Tuning a nose to forage: Evidence for olfactory learning in a procellariiform seabird chicks

Gregory B. Cunningham
Saint John Fisher College, gcunningham@sjfc.edu

Gabrielle A. Nevitt
University of California - Davis

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Tuning a nose to forage: Evidence for olfactory learning in a procellariiform seabird chicks

Abstract
Burrow nesting procellariiform seabirds use olfactory cues for both foraging and nest recognition. As chicks, burrow nesters develop in the dark, but are exposed to both prey-related and individual-specific scents through contact with their parents. This exposure suggests that chicks may have the opportunity to learn odours while still in the nest. In this study, we examined whether exposure to odourants during development might influence olfactory search behaviour expressed later in life. To test this idea, we exposed eggs of thin-billed prions Pachyptila belcheri to a rosy-scented novel odour (phenyl ethyl alcohol, PEA) or a control (water) just before hatching; chicks were then tested with these odours in a simple wind tunnel. Prior to fledging, subjects who had received pre-exposure to PEA displayed head sweeps nearly twice as frequently as control birds did when presented with PEA. This study demonstrates that under natural rearing conditions, procellariiforms learn odour characteristics of their rearing environment in the nest.

Disciplines
Biology

Comments
PowerPoint presentation given at the 2010 Society for Integrative and Comparative Biology Annual Meeting.
Tuning a nose to forage: Evidence for olfactory learning in a Procellariiform chick

Gregory B. Cunningham
Gabrielle A. Nevitt
Procellariiforms and olfaction
DMS production
DMS production
DMS production

EAT

DMS
DMS production

EAT

DMS

EAT
Wilson’s Storm–petrels are attracted to DMS

Based on Nevitt et al. (1995)
DMS responses vs. size of bird

- Small birds react more strongly to DMS than large birds
- Small birds tend to nest in burrows

Based on Nevitt et al. (1995)
Procellariiform breeding biology

• Fed regurgitated prey or fed stomach oils
• Never encounter their prey in an unprocessed form
• Must forage successfully despite prey being small and patchily and the ocean being immense
• Fledge without help from their parents
Procellariiform breeding biology

• Fed regurgitated prey or fed stomach oils
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• Must forage successfully despite prey being small and patchily and the ocean being immense
• Fledge without help from their parents

➔ Do chicks learn about food related odours while in the burrow?
Kerguelen Island
Mayes Island
49°28'S, 69°57'E
Study species: Blue petrel (*Halobaena caerulea*) and Thin-billed prion (*Pachyptila belcheri*)

- As adults, both respond to DMS deployments at sea
  - Nevitt et al. (1995)
The Porter method
Blue petrel chicks can detect DMS and PEA (a novel scent)

- PEA > Control
  - $P = 0.001$
- DMS > Control
  - $P = 0.014$

From Cunningham et al., Journal of Experimental Biology (2003)
Results from Porter method study

- Blue petrels and Thin-billed prions can detect and respond to a variety of odours shortly after hatch
- Suggests that learning may occur while chicks are still in the burrow
Methods

• Collected 20 dead Blue petrels at two life stages:
  – 10 adults
  – 10 Chicks > 30 days old (close to fledging age)
• Removed brains from samples using dissecting scope and photographed brains
The olfactory bulb, but not the telencephalon, is fully grown in older chicks.
The story thus far...

- Chicks can respond to odours following hatch
- Chicks appear to be allocating resources towards growing their olfactory bulb rapidly during early stages of development
Embryonic exposure alters behaviour

- Painted chicken eggs with liquid strawberry
- Treated chicks hatched with preferences for strawberry
- Control exposed chicks had an aversion to strawberry

Sneddon et al. (1998)
Does pre-exposure to PEA alter a chick’s response to PEA later in life?

- 7-10 days prior to hatch, we painted 40 Thin-billed prion eggs
  - 20 with 0.1 μM PEA
  - 20 with distilled water

- At 37-42 days post hatch, chicks were tested with μM PEA and distilled water in the wind tunnel
  - Porter method: chicks can detect PEA
  - An earlier study (Cunningham et al. 2006) showed that chicks do not initiate search behaviours in response to PEA
Thin-billed prions are ‘blobs’
Pre-hatch exposure affects response

- In the presence of PEA
  \[ P = 0.048 \]

- In the presence of control
  \[ P = 0.84 \]

From Cunningham et al., submitted
Discussion

• Our earlier work suggests that chicks may be learning about odours following hatch
• Brain development appears to support this
• Painting an egg with PEA → search behaviour
• Current study suggests learning may occur
  – While in the egg
  – While hatching
• Adult procellariiforms returning to the burrow often smell of DMS
Early olfactory learning is common
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