock B remained in a corner of the experimental room until removed by the experimenter.

Discussion

Mirror presentation and the playing of recorded crows did not reinforce operant responding in the Bantams. Rather, the stimuli/reinforcers appeared to be operating in a punishing or aversive manner. The occurrence of immobility and displacement activities seems to underscore the negative qualities of these stimuli. But, it is possible that these behaviors were induced and/or enhanced by factors other than those related to the reinforcers present in the experiment, such as the poor health of the cocks, the proximity and gaze of the experimenter, and manual restraint. These and other factors are discussed in more depth in the overall discussion. The appearance of aggressive behavior in the experiment appears to support the hypothesis that factors other than the reinforcers resulted in behaviors antagonistic to learning to key peck. In the overall discussion, the characteristics of the immobility responses, the aggressive behavior, and the displacement activities, as well as their relevance to the findings of this study, are examined also.

In the three sessions outside of the experimental space, aggressive and fear responses were elicited by the mirror images, as were displacement activities. However, unlike mirror presentation, the playing of the recorded vocalizations outside of the chamber released aggressive behavior exclusively from the Bantams.

There is the strong possibility that the failure to establish the positive reinforcing effects of mirror and audio presentation in this experiment was due to the presence of confounding variables which interfered with the birds learning to key peck and was not due to the reinforcers as such. Therefore, in Experiment II, some of the more preventable confounding factors, e.g. manual restraint, were eliminated altogether or reduced in extent as much as possible. Unfortunately, not all such factors could be eliminated, e.g. the noisy location of the experimental room. Because of the overall impression of the lack of aggressiveness of the Bantams, two Gamecocks were purchased, as these birds are reputably quite aggressive and fight fiercely (Fennell, 1945).

Experiment II

Method

Subjects. Two experimentally naive Old English Black and Red Gamecocks (*Gallus gallus*), 4 and 5 years old, were used as subjects. These cocks, designated C and D, were housed in cages measuring 137.16 cm x 41.28 cm x 38.42 cm in separate areas of the housing laboratory and were kept under conditions of near constant lighting and ventilation. The cocks had continuous access to water and food, the latter consisting of grain, eggshells, grit, lettuce, the occasional banana, and raw liver daily. During this experiment, one subject required medication, terramycin, and as a result of ill health was eventually eliminated from the experiment. The cocks were purchased from Mr. D. Wilson, Milton, Ontario.

Apparatus. Although the apparatus used in this experiment was similar to that used in Experiment I, there were a few modifications. A larger experimental space (61.75 cm x 45.42 cm x 51.44 cm) incorporating the aluminum side of the Gerbrands' chamber was required for these cocks. The four bulbs in the mirror box were reduced to two, in order to help decrease the amount of heat in the unventilated experimental room. A BRS solid state unit was added to the equipment and it now controlled the occurrence of the reinforcers. Two counters on the programmer recorded the number of responses made (but not those made during reinforcement) and reinforced. Three pens were operative on the event recorder: pen 1 recorded the number of responses made on the operandum during reinforcement, pen 2, the number of responses made during the extinction and baseline periods, and pen 3, the number of reinforced responses. Pens 1 and 2 also recorded the reinforced responses. With a CRF schedule, pens 2 and 3 were the same during the shaping and reinforcement periods.

Procedure. In a brief session, prior to the conditioning experiment, the re-recorded crows of the these cocks were played back to them in their home cages to ensure that their responses towards the taped crows were aggressive.

In order to determine the behavioral responses of the cocks towards their reflections, the standard mirror was placed in the home cages, 1 min each presentation, for a total of 35 presentations, with at least 1 min elapsing between presentations. The mirror was presented to each cock five times the first day and ten times a day for the three next days. The last presentation occurred 1 week before the conditioning part of the experiment. The number of pecks delivered at the mirror were counted during the last 20 presentations.

The design of the conditioning experiment in the chamber was the same as that in Experiment I: one 2-day baseline period, a shaping period--bird C received six 2 hr sessions--, and three 5-day reinforcement periods alternating with three 2-day extinction periods. The duration of the daily sessions of the baseline, reinforcement, and extinction periods was reduced to 30 min a day instead of 1 hr. The subjects were observed only during the final baseline session. Because a self-shaping procedure was used to eliminate the presence of the experimenter in the testing area, the duration of the daily shaping sessions was increased to 2 hr. This was necessary to allow the cocks to become accustomed to the chamber, to learn to peck the operandum, and to do so within the first 30 min of the session. When the cock pecked more than once during the first 30 min of a shaping session, the next session initiated the first session of the initial reinforcement period. All sessions were held between 10 a.m. and 2 p.m.

Cock C was given mirror-then-audio reinforcement during the first two reinforcement periods and both mirror and audio presentation in the final reinforcement period. Cock D received audio presentation in the first reinforcement period, followed by mirror presentation and then mirror and audio presentation in the second and final reinforcement periods.

Results

The cocks' reactions to the playing of the re-recorded crows were aggressive; neck hackles were raised and crowing was elicited from each subject. The birds oriented towards the sound source.

Baseline period. Neither cock pecked at the operandum during this period. In the final session, bird C engaged in the following behaviors: defecation (2), pecking (6) on all sides of the chamber, calls (6) consisting of barely audible clucking, preening (4), head scratching (1), eye closure (3), immobility (3) for a few seconds each episode, and head drooping (1). Crowing did not occur. The following behaviors were observed for cock D: pecking (8) on all sides of the chamber, eye closure (3), immobility (1) with a duration of 2 min, preening (5), and calls (2) consisting of barely audible clucking. Crowing and defecation were not observed.

Shaping period. Cock C received 12 hr of shaping; bird D, however, received only one 2 hr session. At this point, cock D was eliminated from the experiment because of ill health. When cock C had made more than one response during the first 30 min of a session, the shaping period was ended. During this period, bird C received a total of 85 reinforcements; an additional 35 responses were made during reinforcement.

Reinforcement periods. During cock C's first reinforcement period (mirror presentation), the total number of responses made on the disc for the 5 days was 38 with 23 of these reinforced. The range of the total number of pecks over the period was 10; the range of the reinforced pecks was five. During the second reinforcement period (audio presentation), the total number of pecks on the disc for the 5 days was 58, 17 of these were reinforced. The range of the total number of pecks was 29 and that for the reinforced pecks was five. In the final reinforcement period (mirror and audio presentation), the total number of responses was 112, with a range of 18, and the total number of reinforced pecks was 43, with a range of eight.

Extinction periods. Cock C made one response during session one of the first extinction period and six responses during session one of the second extinction period. No responses were made during the second sessions of these periods. During the first and second session of the third extinction period, 22 and 12 responses were noted.

Figure 1 illustrates graphically the total number of responses made and those reinforced during each of the reinforcement periods and the total number of responses made during each of the extinction periods.

In the home cage, during 28 out of 35 presentations of the mirror, cock C responded aggressively towards its reflection, with neck hackles erected, pecking, and jumping at the mirror image. Bird C pecked at its image 51 times during the final 20 presentations. This subject was immobile before the mirror during seven of the presentations. Cock D responded aggressively towards its reflection 33 out of 35 presentations; during two presentations, the cock remained immobile. The total number of pecks delivered at the mirror in the final 20 presentations was 67. The aggressive behavior of cock D included raising the neck ruff, crowing, pecking, and jumping at the mirror image. Rapid and repetitive clucking before and after the attacks at the image were also heard.

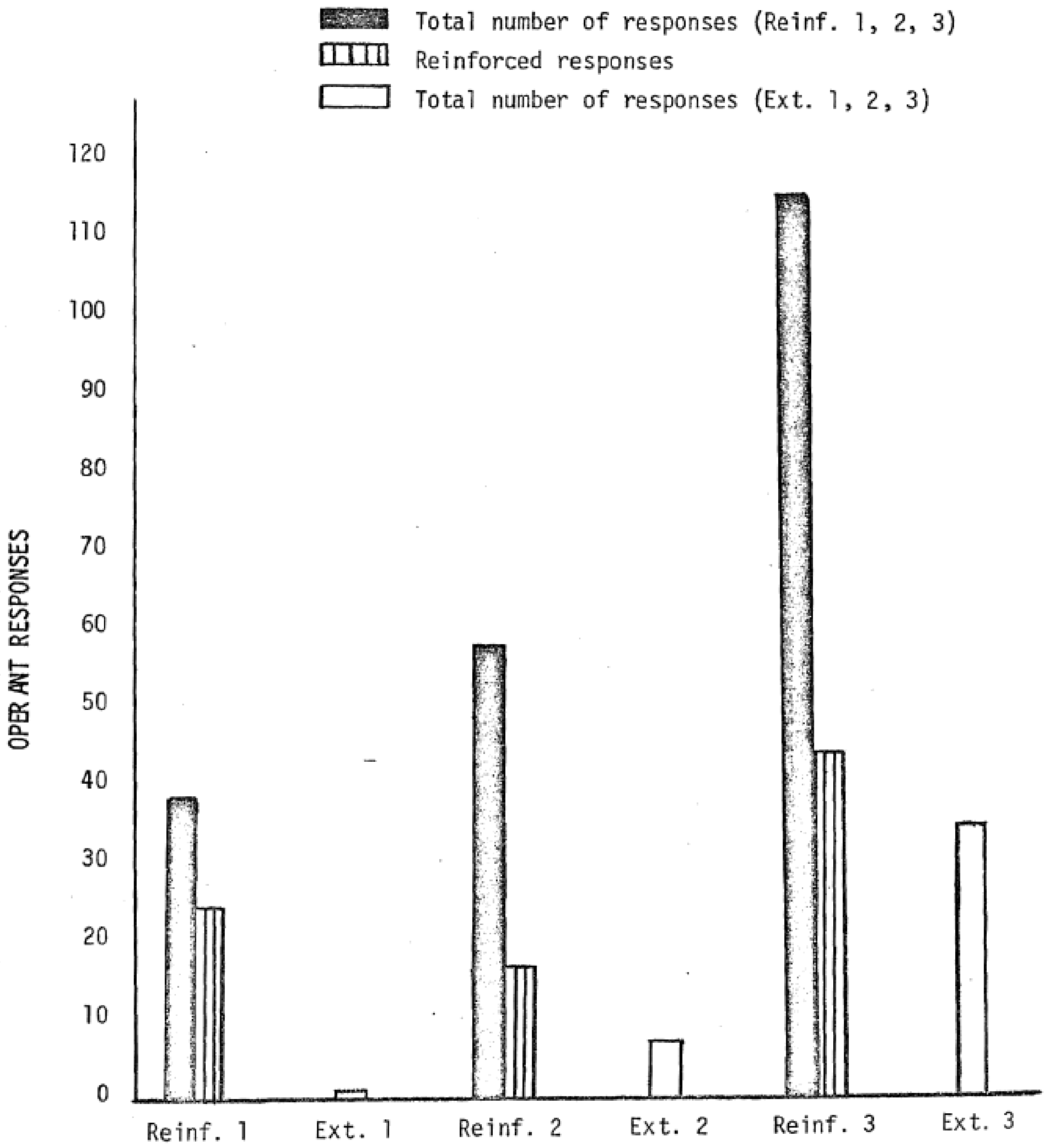

Fig. 1. The total number of responses made and reinforced during the reinforcement periods (Reinf. 1, 2, 3) and the total number of responses made during the extinction periods (Ext. 1, 2, 3).

Discussion

Examination of the data for cock C indicate that both mirror and audio presentation, alone or combined, could act as positive reinforcers for adult Domestic Fowl in an operant situation, without the presence of food and water reinforcement. The total number of responses made each reinforcement period increased over the three periods and the total number of reinforced responses in the final reinforcement period amounted to more than the combined total of the first two reinforcement periods. The data for this subject appear to suggest that the reinforcing effects of aggression-releasing stimuli are additive, i.e. the magnitude of the reinforcing effects of the combination of mirror and audio presentation was greater than the reinforcing effects of either stimulus alone. The effectiveness of each reinforcer alone, however, cannot be realistically evaluated in terms of the present data particularly because one cock did not complete the experiment.

The drop in the number of reinforced key pecks in the second reinforcement period, relative to the first reinforcement period, might reflect the lesser reinforcing effectiveness of audio presentation. Stevenson (1967), Dobson and Petrinovich (1973) also noted that audio presentation produced a low rate of responding in their experiments. However, a factor apparent in the data of this experiment that could at least partially account for this drop was that, after the first extinction period, the recovery of responding did not occur until the second session of this period.

The possibility exists that other behaviors, such as fear and/or displacement activities, might have been prevalent in the reinforcement periods, particularly since behaviors reflecting these tendencies were observed during the final baseline session. If such was the case, then the opportunity to key peck might have been reduced during each session. The increase in responding over the three reinforcement periods might possibly reflect the waning of these other postulated tendencies and the increasing of aggression.

An adequate comparison of the mirror presentation data with those of Thompson's (1964) is impossible, especially since the data as Thompson presented them are not comparable with those of this experiment, e.g. his data were presented as logarithms of responses per 24 hr session over 61 days. Also, while other studies of the effectiveness of mirror presentation as a positive reinforcer for various animals used a CRF schedule (e.g. Hogan, 1967), as did this experiment, Thompson used fixed-ratio schedules, ranging from FR 1 to FR 25. Aside from these considerations, Thompon's Red Gavillans spent a much longer period of time in the chamber where they received food, water, and social stimulation. This point is discussed further in the overall discussion.

Responding during the first two extinction periods dropped off rapidly but was particularly abrupt during the first period. Operant responding did not cease altogether during the third extinction period as it had done in the earlier periods. The rapid extinction of responding after mirror reinforcement is not uncommon; it was found to be the case for Bettas (Hogan, 1967) and Red Gavillans (Thompson, 1964) but not the case for Paradise Fish (Melvin & Anson, 1970). However, resistance to extinction increased over the three extinction periods and was especially evident during the third period. Using single reinforcers, successive acquisition and extinction studies with rats have shown increased, constant, or decreased levels of resistance to extinction across extinctions (Wolach, Latta, Manshio, & Aderman, 1972). Perhaps, a different reinforcer each reinforcement period over successive acquisitions and extinctions increases the resistance to extinction in some manner across the extinction periods.

In the home cages, the responses of the cocks towards their mirror images and the playback of their crows were quite aggressive, although immobility was observed during some of the mirror presentations.

Two additional Old English Black and Red Gamecocks were purchased in order to replicate the finding that mirror and audio presentation, alone or combined, could act as positive reinforcers for an operant response. Maintenance variables were manipulated in order to generate more robust reinforcing effects. A negative reinforcement contingency was also implemented to determine if a cock would work to terminate mirror presentation.

Experiment III

Method

Subjects. Two Old English Black and Red Gamecocks (*Gallus gallus*), each about 6 months old, served as experimental subjects. Both cocks had fully developed combs and were capable of crowing. Although kept in the same area of the animal laboratory, the cocks were housed separately in the cages described in Experiment II. A hen was also present in each cage. The diet was the same as that in the second experiment but without the addition of liver which was unavailable. Food and water were always available in the home cages. However, before several shaping sessions, food was reduced to one-quarter the usual amount. Ventilation and lighting were nearly continuous in the laboratory.

Apparatus. The apparatus was the same as that used in Experiment II. For three final sessions, adjustments were made on the equipment so that mirror termination rather than mirror presentation became the reinforcer for an operant response. Because of technical limitations, similar adjustments were not made for auditory reinforcement.

Procedure. The recorded crows used in Experiment II were played to the cocks in their home cages. The purpose of this was to ensure that the audio reinforcer would elicit aggressive responses from them. The design of the conditioning situation in the testing chamber was unchanged from Experiment II, i.e. a baseline period followed by three reinforcement periods alternating with three exinction periods.

The subjects were not observed during the baseline period which consisted of two 30 min sessions. Daily sessions were held between 10 a.m. and 1 p.m.

During 43 hr of shaping sessions, one bird, designated as E, received mirror reinforcement and during 24 hr of shaping sessions, the other bird, designated as F, received audio reinforcement. Apart from the 1 hr daily sessions, cock E was left in the chamber for one 23 hr session. Because of equipment limitations, cock F did not receive a similarly extended session. Grain and water were present in the chamber during this long session and food alone was also available during an additional 6 hr for cock E and 9 hr for cock F. The chamber was cleared of spilled grain before the next session. Food was not present in the chamber during the initial 14 hr for bird E or the first 15 hr for bird F.

Both successive approximation--12 hr for bird E and 14 hr for bird F--and self-shaping methods were used during the shaping period. The successive approximation method was typically terminated during the session when the cocks showed signs of immobility. Exposures to the stimuli were sometimes given after the onset of immobility. When immobilization occurred, because the experimenter's presence might result in the enhancement of the response, the subject was then left alone in the chamber for the remainder of the session. Usually, the experimenter did not remain in the experimental room longer than 10-15 min per session. However, during two of cock E's sessions and one of cock F's, the experimenter stayed the entire session. During one session, the behavior of each cock in response to reinforcement presentation was recorded in detail. In another session, cock E was given repeated exposures to the mirror.

The experimenter was entirely absent from the experimental room for 31 of bird E's sessions and 10 of bird F's. Cock E's 31 hr included the 23 hr session. The subjects were left alone during some of the sessions in order to reduce any experimenter effects on the birds' behavior.

In three 1 hr testing sessions in the chamber, mirror termination rather than mirror presentation became the reinforcer for cock E. The cock's responses during these sessions were noted. Experiment III was terminated after these sessions.

One week prior to the baseline period, in order to determine the subjects' reactions towards their mirror images, a standard mirror was placed in the home cage of eac cock for 1 min on four occasions. Evidence of aggressive or fear responses were recorded.

Results

The playback of the re-recorded crows elicited crowing, raised neck hackles, and general agitation, both during the crowing and after its cessation. The agitated behavior included pacing and threat displays directed towards the hens.

Baseline period. No responses on the operandum were recorded for either bird during this period.

Shaping period. Cock F pecked the operandum once during the period; cock E did not peck the disc at all. Cock E received a total of 189 shaping reinforcements (mirror presentation) and cock F, a total of 133 shaping reinforcements (audio presentation).

During the second session, the responses of the cocks towards their respective reinforcers were recorded. Cock E was given 10 mirror presentations and cock F received 14 audio presentations. The first four exposures elicited from cock E aggressive responses including approaching the mirror image with raised hackles and pecking at the image. Head zigzagging occurred once after a mirror exposure. Four presentations elicited crowing as the predominant response during the reinforcement. After mirror exposure, tail wagging, ground pecking, preening, and head shaking were each observed once. Up to this point, the cock was more mobile, when compared to bird F, in the chamber. In the last 30 min of the session, during the tenth exposure to the mirror, the subject became immobile, for a period of 19 min. Immobility was terminated by the experimenter at the end of the session. Eye closure, with the eyes closed for most of the response, beak opening (5), and yawning (2) were noted during the reaction. Defecation and distress calls were not observed.

Cock F became immobile on three occasions, after three (later) audio presentations, for a total of 38 min. Head shaking and pecking the disc wall each occurred once during audio presentation. This cock was not as mobile as bird E; although it looked around the chamber, the bird remained in one position, i.e. its head and body were oriented towards the disc wall the entire session. During the majority of audio presentations, cock F assumed an alert posture (9) during the exposure. After the exposures, it immediately looked around.

The experimenter observed that the initial responses of the cocks towards their reinforcers were aggressive, including raising neck hackles and pecking the image by cock E and crowing with occasional neck hackle raising by cock F. Cock E also crowed during the initial minutes of the sessions, both before and after mirror presentation. However, after several exposures to the reinforcers, ranging from 5-27 exposures for cock E and 1-19 exposures for cock F, the subjects became immobile or their mobility was sharply reduced. Some exposures to the reinforcers, not more than five, were occasionally given to the birds after immobility had begun; on one occasion, cock E was given 93 mirror presentations during which time crowing and immobility were the predominant responses. Bird E typically either turned its head and body away from the mirror or averted its head only. Eye closure always accompanied either movement. Distress calls were absent during the experimenter's presence; defecation rarely occurred.

Once, both birds became immediately immobile upon their release in the chamber, session seven for cock E and session 16 for cock F.

When released in the chamber, cock F always immediately overturned the plastic container when grain was present, thereby spilling the seeds onto the chamber's floor. In the experimenter's presence, cock F never pecked at the grain, before or after spilling it. Cock E rarely pecked at the grain more than five or six times in the experimenter's presence. Very little grain was ever missing at the end of cock E's sessions. During cock E's 23 hr session, half of the water was gone but at the end of the session only a little grain was missing.

In the three final sessions, the behavioral responses of bird E towards the mirror-termination reinforcer and the mirror-on condition were recorded. Cock E received a total of 84 shaping reinforcements (mirror termination) and, of these, 56 were given during the last session. Bird E became immobile once for a period of 49 min during the first session. The subject was immobile on six occasions, for a total of 53 min, during the second session and immobile four times, for a total of 50 min, the third session. During the first two sessions, a total of 28 mirror terminations elicited several responses: crowing (6), pecking the sides of the chamber (4), immobility (5), preening (4), head averted away from the mirror box when the lights were on (5), head towards the mirror box when the lights were on (2), and head shaking (2). The longest immobility responses in the first 2 hr followed the final exposures of the reinforcers. After the first mirror termination in the third session, cock E became immobile for 46 min. In the final 14 min of the hour, the subject was given 55 presentations of the reinforcer; the bird remained immobile for 4 min and then terminated the long immobility response. In the last 10 min, cock E lapsed in and out of immobility, with yawning (14) and crowing (10) occurring at the same time. The cock was immobile for about 50 min of this session.

Crowing preceded and terminated immobility four times during the 3 hr. Apart from the crowing elicited by mirror termination, 49 crows were recorded during the three sessions.

During immobilization, eye closure, tail depression, and the head averted away from the mirror were the main features of the response. The eyes were closed for the most part during the reactions. Yawning (29) and beak opening (9) also accompanied immobility.

Aside from following mirror termination, preening (2) and head shaking (1) occurred in the chamber. Head scratching (3) and body shaking (1) were noted too, although distress calls and defecation were absent.

On four 1 min occasions when the standard mirror was placed in the home cages, cock E approached and then withdrew from its mirror image. This was repeated two or three times before the bird finally withdrew from it entirely. Cock E approached the mirror aggressively each time, with neck hackles and wings lowered. Cock F behaved in a similar manner towards its reflection on two occasions; on the other two occasions, the cock became immobile. Eye closure was not observed either time. Immobility was terminated with the removal of the mirror. Pecking at the image, crowing, defecation, and distress calls were absent from the four trials.

After the mirror's removal, cock E threatened and then pecked the hen also present in the home cage. This occurred after each trial. Although cock F threatened the hen present in its home cage, the bird did not peck at her.

Discussion

With the exception of cock F's one peck on the operandum, the subjects did not peck the disc for mirror or audio presentation. Mirror and audio stimulation did not function as positive reinforcers. In the chamber, the reinforcers appeared to be eliciting fear responses, aggressive behaviors, and to a lesser extent displacement activities. Outside of the chamber, the playing of the recorded vocalizations elicited aggressive responses exclusively whereas mirror presentation released mainly approach and withdrawal behavior from the cocks.

Mirror termination did not function as a negative reinforcer for cock E. Immobility was the principal behavior in the chamber; crowing and displacement activities were more frequent.

The presence of food and water in the chamber had no apparent effect on the behavior of the cocks, i.e. in reducing the frequency or duration of fear responses or increasing the occurrence of aggressive responses.

Summary of the Results of Experiments I, II, and III

In Experiment II, mirror stimulation, audio presentation, and the combination of mirror and audio presentation acted as positive reinforcers for an operant response. Unlike Thompson's (1964) study, the positive reinforcing effects of mirror stimulation were established without the presence of food and water reinforcement. Also, in this experiment, the magnitude of the reinforcing effects of mirror and audio presentation combined amounted to more than the reinforcing effects of either stimulus alone.

On the other hand, mirror and audio presentation did not function as positive reinforcers in Experiments I and III. A number of behaviors exhibited by the subjects in the operant chamber were recorded. In Experiment I, during the mirror reinforcement period, preening, distress calls, and immobility were the most prevalent responses for the one Bantam and during the audio reinforcement period, preening, pecking, and immobility were the most frequent occurring responses of the other Bantam. The Old English Blackreds of Experiment III typically reacted aggressively to the reinforcers early in each session but fearfully to them later in each session. Displacement activities occurred infrequently in Experiment III.

Mirror termination did not act as a negative reinforcer in the final sessions of Experiment III. Fear behavior, specifically immobility, dominated the behavior of the cock.

CHAPTER 3

An examination of the findings of this study indicates that there were primarily four classes of behavior which were observed within the chamber. These can be identified as operant responding, fear, displacement activities, and aggression. Each of these classes of behavior is analysed more fully in separate sections of this overall discussion. Some prospects for future studies are given in each section too.

Operant responding reinforced by mirror and audio presentation was observed in Experiment II. The significance of the data for Seitz's (1940) law is discussed briefly as are topics concerning the species generality of the reinforcers and the variety of operant responses which the stimuli appear capable of reinforcing. A longer discussion of the reinforcement properties of mirror and audio presentation follows these sections. Under this heading, the nature of the displays elicited by the reinforcers is considered and this serves as a basis for a discussion of the alternative interpretations of the reinforcing effects of the stimuli.

Fear, displacement activities, and aggression were all observed in Experiments I and III. Fear is discussed first. A number of factors which can induce fear are defined and and examined. The nature of these variables and their relevance to this study are analysed in detail. Displacement activities represent the third class of behaviors observed in the chamber and their appearance is discussed. There is also a brief discussion of why displacement activities would occur in the chamber. The final class of behavior discussed is aggression, as it occurred in Experiments I and III. Included under this heading are discussions concerning the appearance of two aggressive responses and the occurrence, and relevance, of redirected aggression in these experiments.

Under a separate heading, there is a short analysis of mirror termination and its failure to function effectively as a negative reinforcer. Following this section, a number of conclusions are drawn concerning the findings of Experiments I, II, and III. Some additional prospects for future studies are also given.

Mirror and Audio Presentation as Positive Reinforcers

Visual and audio stimuli which elicit aggressive displays in Domestic Chickens can function as positive reinforcers for this same species. In Experiment II, mirror stimulation and the presentation of recorded crowing, alone and in combination, did reinforce an operant response.

Species Generality of the Reinforcers

Mirror presentation has been previously proven an effective reinforcer for a variety of species, including Fish (Goldstein, 1967; Melvin & Anson, 1970; Thompson, 1963), Chickens (Thompson, 1964), and Monkeys (Gallup, 1966). The species generality of the reinforcing properties of the playback of recorded aggressive calls is limited at this point. Aside from the findings in Experiment II, the reinforcing properties of territorial song have also been demonstrated for Chaffinches (Stevenson, 1967; Stevenson-Hinde, 1972) and for White-crowned Sparrows (Dobson & Petrinovich, 1973).

Generality of Responses that can be Reinforced by Mirror and Audio Presentation

A variety of operant responses have been reinforced by mirror stimulation and these include key pecking in Chickens (Thompson, 1964), a finding which has been replicated in Experiment II, swimming down a runway in *Bettas* (Hogan, 1967), and swimming through a ring in *Bettas* (Thompson, 1963). On the other hand, the presentation of species-specific vocalizations have reinforced key pecking in Chickens, e.g. Experiment II, and alighting-on-the-active-perch in Chaffinches (Stevenson, 1967) and in White-crowned Sparrows (Dobson & Petrinovich, 1973).

Significance of Data for Seitz's (1940) Law of Heterogeneous Stimulus Summation

The combination of mirror and audio presentation in Experiment II resulted in the summation of their reinforcing effects. This finding suggests that Seitz's law might be extended to include the additiveness of the reinforcing properties of key stimuli. Moreover, the summation of the reinforcing properties of such stimuli does not apparently result in a simple addition of their effects, although future studies will have to verify this point.

The Reinforcing Properties of Mirror and Audio Presentation

In Experiment II, the cock's behavior in the operant chamber was not recorded, i.e. the responses elicited by mirror and audio stimulation were not observed. Therefore, in this experiment, the specific features of the stimuli which had appetitive, and consequently reinforcing, properties for the cock cannot be determined. However, there exists two basic interpretations, each based upon experimental evidence, concerning the nature of the reinforcing effects of the mirror stimulus. Because these interpretations have been developed exclusively for mirror stimulation, there is more emphasis on it in this discussion. But, there is some suggestion that they might also apply to audio presentation and, therefore, some remarks concerning this stimulus are included in the discussion. First, the evidence upon which the interpretations are based is examined and then the interpretations per se are considered.

The nature of the displays in response to mirror and audio presentation. On the one hand, aggressive displays elicited by mirror stimulation have been observed to reinforce operant responding in _Bettas_ (e.g. Goldstein, 1973; Hogan, 1967) and in Paradise Fish (Melvin & Anson, 1970). These studies indicate that the aggressive displays released by the mirror stimulus constitute the appetitive properties of the mirror for animals and not the mirror image _per se_. On the other hand, Gallup and Hess (1971) suggested that the aggressive responses elicited by mirror stimulation are not a sufficient basis for the appetitive properties of the mirror. Their argument is based upon findings that there are species which do not show aggression towards mirror images, e.g. Parakeets (Gallup & Capper, 1970) and Goldfish (Gallup & Hess, 1971). It has been suggested that the novel properties of the mirror make up its appetitive qualities (Gallup, 1968).

There is not enough evidence available to support either interpretation of the reinforcing effects of audio stimulation. However, Stevenson (1967) did find that the audio stimulus (territorial song) did not elicit agonistic responses from the Chaffinches, although singing was occasionally heard immediately after reinforcement presentation.

Alternative interpretations of the reinforcing effects of the stimuli. A strict novelty interpretation of the reinforcing effects of the mirror image implies that is the novel or unique properties of the mirror that are reinforcing and not the aggression-eliciting properties of the mirror conspecific. This line of argument suggests that a live conspecific cannot reinforce an operant response because, for the most part, it does not have the unique properties of a mirror image (Goldstein, 1971). But, live conspecifics do function as effective reinforcers (e.g. Thompson, 1964). Moreover, if the reinforcing effectiveness of mirror images is due to novelty alone, Baenninger *et al.* (1969) proposed that one might expect fish to habituate more rapidly to mirror images than to live conspecifics, assuming that the responsiveness towards the latter is because of properties other than novelty. Their findings indicated that there was no difference in habituation between stimuli. This suggests that it is the innate aggression-releasing properties of the mirror image that are reinforcing. Furthermore, Thompson (1963) found that the relative reinforcing properties of three stimuli, including mirror presentation, covary with the degree to which they are capable of eliciting aggressive behavior.

The alternative interpretations proposed by Gallup (1968) might also be applicable to audio presentation. But, as far as Chickens are concerned, there is no datum available to support one interpretation over the other. Crowing is part of the behavior repertoire of cocks and it does have aggression-releasing properties. Yet, the manner in which it was presented to the cocks was novel, i.e. Domestic Fowl do not normally hear crowing presented in this way.

Unfortunately, Experiment II does not help to assess the validity of either interpretation and it does not help to reconcile the arguments and findings of Gallup and Capper (1970), Gallup and Hess (1971), and Stevenson (1967) with those of Baenninger _et al_. (1969), Goldstein (1971), and Thompson (1963).

Although these problems cannot be resolved on the basis of the data from this experiment, there are, however, at least two areas of concern that future studies should consider. First, the aggressive displays of the species under study should be known. The question of how likely it is that these displays would be shown in response to the presentation of a conspecific and to the presentation of the reinforcer (s) must be regarded as important. If a species does not exhibit obvious aggressive displays to a live conspecific, it is unlikely to show such behavior towards a mirror image. Secondly, one approach to assessing the validity of one interpretation over the other consists of an analysis of the subject's behavior during mirror and audio reinforcement and an examination of its post-reinforcement behavior. This approach could indicate exactly what features of the stimuli are reinforcing operant responding, i.e. their aggression-releasing properties or their novel qualities.

Fear Behavior

The fear behavior aroused in Experiment I and especially in Experiment III appeared to have interfered with, or inhibited, the aggression-eliciting qualities of mirror and audio presentation. Hence, the effectiveness of aggressive stimuli as positive reinforcers for an operant response was impaired.

Although alert postures occurred within the chamber too, the most prevalent form of fear elicited in these experiments was immobility, a response antagonistic to learning to key peck. In this section of the discussion, immobility is first established as a fear response and its appearance, along with accompanying responses, in these experiments is examined.

A number of factors can decrease the likelihood of aggressive behavior being exhibited, and, therefore, operant responding, and can increase the appearance of fear behavior. In this discussion, these factors are subdivided into four broad categories, involving the subjects, the reinforcers, the shaping procedures, and miscellaneous variables associated with the study and physical features of the chamber. Each of these categories is discussed separately as if they are mutually exclusive. However, there is a real possibility that many or all of these factors interacted in a complex manner, but not in a systematic fashion to produce the results found in this study. Moreover, in terms of the findings of these experiments, the factors do vary in the amount of supportive data for their influence. But, since all the factors have proven relevant in other experiments and are significant in encounters between Fowl, they are discussed in regard to this study.

Immobility: A Fear Response

Immobility has been designated by various names such as cataplexy, death feint, hypertonicity, myotonia congenita, and mesmerism (Gilman & Marcuse, 1949; Gallup, 1974). The condition is generally believed to be a fear response (Braud & Ginsburg, 1973a,b; Feekes, 1972; Gallup, Rosen, & Brown, 1972; Gilman & Marcuse, 1949; Gilman, Marcuse, & Moore, 1950; Kruijt, 1964). A variety of evidence is available to support this position. On the one hand, immobility is enhanced by stimuli known to increase fear, such as electric shock (Gallup, Creekmore, & Hill, 1970; Gallup, Nash, Potter, & Donegan, 1970), inescapable restraint (e.g. Gilman *et al*., 1950), and the administration of adrenalin (Braud & Ginsburg, 1973a). On the other hand, immobility is decreased by factors known to reduce fear, such as the presence of conspecifics in socially-reared Chicks (Salzen, 1963), the administration of tranquilizers, e.g. Pacitran, (Gallup, Nash, & Brown, 1971; Gallup, Rosen, & Brown, 1972), and conditioned safety signals (Gallup, 1974).

Under natural circumstances, immobility might serve as a defense against predation, and against intraspecifics attacks, in that it tends to minimize the stimulation to the predator, or opponent, to attack (Bolles, 1972; Gallup, 1972, 1974; Gallup, Cummings, & Nash, 1972; Gilman & Marcuse, 1949).

Immobility in Experiments I and III

Even though often characterized by complete motionlessness, immobility, or freezing (Kruijt, 1964), can be accompanied by eye closure, defecation, and vocalizations (Gallup, 1974; Gallup, Nash, & Wagner, 1971; Rovee, Agnello, & Smith, 1973). During the shaping period of Experiment I, immobility with eye closure, defecation, and distress calls were frequently observed for the Bantams. During the shaping sessions of Experiment III, eye closure accompanied immobilization, defecation occurred infrequently, and distress calls were absent. Other small movements of the limbs, neck, and eyes can occur in conjunction with the response, (Gallup, 1974) and these kinds of movements were observed in the experiments.

Eye closure apparently has the function of cutting off aversive, or fear-arousing, stimuli. This action permits the predominant motivation of the animal to weaken with the result that a change in behavior can occur, if a change is appropriate (Chance, 1962; Lill, 1968). In these experiments, eye closure could have had the function of cutting off the fear-arousing mirror and audio stimuli.

The presence of eye closure and defecation has been associated with prolonged immobility (Gallup, Nash, & Wagner, 1971; Rovee, Agnello, & Smith, 1973). In Experiments I and III, although eye closure was noted during both the briefer and longer immobility episodes, defecation was infrequent during the long immobility responses of the final experiment. This latter point appears to be in conflict with earlier investigations. However, it has also been observed that, if the fear elicited in an animal is intense enough, those responses normally associated with it, such as defecation, evocation, and frequency of distress calls, can be inhibited (Feekes, 1972; Ginsburg, Braud, & Taylor, 1974). Perhaps, the infrequency of defecation, and the absence of distress calls, reflects a higher level of fear in the birds of Experiment III than that in the Bantams of Experiment I and does not reflect a true conflict in experimental findings.

In Experiment I, distress calls sometimes preceded the termination of immobility responses and on a few occasions in Experiment III, crowing was observed to come before the end of cock E's immobility episodes. That the termination of immobility can be preceded by distress calls has been noted before (Gallup, Nash, & Wagner, 1971; Rovee, Agnello, &

Smith, 1973). However, crowing in this context has not been discussed. Ground pecking can also precede the end of immobility (Gallup, Nash, & Wagner, 1971). But, this behavior did not occur in these experiments under that circumstance.

Factors Associated with the Subjects

There are essentially three factors associated with the cocks which could operate to increase the occurrence of immobility in the testing situation and to decrease the appearance of aggression. These are lack of familiarity with the experimental situation, prior social experience which includes dominance status and past rearing experience, and differences in aggressiveness under which are assumed health of the cocks, state of moult, and maturity. It is probably the influence of the latter factors that is the most speculative. However, they might actually represent two of the more important variables to consider in any investigation involving Chickens.

Lack of familiarity with the experimental situation. In Chicks, familiarity with a testing situation tends to decrease susceptibility to immobility (Braud & Ginsburg, 1973b; Gallup, Cummings, & Nash, 1972). Feekes (1972) also found that Chicks had to be thoroughly at ease in the experimental situation before testing could begin, otherwise alarm behavior would interfere with the effects of the experimental procedure, especially in studies involving single birds. This period of familiarization varies between individual birds (Feekes, 1972).

Immobility did not occur in Thompson's (1964) study of visual reinforcement. Perhaps, this was because his cocks spent 61 days, 24 hr a day, in the testing chamber where they received all their food, water, and social stimulation. As these birds had become thoroughly familiarized with the testing situation, fear responses in the form of immobility did not interfere with the study's experimental procedures. But, the 1 hr per day given the cocks of Experiments I and III was possibly insufficient for them to become thoroughly accustomed to the chamber. On the other hand, the one 23 hr session given cock E of Experiment III did not seem to have affected the bird's behavior in the chamber. This session occurred later in the shaping period and, therefore, could not substantially alter the responses the subject had already learned to make in the chamber. The longer shaping sessions given cock C of Experiment II might have been sufficient to allow the bird to become used to the experimental situation.

Familiarity with an area is recognized as an important deciding factor in the pair contacts of many animals, including Chickens: in every individual the readiness to fight is the greatest in the place most familiar to the animal and the least diminished by the readiness to escape (Allee _et al_., 1939; Collias, 1943; Douglis, 1948; Lorenz, 1966; McBride _et al_., 1969; Potter, 1949). The readiness to fight in Chickens in a strange area might be increased by the presence of flockmates (Guhl, 1953).

Lack of familiarity with experimental space might have placed the cocks of Experiment I and III in the position of being an intruder in another Chicken's territory; such a position would have been reinforced by the appearance of mirror or audio presentation and, as a result, would have increased the likelihood that fear behavior would occur. If the readiness to escape was increased, actual escape from the situation was made impossible by the chamber's walls; consequently, the Bantams and the younger Old English Blackreds assumed the posture least likely to arouse attack, i.e. immobility.

One coincidental variable which might have decreased the chance that the subjects of Experiments I and III would become accustomed to the chamber was the absence of food and water at the onset of these experiments. But, the presence of food and water in some later sessions of the final experiment did not alter the predominant response, fear, displayed in the chamber in a noticeable way.

<u>Prior social experience</u>. An important variable affecting the operant rate in the visual reinforcement situation is the previous social experience of the subject (Baenninger, 1970). The presentation of mirror images is significantly more reinforcing to a fish which has experienced being dominant in prior social encounters than to a fish which has experienced being subordinate (Baenninger, 1970). Under normal circumstances, the prior social experiences of Domestic Fowl do have important consequences on future interactions

with strange conspecifics, e.g. low social rank decreases the chance for success in future encounters (Allee et al., 1939; Collias, 1943; Douglis, 1948; Potter, 1949). Extending Baenninger's (1970) conclusions to include the audio reinforcement situation, if a relationship between previous dominant and subordinate experiences of the cocks in this study and the effectiveness of mirror and audio stimulation as reinforcers did exist, then this relationship between dominance and the positive reinforcing effects of the stimuli might be reflected in the results of Experiment II. The relationship between subordinate status and the failure of the stimuli to act as positive reinforcers might be seen in Experiments I and III. However, the relationship between the reinforcing effects of mirror and audio presentation and dominance status must be experimentally established for Chickens.

Another aspect of prior social experience concerns the rearing of the cocks. Salzen (1963) noted that the past rearing experience of Chickens is important in the occurrence of immobility in the testing situation. He found that the sudden isolation of socially-reared Chicks from flockmates, as opposed to Chicks reared in isolation, can elicit immobility. In the present study, the isolation of the cock from its flockmate in the animal laboratory might also have been responsible for the induction of immobility.

Differences in aggressiveness. This variable can be approached from two levels, one regarding the differences in aggressiveness between pairs of birds and the other regarding the individual differences in aggression reflected in differences of operant rates.

Examination of the findings suggests that the fear aroused in the cocks of Experiment I was apparently not as intense as that elicited in the cocks of Experiment III. The Experiment I subjects were relatively more aggressive than the cocks of Experiment III. Although observational data concerning the behavior of the cocks of Experiment II within the operant chamber are not available, an analysis of the behavior of these birds in the home cages indicated that they were more aggressive than the birds of Experiments I and III. Whether or not strain or variety differences were responsible for the differences in aggression among the pairs of birds would have to be determined experimentally.

Goldstein (1971) argued that operant rates reflect individual differences in aggressiveness in mirror presentation studies. He found that fish with high operant rates defeated those with low operant rates, which indicates that operant responding and the likelihood of victory may be controlled by a common mechanism. Assuming that operant rates could also reflect individual differences in aggressiveness in Domestic Fowl, the absence of operant responding by the cocks of Experiments I and III might suggest that these subjects were less aggressive and more fearful than cock C of Experiment II. Of course, in this study, in order to have verified the assumption that a common mechanism controls both operant responding and the likelihood of victory in Chickens, encounters between cock C and each of the other subjects would have been required. In each encounter, cock C would have had to defeat the other bird.

In Domestic Fowl, individual differences in aggressiveness can result from a number of factors, other than genetic differences, such as the state of health, moult, and maturity (e.g. Allee _et al._, 1939; McBride, 1958). The lack of aggressiveness, and, therefore, the increased fear behavior, exhibited by the cocks of Experiment I might have been due to their poor health and the fact that they were moulting. The exaggerated fear behavior shown by the cocks of Experiment III might have resulted from their lack of maturity and consequent lack of fighting experience. Conversely, cock C was healthy and was not moulting at the time of testing. Moreover, this bird was considerably older than the other subjects and presumably had more fighting experience.

Factors Associated with the Reinforcers

Under the conditions operative in Experiments I and III, the mirror and audio reinforcers might have been responsible for the induction of fear behavior and the inhibition of aggressive behavior, and consequently of operant responding.

When the mirror or audio reinforcers became available in the chamber, the frequency of occurrence of immobility for cocks A and B jumped from the five and three occasions during the baseline session to the 50 and 73 occasions during the shaping period. In Experiment III, immobility followed later presentations of the stimuli in each session. Considering mirror presentation in particular, this point might be substantiated by the fact that, during the final three sessions of Experiment I, only one instance of immobility was noted when the cocks were not oriented towards the mirror but many more were seen when they were oriented towards their mirror images.

Mirror and audio presentation are discussed in the following sections in terms of supernormal stimulation and novelty.

Mirror and audio presentation: Supernormal stimuli. Gallup, Montevecchi, and Swanson (1972) suggested that mirror stimulation represents a supernormal stimulus which can elicit exaggerated aggressive responses from Chickens. Since it can accentuate the duration of immobility, 12 times longer than a conspecific (Gallup, 1972), mirror presentation can apparently also function as a supernormal stimulus which can release exaggerated fear responses, specifically accentuated immobility durations. Recognizing that in a given time period the duration of a response sets limits on its frequency, perhaps mirror presentation, operating as a supernormal stimulus, can also elicit an exaggerated frequency of occurrence of immobility. Prolonged immobility episodes were recorded in Experiment III and numerous immobile responses were noted in Experiment I. Why mirror presentation as a supernormal stimulus had this apparently differential effect, i.e. prolonged immobility in Experiment

III and high frequency of immobility in Experiment I, cannot be determined from the data available in the study.

The near continuous nature of audio presentation, perhaps its loudness too, might have functioned as a supernormal stimulus resulting in the frequent occurrence of the immobility responses in Experiment I and the exaggerated durations of the reaction in Experiment III. Again, this differential effect of audio presentation as a supernormal stimulus cannot be explained from the available data in this study.

Mirror and audio presentation: Novel stimuli. Aside from factors which might predispose the cocks to respond aggressively or fearfully to the stimuli and apart from any supernormal properties the stimuli might have, the question arises whether it is the novelty of mirror and audio presentation which elicits aggression or fear or is it the capacity of the stimuli to release aggressive or fear behaviors which normally occur in response to a conspecific. Mirror stimulation does represent a novel stimulus, although experience with surfaces approximating a mirror cannot be excluded (Gallup, 1968). The presentation of the audio stimulus, in the form of near continuous crowing, is novel too. The effects of the novel components of the stimuli would be expected to habituate eventually, and more or less permanently, relative to the habituation, if any, of the innate releasing properties of the stimuli, although in certain situations the aggression-releasing properties of stimuli do habituate for long periods of time (Lorenz, 1966).

If such is the case, and since the fear aroused in Experiments I and III did not habituate, the innate releasing properties of the stimuli must be at least partly responsible for the occurrence of fear behaviors recorded.

Factors Associated with the Shaping Procedures

The shaping procedure used in Experiment II, self-shaping, differed from the successive approximation method common to Experiments I and III. The latter shaping method might have had adverse effects on the learning of the operant response, particularly if the stimuli were fear-arousing.

Manual restraint is fear-arousing in untamed (not handled) birds (Gilman et al., 1950). With short intertrial intervals, repeated induction of immobility by means of manual restraint has the effect of punishing the Chicken for showing a righting response (Gallup, 1974). As a result, the subject remains instrumentally immobile for prolonged periods in order to avoid manual restraint. A similar result might have been incurred by the successive approximation method. Assuming that the reinforcers are fear-arousing, the immobility response might have become a means of avoiding not manual restraint but the onset of the stimuli. Consequently, immobility became adventitiously the appropriate response to avoid the reinforcers. If the reinforcers were also fear-arousing in Experiment II, perhaps the self-shaping procedure, because the cock was actively controlling the occurrence of the reinforcers, contributed to the habituation of fear-arousing factors.

Miscellaneous Factors

In this category, several different factors are discussed: manual restraint, pretest holding conditions, proximity and gaze of the experimenter, the experimental room, and the experimental chamber. Each of these factors could have contributed significantly to the induction and increased duration of immobility in Experiments I and III.

Manual restraint. This is the technique most commonly used to induce immobility in animals; the subject is usually manually restrained for a period of 15 sec (e.g. Gallup, Cummings, & Nash, 1972; Gilman et al., 1950; Salzen, 1963). Tactile stimulation releases strong escape (fear) reactions in Fowl (Kruijt, 1964). Since the Bantams were removed from their home cages by hand and placed in the testing space by hand, this procedure could have had the effect of inducing at least initial immobility episodes in these birds. But, with repeated trials, a decrease in susceptibility to and the duration of manually-induced immobility has been noted (Gilman et al., 1950; Ginsburg et al., 1974; Salzen, 1963). The other cocks in this study were not subjected to manual restraint at any time; therefore, it is unlikely that this factor was involved in the immobility responses of the cocks in Experiment III.

Pretest holding conditions. This factor appears to be an important source of variation in immobility. The duration of immobility responses for hand-carried subjects was significantly shorter than for birds transported in a cardboard box (Gallup, Wagner, & Nash, 1971). All the cocks in this study were transported to the experimental room in a cardboard box; there was the possibility then that this method of carrying the cocks could have induced initial immobility reactions. An appropriate alternative to this carrying procedure was not available during this present study, however.

The proximity and the gaze of the experimenter. The proximity and especially the gaze of the experimenter can significantly increase the duration of immobility in Chickens (Gallup, Cummings, & Nash, 1972). The experimenter was physically close to the chamber and did observe the behavior of the cocks in Experiment I and to a lesser extent the behavior of the birds in Experimenter III. The experimenter's presence was strictly limited in Experiment II.

Experimental room. The experimental room was not soundproof and, because it was located in a busy area, the noise outside of it might well have initiated or enhanced the appearance of immobility in this study. Also, the removal of the subjects from the familiar auditory stimuli of the animal laboratory might have influenced the induction and duration of the immobility responses (e.g. Rovee _et al_., 1973). Perhaps this factor and the noise outside of the experimental room acted in combination to increase the susceptibility to and the duration of immobility in the cocks. The one cock, C, which learned the operant response, was tested at a time when there was considerably less noise outside of the experimental room.

Experimental chamber. The size of the experimental chamber and its dissimilarity to the home cage of the subject can constitute important variables in an operant situation particularly if they engender or increase fear or if they prevent the performance of any behavior.

The size of the chamber, or its available space, has impaired the performance of Canaries in discrimination tests. Neumann and Klopfer (1969) found that, when Canaries were placed in cages just large enough to permit them to move about, their performance on the task was affected. But, when placed in cages four times as large, their performance became stable. The experimental chamber used in Experiment I was considerably smaller than that used by Thompson (1964) and Ratner (1961) and relative to the size of the Bantams, it did appear small. In Experiment I, tail wagging and wing flapping, an action which can precede an attack, did not occur within the chamber although they were observed outside of it. The occurrence of these behaviors within the chamber might have had important consequences on the findings of this experiment. The chamber used in Experiments II and III was still smaller than Thompson's (1964). However, the size of the experimental space did not appear to have had adverse effects upon cock C's behavior. Possibly, the size of the operant chamber is only important if the birds are exhibiting fear in response to the presentation of the mirror and audio stimuli, i.e. they cannot escape from them by increasing the distance between themselves and the other "bird".

If the testing chamber is appreciably different from the home cage, its novel features can induce fear, and even death, in Chickens (Biswas & Craig, 1970). In this study, the home cages and the operant chambers were different; but, the nature of the effect (s) of this difference on the behavior of the cocks was not experimentally determined. This difference between the home cage and the experimental chamber might have a more adverse effect on birds which are predisposed to exhibit fear than on cocks which are more aggressive.

Displacement Activities

Several behaviors were performed during the shaping sessions of Experiments I and III. Some of these have been previously regarded as displacement activities.

Displacement preening was the most frequent behavior recorded for the Bantams. Two features of this behavior were evident in this study and Duncan and Wood-Gush (1972) have considered them important aspects of displacement preening as opposed to preening under normal circumstances. First, although not objectively measured in these experiments, the preening bouts in the chamber appeared to be brief, a matter of a few seconds; secondly, preening was limited to near plumage, the breast and neck feathers.

Like eye closure, displacement preening has been considered as a cut-off posture (Chance, 1962). This behavior might have been an alternative means to eye closure to avoid fear-arousing stimuli, in these experiments mirror and audio presentation.

Other behaviors previously viewed as displacement activities in Chickens were also performed particularly by the Bantams and to a lesser extent by the cocks of Experiment III: wing scratching, wing stretching, head shaking, body shaking, wing flapping, but not performed on the toes, and tail wagging (e.g. Armstrong, 1950; Duncan & Wood-Gush, 1972; Feekes, 1972; Kruijt, 1964). The latter two activities were seen only outside of the chamber in Experiment I. Ground pecking is another displacement behavior; the pecking at the chamber's floor grid during the shaping sessions of Experiment I might be considered as a form of this activity. Yawning, the upper part of the bill is raised far upward while the lower part is kept in the normal position (Kruijt, 1964), occurred in these experiments and appeared to be a displacement activity. Yawning was especially frequent in cock E's three final sessions.

In encounters between Chickens, preening and head shaking are performed predominantly by losing birds; winning birds perform ground pecking more frequently, and to a lesser extent intention ground pecking; head zigzagging is performed equally by winners and losers (Feekes, 1972; Kruijt, 1964). The frequency of preening in Experiment I might indicate that in their encounters with the mirror or audio "opponent", the cocks could be considered the losing birds.

The subjects appeared to regard the stimuli as superior opponents. Ground pecking was performed by the birds but this activity was observed infrequently, suggesting again that the Bantams were the losers. Head zigzagging occurred too; however, this activity does not distinguish winners from losers.

Why did displacement activities occur in these experiments?

Quite often comfort and feeding behaviors appear as displacement (Eibl-Eibesfeldt, 1967) or functionally irrelevant activities (Kruijt, 1964). The appearance of displacement behaviors can occur as a result of the activation of two antagonistic tendencies, e.g. escape (fear) and aggression (attack) (Armstrong, 1950, 1961; Eibl-Eibesfeldt, 1967; Kruijt, 1964). The activation of these two tendencies in this study can be most clearly seen in the reactions of the two cocks in Experiment III towards their mirror images in the home cages. Both birds initially approached the mirror image but then withdrew from it. This vacillation continued two or three times before the cocks finally withdrew. Gallup (1968) noted that such vacillation is a frequent feature of the behavior in response to mirror presentation and it apparently continues until either aggression or fear becomes the predominant motivation. In the above example, fear became the predominant motivation each session.

Where the birds are well-matched at least physically, the probability of ambivalence—the conflicting tendencies are balanced--is higher and the occurrence of displacement activities is more likely (Kruijt, 1964). In terms of a hypothesis proposing a balancing of motivational systems, the cocks and its mirror opponent should be perfectly matched. There are, however, differences between an encounter involving well-matched cocks and an encounter involving a cock and its mirror image. For the most part, the differences are due to the characteristics of the mirror (e.g. Gallup, 1968). On the other hand, that the cock and its audio "opponent" are perfectly matched seems less certain, although if the cock were presented with its own crowing, it and its audio "opponent" might be better matched than if it were presented with another cock's crowing.

The infrequent occurrence of displacement behaviors in Experiment III suggests that the conflicting tendencies of aggression and fear were not equally aroused; fear appeared to be the predominant motivation but aggression was not altogether suppressed. The more frequent occurrence of displacement activities in Experiment I indicates that the two tendencies were more equally aroused, although fear might have been the more predominant motivation. Because cock C was not observed during the shaping, reinforcement, and extinction periods, it is not known whether displacement activities were performed.

Aggression and Redirected Aggression

Aggressive behavior, specifically pecking and erecting of the neck hackles, was exhibited in Experiments I and III.

There is a brief analysis of its appearance in these two experiments. The question of redirected aggression and its occurrence in Experiments I and III is discussed as well.

Two Aggressive Responses

Aggressive pecking directed at the Plexiglas sides of the chamber during the shaping period of Experiment I was observed, with cock B pecking more than cock A. Aggressive pecking was also seen in Experiment III; cock E's initial reactions towards the mirror image included such pecking. During aggressive pecking, the bird stretches its neck vertically upward with the beak pointed downward; pecks are directed downward vigorously (Feekes, 1972).

The erection of neck hackles is part of the aggressive display of Chickens. It occurred during cock B's shaping period and in the final sessions of Experiment I; it was also observed during the shaping period of Experiment III.

Redirected Aggression

An activity can be redirected to a substitute object not because of the fear-arousing properties of the normal object nor because of any inhibition or obstacle but because of the absence of the object normally involved (Armstrong, 1961). In default of the proper object, the activity is then transferred or redirected and expressed in relation to some other object. If a bird is aroused to attack either by hearing a recording of its species-specific song or by seeing its reflection in a mirror, it may in the absence of the proper object, another male, peck at some substitute

(Armstrong, 1961). Perhaps, during audio presentation the pecking at the chamber's sides reflected the redirection of aggression because there was no other male phyically present. The absence of another male during the mirror presentation sessions in the home cage might also have resulted in cock E pecking at the hen present in the cage.

Mirror Termination as a Negative Reinforcer

Why did cock E of Experiment III not learn to terminate mirror presentation? Siamese Fighting Fish, for example, work both to obtain and to escape from mirror presentation (Baenninger, 1970). Mirror presentation can act as a positive reinforcer and, after increased exposure, mirror termination can act as a negative reinforcer (Baenninger, 1970). Assuming then that mirror presentation had fear-arousing properties for cock E, it would be expected that this cock would learn an operant response in order to terminate the mirror.

A partial answer to the posed question might be found in the nature of the operant response required from the cock. Lewis, Lewin, Stoyak, and Meuhlissen (1974) and Seligman (1970) noted that Pigeons are contraprepared to associate pecking with the avoidance of an aversive stimulus such as shock, although pecking can eventually be established but with great difficulty. Had cock E been given more mirror termination trials, the bird might have eventually learned to peck the operandum.

Concerning the nature of the avoidance response, Bolles

(1972) stressed that it cannot be any response drawn from the subject's repertoire; in order to be effective, it must be a response from the animal's species-specific defense reactions. Even then, the avoidance response must be the most appropriate to the situation in order for it to be learned quickly.

Therefore, had a prepared operant response drawn from the cock's defense behavior been required, the subject might have learned to terminate the mirror presentation. Concerning this point, observation in the final session of Experiment III indicated that, when vocalizations were followed by mirror termination, the frequency of the vocalizations increased. However, the cut-off function of eye closure and the head averted away from the mirror might have been perceptual resolutions to the avoidance of the mirror image and were easier for the bird than a behavioral solution, i.e. learning to key peck, particularly since in previous sessions movement was "punished" by the onset of mirror stimulation.

Conclusions and Prospects for Future Investigations

Mirror and audio presentation acted as positive reinforcers for an operant response in Experiment II and their reinforcing effects were found to be additive. The positive reinforcing effects of the stimuli for Domestic Chickens were analysed in terms of their aggression-releasing properties and their novelty. However, it cannot be confidently determined which of these characteristics of the stimuli had appetitive properties for the cock in this experiment. In future studies, an analysis of the subject's behavior during mirror and audio presentation and an examination of post-reinforcement behavior could indicate exactly what features of the stimuli are reinforcing.

The significance of the finding that the reinforcing effects of key stimuli are additive for Seitz's law of heterogeneous stimulus summation was noted in the discussion. Of course, this finding must be replicated before its full significance for Seitz's law can be established.

That mirror and audio presentation can act as positive reinforcers for a variety of species besides Domestic Fowl and that they can reinforce a number of operant responses other than key pecking were discussed. However, the potential of each stimulus in both these areas has not been fully explored.

In Experiments I and III, fear especially in the form of immobility was exhibited very frequently within the chamber. The greater portion of this discussion has dealt with numerous factors in these experiments which might have operated to increase the appearance of fear within the chamber and to reduce or inhibit the occurrence of aggressive behavior. These factors are associated with the subjects, the reinforcers, the shaping procedures, and miscellaneous variables such as manual restraint. It seems likely that some or all of these factors operated in a complex way, although not necessarily systematically, to produce the results of this study. It is impossible to assign more importance to one factor than to another on the basis of data from these experiments. The appearance of displacement activities, especially in Experiment I, and the occurrence of aggression and redirected aggression, do indicate that more than one motivation was elicited in the chamber. These behaviors were also analysed in the discussion in terms of their importance to the current study.

It appears that future studies of mirror and audio reinforcement will have to control a number factors, such as pretest holding conditions and the size of the chamber relative to the size of the subject, in order to minimize their confounding influence on the effectiveness of the reinforcers. Future investigations can examine the effects of individual or constellations of these factors on mirror and audio reinforcement. For example, dominance status of Chickens and its relationship to the reinforcing potential of mirror and audio stimulation represents a particularly interesting area of investigation.

Mirror termination and audio termination as negative reinforcers represent another area of investigation and a number of questions can be raised concerning their application in this context, i.e. what operant response would a Chicken be prepared to associate with a negative reinforcer? Or, are the negative reinforcing effects of mirror and audio termination additive, as studies of punishment suppression with other stimuli have found (e.g. Van Houten & Rudolph, 1971)?

In summary, it cannot be concluded on the basis of the findings in Experiment II that mirror and audio presentation always act as positive reinforcers for Chickens, since they did not do so in Experiments I and III. The conditions under which they do function as positive reinforcers for Domestic Fowl must be clarified. Also, whether or not their reinforcing effects are always additive must be examined. Moreover, whether or not under certain conditions mirror termination can function as a negative reinforcer for Chickens cannot be determined on the basis of the findings of Experiment III. The resolution of this question and whether or not audio termination can act as a negative reinforcer must be left for future studies.

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