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Discrimination of shape and size sues by day-old chicks in two one-trial learning tasks

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ABSTRACT

The ability of day-old chicks (*Gallus gallus domesticus*) to discriminate between the shape and size of beads was investigated in two one-trial tasks, taste avoidance and sickness-conditioned learning. Previous studies determined that color is a critical classification cue for conditioned stimuli in these tasks. In taste avoidance learning, a chick pecks a bead coated with a bitter substance. In sickness-conditioned learning, chicks peck a dry bead and are injected 30 min later with lithium chloride. Chicks could discriminate beads of different sizes, but not different shapes, when trained in the taste avoidance task, whereas in the sickness-conditioned learning task, chicks could discriminate shape, but not size. These results suggest that chicks use a number of classificatory cues to remember an avoidance response, and, in the absence of color cues, chicks rely on different cues for different learning tasks.

1. Introduction

Newly hatched chicks peck indiscriminately at a variety of small objects, but quickly learn to distinguish food from non-food items (Morgan, 1896). During this time they can learn, in one trial, not to peck at noxious substances. Researchers in learning and memory have capitalized on these observations to produce several one-trial training tasks. One task is taste avoidance learning, in which a chick pecks a bead coated with an aversive-tasting liquid such as methylanthranilate or ethanol (Cherkin and Lee-Teng, 1965 see Rose, 2000, 2004). Because the chick associates the bead with the bad taste, the chick will avoid pecking the bead that was presented at training. The other task is sickness-conditioned learning, in which the chick pecks a bead and is later injected with lithium chloride, which makes the chick ill (Gaston, 1977; Barber et al., 1998). At test, the chick will avoid the bead presented at training because it associates that bead with sickness.

The ability to learn such one trial tasks must involve multiple discriminations of the training bead along a variety of stimulus dimensions. Color is an important stimulus cue for both the taste avoidance and sickness-conditioned learning tasks. Chicks can learn, in one trial, to discriminate between the color of bead presented at training and novel colored beads in both tasks (Barber et al., 1998; Patterson and Rose, 1992). Better discrimination is produced when the novel colored bead is presented first at test. If a bead with a similar color to that of the training bead is presented first at test, the chicks tend to avoid both beads, producing high levels of generalized avoidance.

Color does seem to be a primary discriminative stimulus in these tasks, as lesions of the intermediate medial mesopallium (IMM) impair color discrimination in these two tasks (Patterson and Rose, 1992; Barber, et al., 1999). The impairment is specific to color; IMM lesions produce a deficit in which the chicks fail to retain the association between the color of the training bead and aversive consequences, but still retain the association between other characteristics of the beads and the aversiveness. At test, the lesioned chick avoids all beads of similar shape and size, regardless of the color. This finding suggests that the chick uses a number of different classificatory cues to remember the avoidance response to the bead, and these cues are represented in different storage sites within the brain.

Possible classificatory cues besides color include the size and shape of the stimulus object. Shape discrimination has been shown in many species, including pigeons (Cook et al., 1997; Siegel and Honig, 1970) and rats (Dodwell, 1957). In humans, shape discrimination is superior to that of size discrimination (Nachmias, 2011). Sutherland and Carr (1963) showed that larger shapes are easier to discriminate than smaller shapes in the octopus. The results of Vallortigara et al. (1990) indicate that chicks are able to categorize objects according to color, shape and position. Chicks show a

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preference for pecking round objects over angular objects (Fantz, 1957). Salzen and Meyer (1968) also demonstrated that chicks have an innate preference for round compared to square objects and this preference leads to more easily and strongly learned imprinting with the round objects. Chicks also express innate preferences for pecking small objects compared to large objects (Goodwin and Hess, 1975). Shape preferences can be classically conditioned in birds (Zanforlin and Vallortigara, 1985; Zolman, 1969; Zolman et al., 1975), however these conditioning paradigms involve multiple training trials.

Can chicks learn, in one trial, to discriminate aversive from novel beads using size or shape as stimulus cues? The present experiments examined the ability of chicks to learn a taste avoidance or conditioned-sickness aversion task using shape or size discriminations, using a fully counterbalanced design. It was hypothesized that shape and size discrimination learning could be found using one trial tasks, similar to those used in color discrimination. If chicks are capable of discriminating the shape and/or size of a stimulus object, animals trained with an aversive bead of either a particular size or a particular shape should avoid that same size or shape at test and prefer a bead differing from the aversive bead by either shape or size alone.

2. Methods

2.1. Animals

Male leghorn-derived chicks were purchased from a local supplier (Hy-Line Hatchery, Elizabethtown, PA) and arrived at 8 a.m. the day after hatching. The chicks were placed in pairs in white opaque Plexiglas pens (22.8 cm × 22.8 cm × 22.8 cm) in the behavioral testing room, which is maintained on a 12 h light/dark cycle (lights on at 8 am) at 38.5–40.5 °C and 45–51% humidity. The Plexiglas pens, which were open at the top and bottom, sat on white paper towels that were replaced before each experiment. A chick in each pen was marked on the back to distinguish one chick from the other. For taste avoidance learning, chick starter meal was scattered on the floor of each pen, however, for conditioned-sickness learning, no food was provided. The chicks were allowed to acclimate to the behavioral testing room for 1.5 h before pretraining. A total of 544 chicks were used in these experiments (20–28 animals per group, 24 different groups). The Dickinson College Animal Care and Use Committee approved these experiments.

2.2. Chemicals and solutions

Saline solution (0.9%) and lithium chloride (1.0 M in 0.9% saline; Sigma Chemical Company, St. Louis, MO) were made up fresh each morning before the experiments began. Intraperitoneal (IP) injections of either saline or lithium chloride were given in a volume of 0.1 ml using a 27 gauge needle.

2.3. Training and testing procedure

The chicks were trained in one of four training paradigms: size or shape discrimination in taste avoidance learning, or size or shape discrimination in sickness-conditioned learning. Identical beads were used for both taste avoidance and sickness-conditioned learning.

The chicks were pretrained 10 min prior to training in all four training paradigms, in order to establish pecking behavior. In shape discrimination learning, the pretraining bead was a small 2 mm round, pearl colored bead. In size discrimination, the pretraining bead was a small (3 mm × 2 mm) oat-shaped, gold-colored bead.

Pretraining and training both consisted of 30 s presentations of beads. First, the experimenter tapped on the side of the training pen to arouse the chicks. The bead, at the end of a thin wire (10 in long), was held at the chick's eye level about 2.5 inches from the end of the beak. The bead was moved back and forth slowly in an arc of about 6 inches around the chick's head at eye level. The 30 s trial began when the chick oriented to the bead, that is, moved its head to follow the movement of the bead. If the chick pecked the bead (which the researcher could observe through visual and tactile means) within the 30 s following orientation, the chick was considered pretrained or trained. Most chicks (over 98% in all experiments combined) readily peck the small pre-training beads and many chicks (over 95%) peck the training beads. At pretraining and training, the behavior of the chicks was recorded as either pecking or not pecking the beads. Chicks not pecking at pretraining or training were not included in the final analyses.

The chicks were trained and tested with the two beads (big and small or round and square) in a fully counterbalanced order. During the retention tests, the chicks were given sequential 30 s presentations of the two test beads, one bead similar to that used at training (the aversive bead), and a novel bead similar in color, but different in either shape or size to the training bead (the non-aversive bead). The test trials were conducted in the same manner

Table 1
Shape and size discrimination learning in one-trial taste avoidance.

		Frequency of response (%)	
	(*n*)	Discriminate	Incorrect response
Square aversive			
Tested square/round	(20)	35.0	65.0
Square aversive			
Tested round/square	(24)	25.0	75.0
Round aversive			
Tested round/square	(20)	25.0	75.0
Round aversive			
Tested square/round	(20)	35.0	65.0
Small Aversive			
Tested small/big	(21)	28.6	71.4
Small aversive			
Tested big/small	(25)	40.0	60.0
Big aversive			
Tested big/small	(28)	28.6	71.4
Big aversive			
Tested small/big	(27)	63.0	37.0*

Note: (*n*):Number of animals per group. Discriminate:Discriminate aversive bead; avoid training bead at test, peck novel bead. Incorrect response includes those chicks that generalize (avoid both beads at test), show a wrong discrimination (peck training bead at test, avoid novel bead) or peck both beads at test.

* $p < 0.05$, discriminate vs. incorrect response.