Abstract  Day-old chicks were exposed to point-light animation sequences depicting either a walking hen or a rotating cylinder. On a subsequent free-choice test (experiment 1) the chicks approached the novel stimulus, irrespective of this being the hen or the cylinder. In order to obtain equivalent local motion vectors, in experiments 2 and 3 newly hatched chicks were exposed either to a point-light animation sequence depicting a walking hen, or to a positionally scrambled walking hen (i.e. an animation in which exactly the same set of dots in motion as that employed for the walking hen was presented, but with spatially randomized starting positions). Chicks tested on day 1 (experiment 2) or on day 2 (i.e. after a period in the dark following exposure on day 1 (experiment 3)) proved able to discriminate the two animation sequences: males preferentially approached the novel stimulus, females the familiar one. These results indicate that discrimination was not based on local motion vectors, but rather on the temporally integrated motion sequence.

Key words  Biological motion · Imprinting · Chick · Perception

Introduction

Movement is a crucial feature in visual perception of natural objects. Many adaptive responses to natural objects depend on the way these objects are moving, and this is particularly true for the movement of biological creatures. When a vertebrate travels about its environment, in fact, its limbs and torso undergo a pattern of movement in typical synchrony. Johansson (1973) has shown that in humans an animation sequence consisting of just a few points of light strategically placed on the articulations is enough to create an immediate, automatic perception of someone engaged in coordinated activity such as walking. Discrimination in these stimuli must depend on motion cues alone, and in humans they sustain a range of discriminations including the gender of the person (Kozlowski and Cutting 1977), the identity of a friend (Cutting and Kozlowski 1977), the nature of the action (Dittrich 1993; Johansson 1973), and the weight of an object being lifted (Runeson and Frykholm 1981).

Little is known about perception of complex moving patterns in other species. Among mammals, Blake (1993) has proved that cats can be trained to discriminate a point-light animation sequence depicting biological motion (a cat walking) from an equivalent animation in which local motion vectors were variously “scrambled”. The ability to discriminate the so-called “structure-from-motion” – of which biological motion would represent an instance – has been documented in monkeys (Siegel and Andersen 1988).

Among birds, Emmerton (1986) has demonstrated that pigeons can discriminate complex motion patterns (Lissajous figures), being able to differentiate two successively presented cyclic trajectories of a single moving dot. Moreover, there is also some evidence that pigeons can discriminate biological motion using conditioning procedures. Omori and Watanabe (1996) trained pigeons to discriminate between motions of three dots pasted on a pigeon and those pasted on a toy dog: pigeons could learn the discrimination of Johansson stimuli and some of them...
could also transfer from the dot motion to the real movement. Similarly, Dittrich et al. (1998) found that pigeons trained to discriminate between categories of moving stimuli such as walking and pecking presented on videotape could show some transfer to new stimuli in which the same movements were represented by a small number of point lights; the reverse, however, transfer from pointlights display to fully detailed displays, was not observed.

All these studies employed conditioning procedures, which present severe limitations when employed with very young animals. The aim of this paper is to investigate whether discrimination of point-light animation sequences can be obtained in newborn chicks using an imprinting procedure. Imprinting has been widely used as a tool to study visual learning in this species, and it has recently been employed to investigate perception of partly occluded objects (Regolin and Vallortigara 1995; Lea et al. 1996; see also Forkman 1998 for parallels with conditioning procedures). It has the advantage of presenting the animal with a more natural and ecological situation, which is of relevance with respect to the observation of Dittrich et al. (1998) that discrimination of biological motion in pigeons appears to be difficult. The disadvantage is that, because the discrimination is based on free choice, only differences which are valued by the animal as important enough to deserve differential responses are likely to be shown. Previous work with more conventional static stimuli has in fact shown that the direction of choice clearly depends on complex emotional/motivational variables and cognitive judgement by chicks about the degree of novelty and familiarity of the stimuli to be discriminated. For instance, Jones et al. (1996) exposed chicks to one of two moderately different screensaver stimuli on a computer screen, and then gave them a choice between these stimuli in a runway. Neither group preferentially approached the familiar screensaver; chicks spent longer near the unfamiliar image. In some strains sex could produce differences in the direction of the choice, even if there was no evidence for differences in the discriminative abilities between the two sexes: 3-day-old female chicks exposed to cagemates spent longer near familiar than unfamiliar conspecifics, whereas males did the opposite (Vallortigara and Andrew 1991; Vallortigara 1992).

In spite of these potential drawbacks, we feel that imprinting procedures could be an interesting tool to investigate discrimination of complex motion patterns in chicks: motion sequences displayed by a laying hen are important not only for conspecific recognition (Bolhuis 1991) but also for finding food (Turner 1964).

All the experiments comply with Italian national guidelines for animal care and research.

**Experiment 1**

Previous work has shown that chicks can discriminate between animation sequences presented on a monitor display (Jones et al. 1996). However, in those situations, discrimination could be also based on cues other than motion. In our first experiment we employed point-light animation sequences, of the type first introduced by Johansson (1973). Discrimination of these stimuli must depend on motion cues alone.

**Methods**

**Subjects**

A total of 120 (54 males and 66 females) chicks (Gal**lus** **gal**lus **domesticus**) of the Hybro strain (a local variety derived from the White Leghorn breed) were used. Animals were collected soon after hatching in a commercial hatchery (Allevamento La Pellegrina, Ponte di Castegnero, Padova, Italy) and transported to the laboratory into closed cardboard boxes.

**Apparatus and procedure**

Animation sequences were all prepared with the software package MacroMind Director for Macintosh 3.1. The animation of a walking hen was obtained by video-recording an adult animal of the same breed as the chicks. Prior to recording, small pieces of coloured sticky tape were attached to the hen’s body in the following strategic positions: head, neck, legs, tail and wings. The hen was video-recorded while walking unrestricted outdoors, from a distance of about 3 m. We then selected a portion of the video-recording in which the hen was walking from the right to the left side of the image at a regular pace. This portion was digitalized using an A/D hardware tool (Apple presentation system, Focus Inc.). Finally, from this sequence two steps of the hen were selected, starting from a certain posture and ending in exactly the same posture. The sequence was then processed frame by frame with the aid of the MacroMind Director 3.1 in order to place small white circles (of a diameter of 2 mm, luminance 72 cd m⁻²) in the eight predefined body positions (such conditions of very low illumination were employed because of the well-known dramatic drop of critical flicker fusion frequency with reduced stimulus intensity, see D’Eath 1998). All residual graphic information was substituted with a black background (luminance 0.07 cd m⁻²). Temporary occlusion of a body part was represented by the disappearance of the corresponding point-light. The selected positions were: beak, head, neck, base of the neck, the two legs, centre of the body and tail. The translatory component of movement was then subtracted from the obtained animation. The final animation (consisting of a two-step sequence of the walking hen) lasted about 3 s and was looped in order to obtain an endless walking animation (Fig. 1).

The animation of a rigidly rotating cylinder was obtained by plotting the frontoparallel projection of eight points (of the same size and luminance of those employed for the hen) attached to the surface of a black cylinder rotating around its axis on a black background (Fig. 1).