Visual signalling in Canada Geese for the coordination of family units

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Introduction

Canada Geese Branta canadensis use a variety of head movements that are enhanced by their white-orange-black cheek patch. Visual signals are defined as a movement emphasized by a feature which has evolved to serve in visual communication, usually by releasing certain patterns in conspecific individuals (Fabricius 1975). Most head movements in Canada Geese that have been previously identified and described (see Fabricius 1977; Ackerson & Raveling 1982 for reviews) have multiple functions, but are specialized in communicating threat to neighbours. Visual signals or display in Canada Geese during agonistic and triumph ceremony situations are thought to be adaptive in that they aid the reinforcement of pairbonds and possibly enhance the establishment of nesting territories and breeding success (Ackerson & Raveling 1982; Black & Owen, in press).

This study concentrates on visual signals by family members, during the post-hatch season. Analysis was limited to two head movements: head-tossing—a lateral, vertical, or rotary movement of the head usually while the neck is held vertically straight, and head-pumping—a lowering of the head toward the breast and raising it again to a vertical position at various angles to the body.

Other authors have reported a close connection between head-tossing and aggression. Head-tossing demonstrates conflicting tendencies to either stay in one place to protect goslings possibly by attacking neighbours, or to flee from an aggressor (Collins & John 1995; Radekaster 1974). The signal has also been described as occurring when an individual is about to move to a new location by walking or flying (Raveling 1969; Radekaster 1974). Head-pumping indicates a balance in the tensions to attack and escape (Blaylock-Jones 1969; Raveling 1970). When we, therefore, lead to locomotion. To test the locomotory element of visual signals we recorded the type and number of head movements and timed the interval between the last signal and the initiation of walking or swimming.

Methods

The first few goslings from which the study flock originated (now about 150 birds) came from Seney National Wildlife Refuge, Michigan, in 1957. Head and neck movements were filmed with a Super 8 camera or noted opportunistically between May and July in 1980. Cams was supplied for the free-flying gosling each morning (1000 hours) at a 1.2 hectare pond.

The number and type of head movements (signalling bouts) were counted until the behaviour changed, to grazing, preening, walking or swimming, etc. Which signals were performed by birds that were stationary (standing on land or sitting on water) we recorded the elapsed time until any subsequent locomotion. The number of head movements was also counted during signalling bouts when the bird was already moving. The signals included in this report are distinguishable from preflight intention because of the noticeable absence of the low guttural sound that accompanies preflight signalling (Raveling 1969).

In the 1979 breeding season six feather-cut pairs that hatched and reared goslings were kept in individual pens (9m x 15m) where they were easily watched during the first three weeks after hatching. After the female parent initiated a signalling bout the following response of the goslings was noted. Head and neck movements in the goslings were also counted. When a gosling performed a signal bout any locomotory response was recorded for the local bird and its family members. The age at which signalling appeared in those small groups of human raised goslings was also recorded.

Results

Table 1 shows the number of head movements per signalling bout and the elapsed time before any responding locomotion. It also lists the number of head-tosses that were given when the bird was already moving. Head-tossing (Fig. 1) from a stationary bird resulted in locomotion for 85% of the bouts. Film analysis showed that
at the end of a head-toss bout the goose sometimes initiated or changed the direction of its locomotion in the direction in which its bill pointed. When an individual was in front of an obstacle, such as a fence, the locomotory response was greatly delayed and the number of signals given from a stationary position increased nearly five-fold. Head-tossing continued for longer periods of time when the family began to walk or swim. In one case a male gave 82 head-tosses as he and his family swam the length of the pond.

Casual observation indicated that head-pumping by parent birds was mainly induced when another family was approaching from a distance, but the signal was also frequently displayed by wild families, in north-eastern Ohio, that were completely alone on their brooding rearing ponds. Almost two-thirds (73 of 117) of the head-pumping bouts observed resulted in the initiation or continuation of locomotion. Head-pumps, where the head returned to a vertical "alert" position did not result in locomotion. Close examination of the films

Table 1. Signals performed in different situations and the immediate locomotion.

<table>
<thead>
<tr>
<th>Signals type (Direction of situation)</th>
<th>Movements given per signal bout (stationary) mean (range)</th>
<th>Time until locomotion by signaler Number and percentage mean (range)</th>
<th>Movements given per signal bout (in motion) mean (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-toss (forward)</td>
<td>3.0</td>
<td>106</td>
<td>0</td>
</tr>
<tr>
<td>(forward)</td>
<td>(1-10)</td>
<td>88%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>N=123</td>
<td>8%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>N=60</td>
<td></td>
<td>N=60</td>
</tr>
<tr>
<td>Head-toss (to the side)</td>
<td>1.3</td>
<td>28</td>
<td>4</td>
</tr>
<tr>
<td>(obstructed)</td>
<td>(1-4)</td>
<td>88%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>N=32</td>
<td>13%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>N=13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head-toss (obstructed)</td>
<td>18.8</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(obstructed)</td>
<td>(3-38)</td>
<td>19%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>N=28</td>
<td>31%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head-pump (warning or threat)</td>
<td>10.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(warning or threat)</td>
<td>(2-7)</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>N=51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head-thrust (to the side)</td>
<td>2.3</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>(to the side)</td>
<td>(1-4)</td>
<td>100%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>N=22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N=13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Frame by frame analysis of a typical head-toss given prior to the start of locomotion or when a bird is already walking or swimming.
indicated that when locomotion occurred the neck was extended out from in front of the body at various angles from the last pumping movement (Fig. 2). Therefore, in Table 1, we called head-pumping, which resulted in locomotion, “Head-thrust.” Only twice (n=53) when a head-thrust motion was observed did the gosling fail to proceed forward. As with head-thossing when the head-thrust pointed to the left or right the bird initiated or changed its direction of travel accordingly (Fig. 3). Head-pumping also occurred when the birds were mobile. Combined head-throws and neck-thrust throws were also observed (n=27) in which the number of signals before motion was 4.5 (range 1-10) and 94% of the throws resulted in locomotion.

In many situations vocalizations accompanied these signals. The type and intensity of the calls was determined by the proximity of family members. These calls have been adequately described by several authors (Collins & John 1959; Radesater 1974; Ackerson & Raveling 1982).

Head-thossing performed by females caring for young goslings was usually performed at the goslings’ height. Head-thrusts were also performed close to the ground. There was little variation in the number of movements or in response time between these lowered signals and those performed with the head held vertically (Table 2). The only major difference in these lowered head movements was the observation that males rarely performed them, as they spent more time being vigilant while the female more actively directed the path of the goslings during the first days after the hatching. Another head-toss, performed by the female at ground level, was termed “grouping signal” because, together with a rapid succession of clucks, it functioned to bring the goslings together near the female’s head. This head movement was much faster and more vigorous. The call which accompanied this signal may be similar in function to the grouping (mooning) call reported by Frazer & Kirkpatrick (1979) in Emperor Geese. As goslings became older the frequency of response to this signal and call decreased. During the first four days, three grouping signals were recorded where the goslings ran to the female within two seconds. Between the third and fifth day nine responses to the signal took more than two seconds and up to six seconds. The last observation of this female behavior was on the ninth day, and the goslings did not respond at all.

Head-thossing by goslings began on the hatching day and steadily increased from day four until peaking at about 30 days (Fig. 4). These signals were readily distinguished from head-shaking due to excess fluid in the nares. Only 12 head pumps were given by
Table 2. Signals given by the female parent and goslings during the first three weeks after hatching.

<table>
<thead>
<tr>
<th>Signals type (Direction or situation)</th>
<th>Movements given per signal bout (stationary) mean (range)</th>
<th>Time until locomotion by signaler Number and percentage</th>
<th>Movements given per signal bout (in motion) mean (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>head toss (dropped)</td>
<td>3.7 (−11)</td>
<td>100% (N=12)</td>
<td>10.6 (N=16)</td>
</tr>
<tr>
<td>head-thrust (dropped)</td>
<td>2.2 (−8)</td>
<td>100% (N=10)</td>
<td>10.6 (N=10)</td>
</tr>
<tr>
<td>Grouping signal</td>
<td>15.4 (−42)</td>
<td>−a −a −a</td>
<td>0 (−18)</td>
</tr>
<tr>
<td>head toss (by goslings)</td>
<td>1.76 (−17)</td>
<td>100% (N=67)</td>
<td>−a −a −a −a</td>
</tr>
</tbody>
</table>

a. See text.
b. Includes nine goslings all of which gave signals: those broods of two and three broods of one.

Figure 4. The development of head-tossing signals in parent-reared goslings which were followed by locomotory responses in the first 28 days after hatching. The event axis is for the total number of signals that were observed in 67 broods. The minute axis is for signals that were recorded during filmed sequences.
two of the goslings, when they were three days old. They were looking directly at the
gander which we also head-pumping about
one meter way, so it appeared that they
were mimicking his behaviour.

After 18 of 21 (86%) signal bouts, where the
family members' responses were re-
corded, at least one member followed the
goslings which had performed a head-toss
but before running ahead to forage. In 12
(57%) cases both parents and siblings
followed, and in three other situations none
of the family members followed the gos-
lings’ movement.

There was little difference between go-
slings and adults in the number of signal
bouts that resulted in locomotion within
two seconds (Table 2). However, the
number of head tosses gives rise to a station-
ary position before locomotion began was
larger for adults (mean 35) than for goslings
(mean 17).

For the length of the study the human-
raised goslings which had never seen head
and neck signals did not perform them prior to
or during locomotion. However, after
two months three of these goslings were
introduced to gosling which gave signals and on
the following day they performed head-
tosses. Another group of five human-
raised goslings were allowed to remain with
their parents for part of the first day after
hatching during which they left the nest. The
parents performed many signals during
this time. Beginning in the first two weeks
these goslings gave many head tosses. They
especially performed them when they tried to
follow their foster parent after being
separated by the fence of the rearing pen.
The incubator hatched goslings which had
never experienced adult gosling, on the other
hand, did not give any signals in this
situation.

Discussion

Due to the high percentage of bouts (from a
stationary position) that were actually
followed by locomotion of the signaler, it is
evident that the head and neck movements
described in this study are pre-locomotory
signals. This is supported by the finding that
the number of head tosses drastically in-
creased when a bird’s forward progress is
hindered and the motivation toward loco-
motion is assumed to be heightened. Because
a stationary bird usually gives more
than one head or neck movement before
walking or swimming away there is no
time to attract the attention of family
members.

Head-pumping by parent goslings appears
to function as a warning to approaching con-
specifics, thereby advertising the position of
their family. Besides threat functions, the
conspicuous movements, as with head-
tossing, serves to get the attention of family
members so that a change in location or
direction of travel can be synchronised
among them. Once the family is mobilised,
signalling not only continues to communi-
cate a warning to neighbours but facilitates
family cohesion and redirection of travel
paths, thus avoiding conflict with other
families. To stress the locomotory element
of visual signals it should be mentioned that
both signal types were observed in wild
goslings when there were no conspecifics
present which may have otherwise elicited
such behaviour.

The white-on-black check patch made
conspicuous by these head movements may
be the initial directing stimulus, together
with auditory cues (Cowan 1975), that
newly hatched goslings respond to when the
brood leaves the nest for the first time. This
suggestion is supported by the effectiveness
of the grouping signal, and other head
movements that are performed close to the
ground in front of young goslings. Indeed,
the contrasting check patch is the first
stimulus a hatching gosling perceives as the
female slightly lifts her body and frequently
bends her neck to “fuck-in” around the nest as
the eggs hatch.

In the wild during the post-hatch period
flightless gosling often travel long distances
on foot to brood resting areas when gosling
mortality is known to be high (Gillmor 1980;
Zicun 1981). A system of social signalling
that functions to synchronise such efforts
and thus facilitates a cohesive family unit is
presumably advantageous. Visual signals,
instead of loud calling, would also allow
families to escape undetected by predators
during the flightless period. Such occur-
rences were observed when approaching
wild birds; both the males and females
silently gave head movements to direct their
brood into cover. During other seasons,
flight is known to demand a great amount of
energy reserves. It is also known that
Canada Geese spend most of their time on
the ground or in the water. For such a life-
style, selective pressures would favour a
communication system that would specialise in terrestrial or aquatic locomotion, since it would often be more efficient than flying, e.g. over short distances.

We found that goslings reared by their parents gave head and neck signals at an early age, and that human-reared goslings did not unless they experienced signals by their parents during the first day. Hatchlings reared goslings quickly developed head-tossing at two months of age after a brief exposure to the signal.

In the light of these findings, it may be instructive to use these, or similar criteria, as used in this study, to test if visual signalling behaviour in birds, which were reared apart from their parents, varies significantly from parent-reared (or wild) birds. It is our impression that the number of signals per bout, the presence or absence of locomotion and the time until locomotion (in the focal animal as well as its family members) will vary if the birds do not experience the behaviour early in life. In view of the possible functional adaptations associated with the signals in question, to the extent to which those functions are measurable, studies such as these may be an important test for biologists who conduct reintroduction programmes on endangered species as it would be to sociocultures.

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Summary

In 120 observations when a stationary Canada Goose Branta canadensis was being tossed by the bird began to walk or swim within ten seconds. The number of head tosses increased considerably when the signaliser stood in front of an obstruction. After 70% of the head-pinning bouts (n = 55), when the signaliser’s neck was thrust away from the body, the bird began to walk or swim within ten seconds. When the signal movement ended with the head and neck pinned to one side the signaliser proceeded or changed course in that direction. Head and neck signals were also used when families were already walking or swimming, which seemed to reinforce, maintain, or redirect the initial movement.

Female parents performed the same head and neck movements at ground level near their young. During the first week after hatching goslings responded to a “pairing” signal by running to the signaliser’s head. Goslings reared with their parents began head tossing during the hatching day. The number of signals performed by them peaked on the tenth day. In 80% of the observations (n = 21) at least one family member followed a gosling which gave head tosses before it was walking or swimming. Human-reared goslings that were kept from adult presa did not develop head-tossing until they were exposed to other gosling. We venture to speculate that visual signalling in some way improved if goslings are not reared with their parents at least for a short period.

The possible functional adaptations associated with these signals in Canada Geese as single transmission of threat or warning to conspecifics; obtaining the attention of family members in order to synchronise their travel especially during the brood carrying stage; facilitating unobtrusive retreat from predators during lightless periods; and serving as a specialised system of communication for terrestrial and aquatic locomotion, as flight has great energetic demands.

References

Canada Goose visual signalling


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