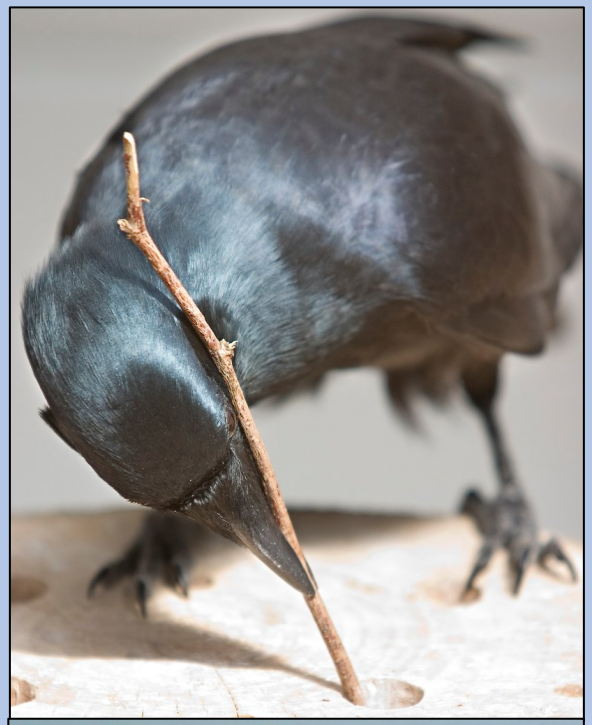
# Major Study Groups: Birds

## Social learning, culture and cultural evolution in birds (Aves)

Max-Planck-Institut
für Verhaltensbiologie

Lucy Aplin

# Birds




© Joe Duff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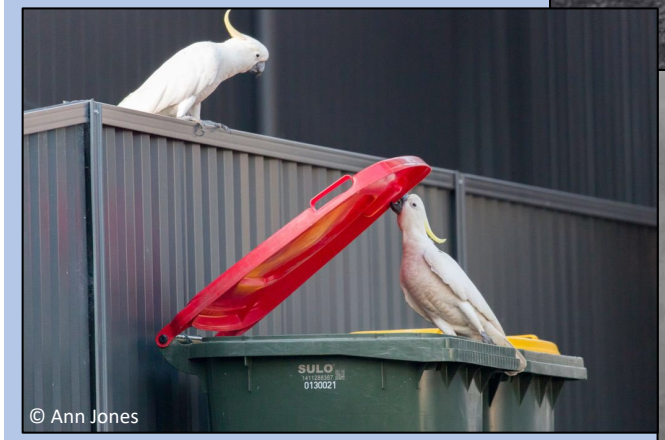
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Fisher & Hinde (1949)


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# 1. Evidence for social learning in birds

"Learning that is influenced by observation or interactions with another individual or its products" Heyes 1994 Biol. Rev 69: 207-231

# This Lecture

1. **Evidence for social learning in birds: ecological contexts**
   - Vocalisations
   - Foraging Skills

2. **Evidence for cultural inheritance and vertical transmission**
   - Cross-fostering experiments
   - Evidence from imprinting
   - Imprinting x Cross fostering: across-species fostering

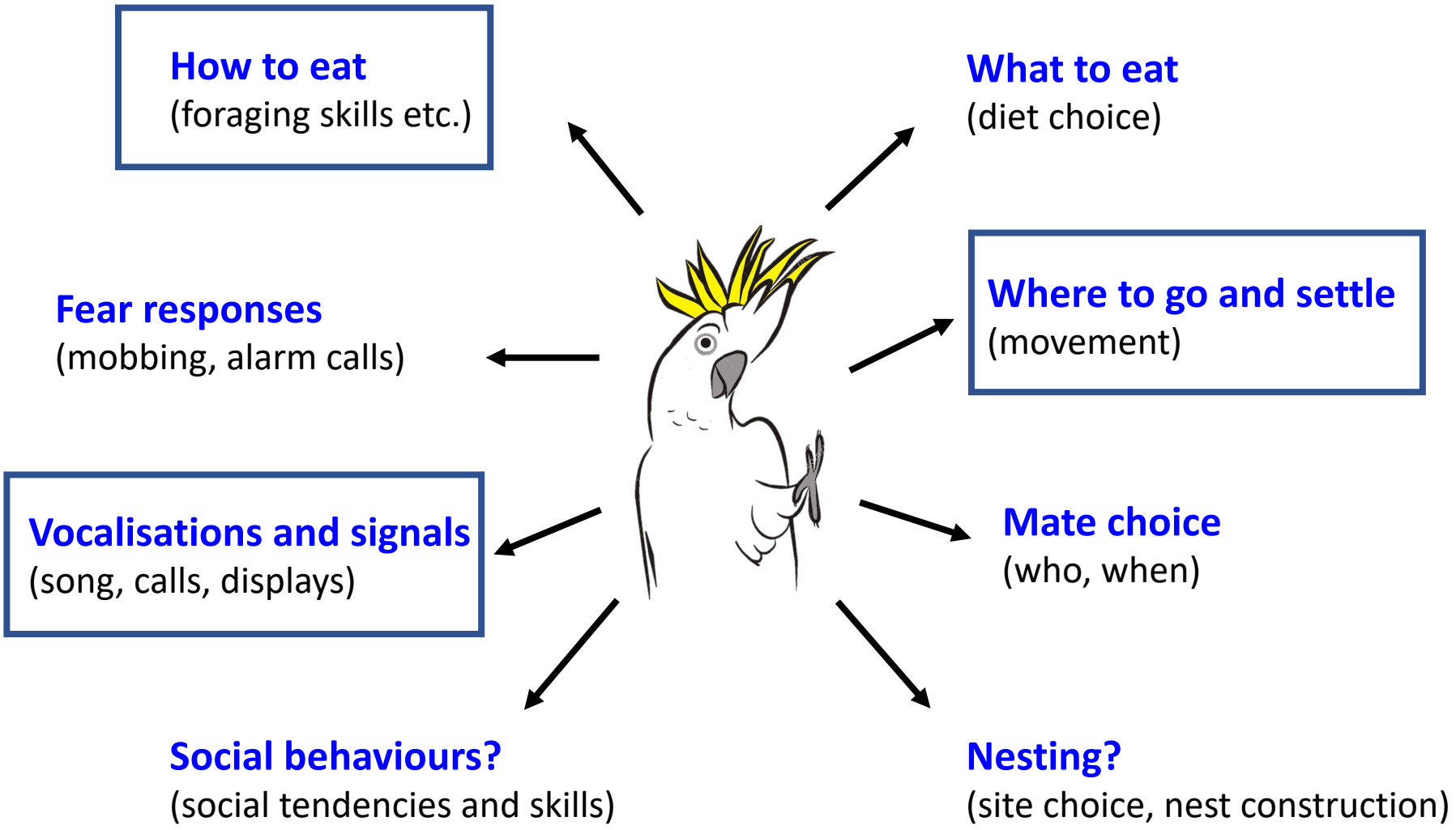
3. **Wild cultures?**
   - Vocal cultures: song and dialects
   - Tool use in New Caledonian crows

4. **Spread of innovation and cultural change**
   - Human induced innovation and change
   - Cultural diffusion experiments in tits
   - Cultural evolution in song

# This Lecture

1. **Evidence for social learning in birds: ecological contexts**
    - Vocalisations
    - Foraging

# 1. Evidence for social learning in birds: ecological contexts

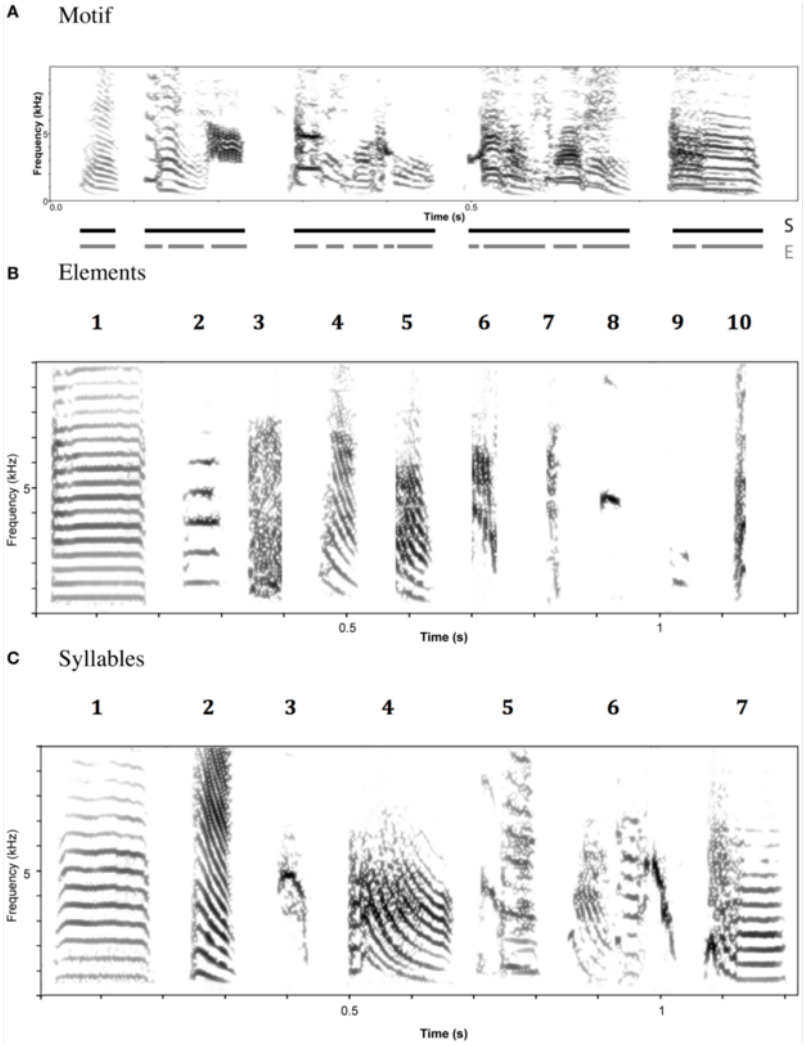


# 1a. Evidence for social learning in birds: song

*White-rumped Shama, Hawaii,* © Benjamin Clock and Macaulay Library

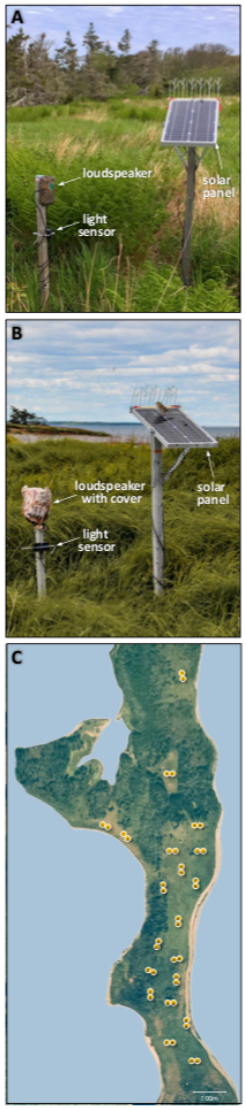
# 1a. Evidence for social learning in birds: song

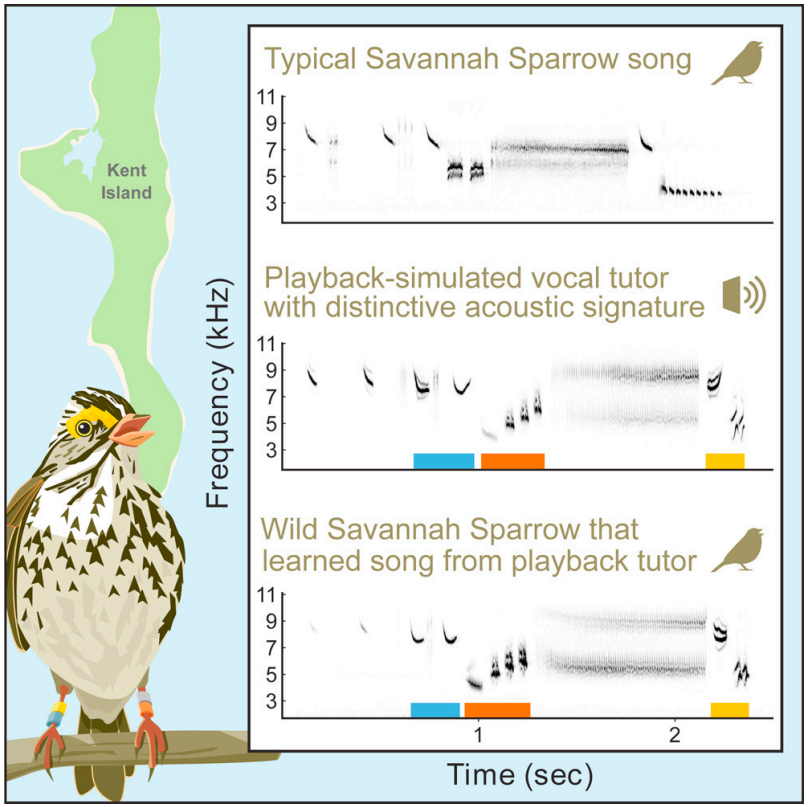
Song learning in zebra finches,
*Taeniopygia guttata*



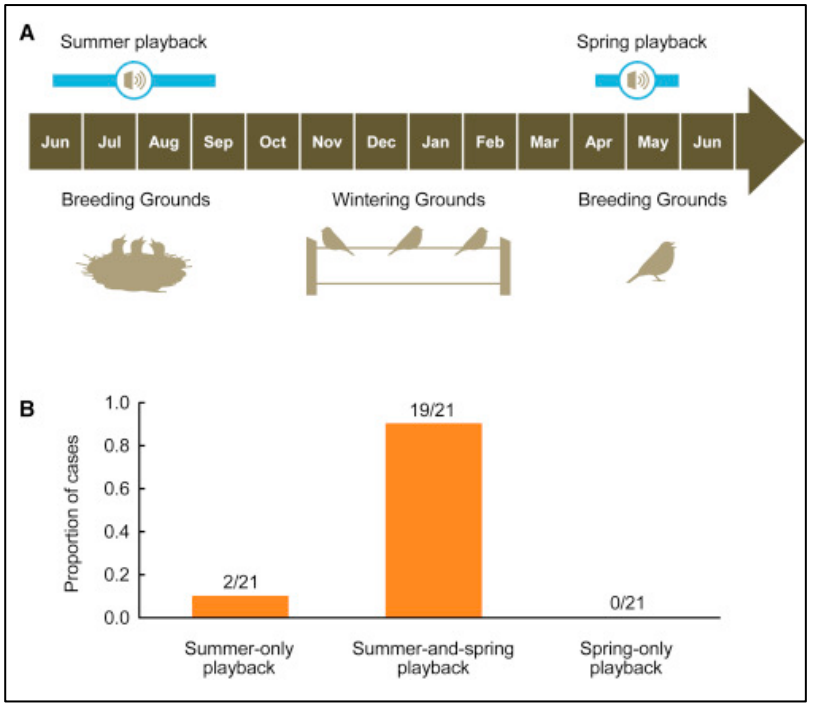

Lachlan et al. (2016) Frontiers in Pyschology

# 1a. Evidence for social learning in birds: song




Experimental demonstration of vocal learning of song in wild Savannah sparrows (*Passerculus sandwichensis*)

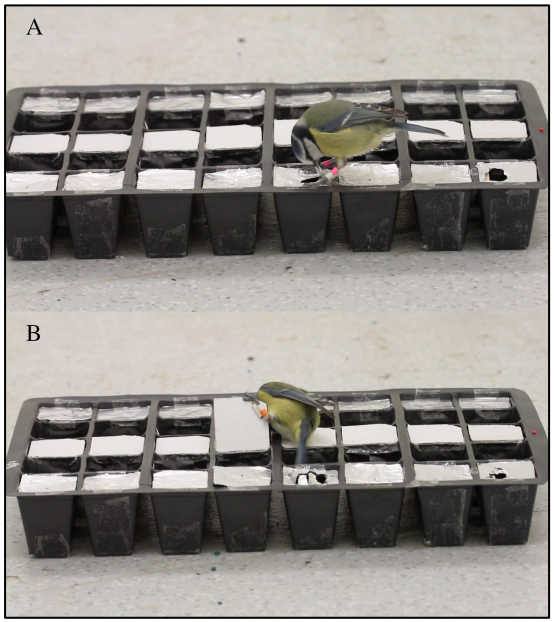


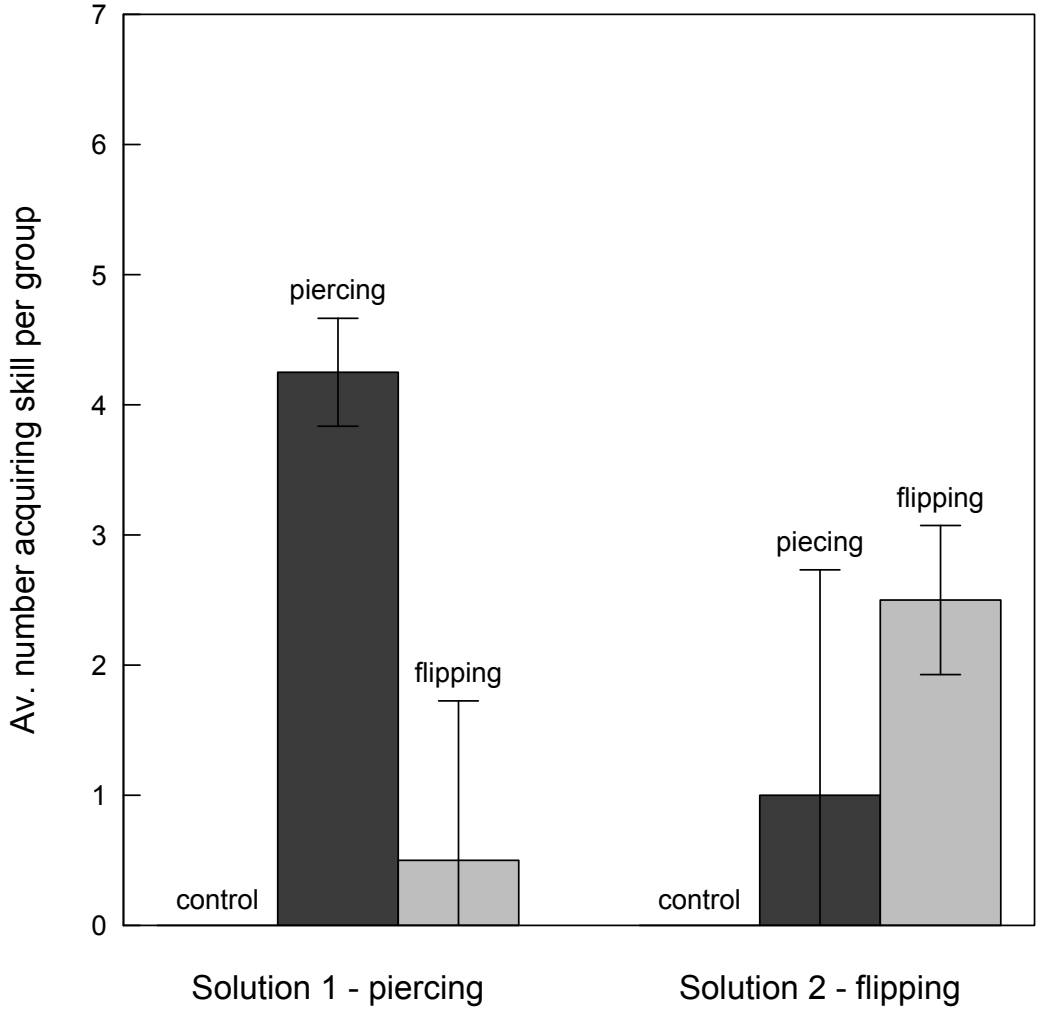

Mennill et al. (2018) Current Biology

# 1b. Evidence for social learning in birds: how to eat


Aplin et al. (2013) Animal Behaviour

# 1b. Evidence for social learning in birds: how to eat




Aplin et al. (2013) Animal Behaviour

# 1b. Evidence for social learning in birds: how to eat





**The New Caledonian Crow (*Corvus moneduloides*)**

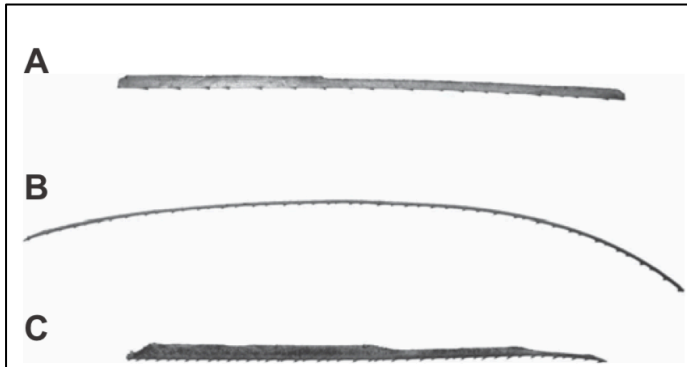



**Figure 2. The three different *Pandanus* tool designs described on Grande Terre. (A) Wide tool. (B) Narrow tool. (C) Stepped tool.**

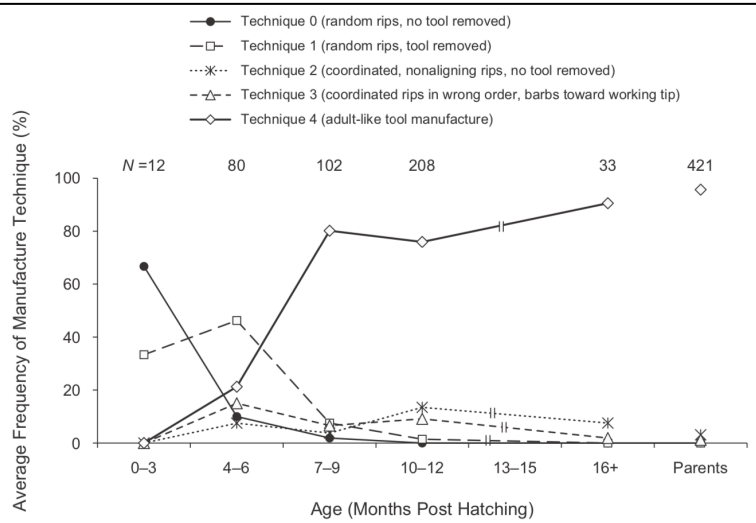



**Figure 4. Development of wide *Pandanus* tool manufacture techniques. *N* = the total number of tools manufactured by the members of each age class.**

Holzhaider et al. (2010) Learning & Behavior; Rutz, C. R. & Sinclair, J. J. H. (2012) Behavioural Processes

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    - Vocalisations
    - Foraging
    - Movement

2. **Evidence for cultural inheritance and vertical transmission**
    - Cross-fostering experiments
    - Evidence from imprinting
    - Imprinting x Cross fostering: across-species fostering

# 2. Cultural inheritance: experiments

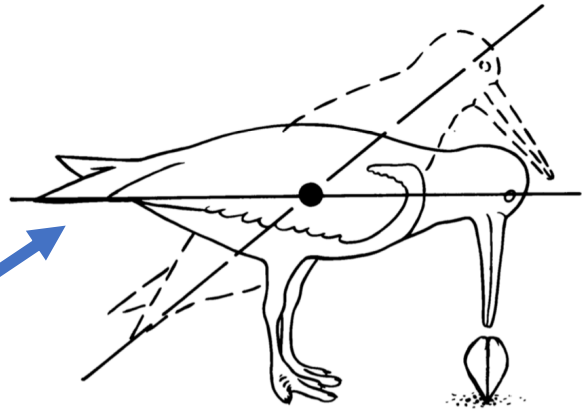
Information transmitted from previous generations. Can form a potentially important part of individuals' behavioural repertoire, when it is often referred to as a ‘second inheritance system’ (Whiten, 2005)


**Cross-fostering**

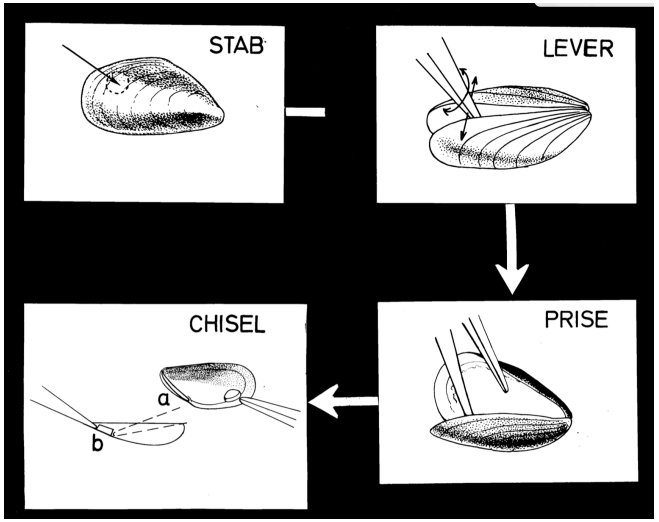
**Imprinting**

# 2. Cultural inheritance


Hammer



Stab




Norton-Griffiths (1967) Ibis

# 2. Cultural inheritance

Information transmitted from previous generations. Can form a potentially important part of individuals' behavioural repertoire, when it is often referred to as a ‘second inheritance system’ (Whiten, 2005)


TABLE 1 THE FEEDING TECHNIQUES DEVELOPED BY YOUNG OYSTERCATCHERS

| Parents' specialisations | feeding techniques of the young: just independent from parents | 2nd year | 3rd year |
|---|---|---|---|
| mussel-Stab (a) | mussel-stab | not seen | mussel-stab |
| mussel-stab (c) | mussel-stab | mussel-stab | not seen |
| mussel-stab | mussel-stab | mussel-stab | mussel-stab |
| mussel-stab | mussel-stab | not seen | not seen |
| mussel-hammer (b) | mussel-hammer ( 2 young ) | mussel-hammer ( 1 young ) | not seen |
| mussel-hammer | mussel-hammer | mussel-hammer | not seen |
| crab-eater | crab-eater | not seen | not seen |
| crab-eater (d) | crab-eater | not seen | not seen |

note: (a), (b), (c), (d) refer to parents used in cross-fostering experiment, see Table 2.

Norton-Griffiths (1967) Ibis

# 2b. Cultural inheritance: cross fostering experiments

**Cross-fostering**

TABLE 2 THE FEEDING TECHNIQUES DEVELOPED BY CROSS-FOSTERED YOUNG OYSTERCATCHERS

| Parents' specialisations | Foster-parents' specialisations | feeding techniques of the young: just independent from parents | feeding techniques of the young: 2nd year |
|---|---|---|---|
| mussel-stab (a) | mussel-hammer (b) | mussel-hammer | mussel-hammer |
| mussel-stab (c) | crab-eater (d) | crab-eater | crab-eater |
| mussel-hammer (b) | mussel-stab (a) | mussel-stab | not seen |

note: (a), (b), (c), (d) refer back to Table 1.

Eurasian Oystercatcher on nest with 3 eggs



Norton-Griffiths (1967) Ibis

# 2. Cultural inheritance: experiments

Information transmitted from previous generations. Can form a potentially important part of individuals' behavioural repertoire, when it is often referred to as a ‘second inheritance system’ (Whiten, 2005)


**Imprinting**

Horwich (1989) Zoo Biology; Nesbitt (1979) *Proceedings of the 1978 Crane Workshop*

# 2. Cultural inheritance: experiments

Information transmitted from previous generations. Can form a potentially important part of individuals' behavioural repertoire, when it is often referred to as a ‘second inheritance system’ (Whiten, 2005)

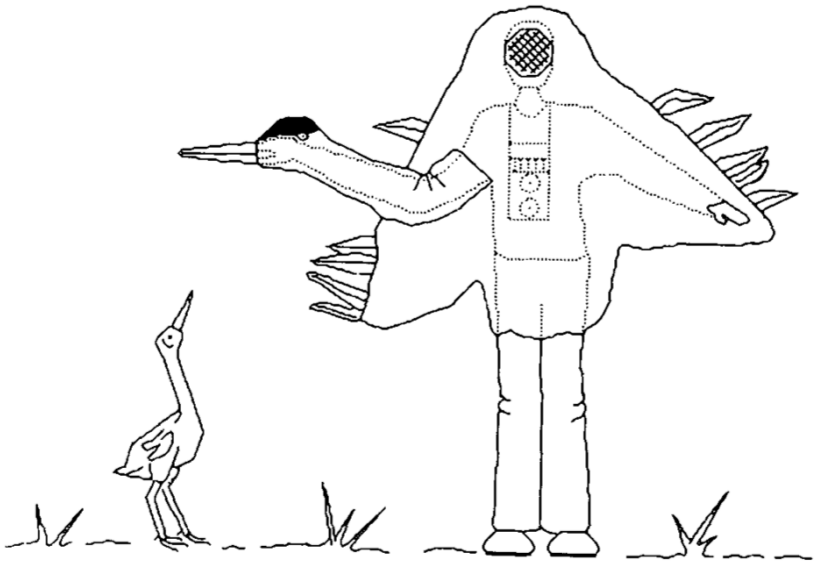
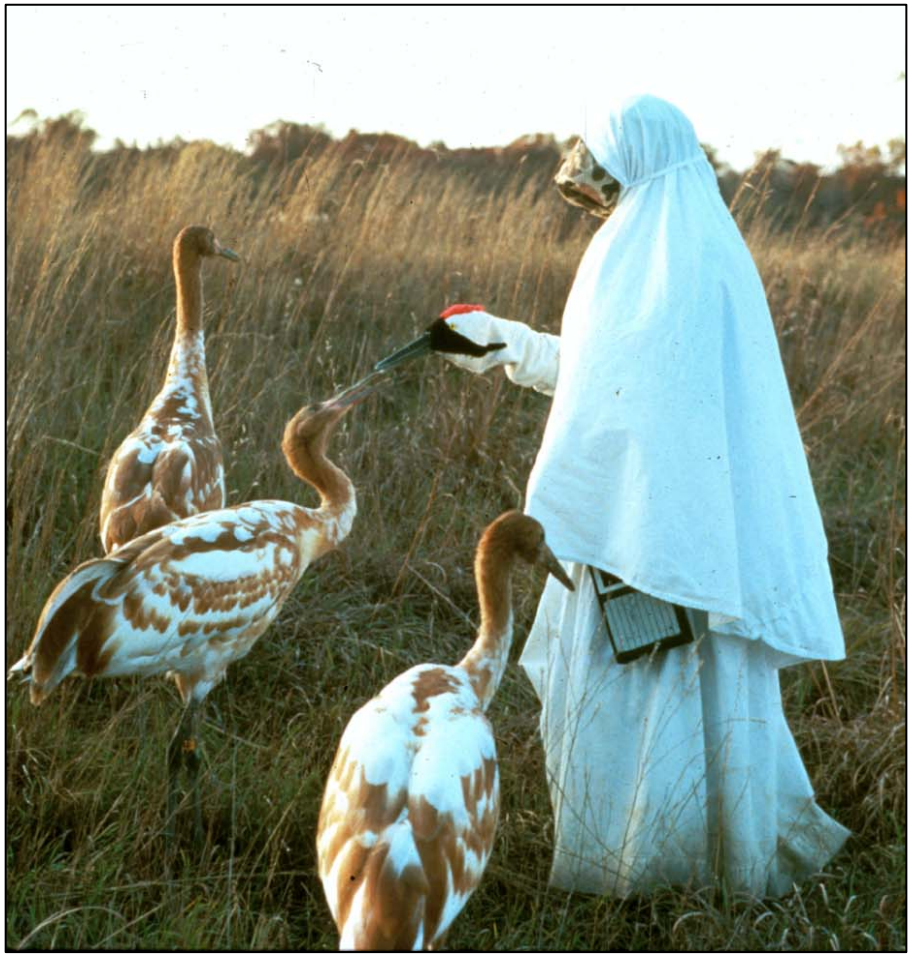


Fig. 2. Costume used for rearing crane chicks in isolation from humans.

**Imprinting**

Horwich (1989) Zoo Biology; Nesbitt (1979) *Proceedings of the 1978 Crane Workshop*

# 2c. Cultural inheritance: evidence from imprinting



Social learning of migration routes in endangered whooping cranes (*Grus Americana*)

Courtesy of www.operationmigration.org

# 2c. Cultural inheritance: evidence from imprinting

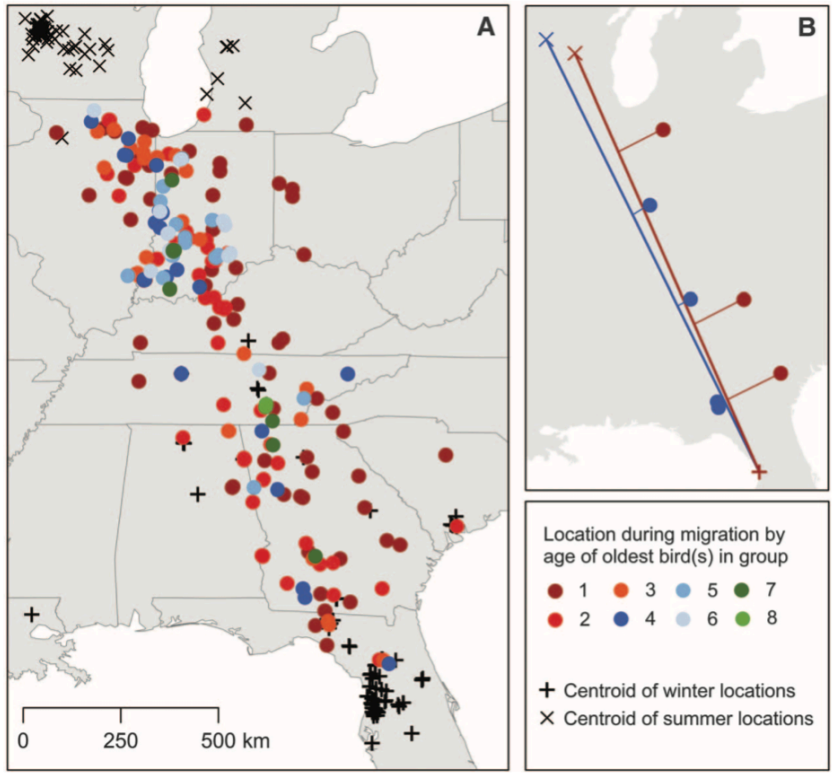



**Fig. 1. Whooping crane location data.** (**A**) Migration map for the EMP of whooping cranes (2002–2009). We identified each bird's summer and winter ranges in each year using the mean coordinates of all locations for that individual during summer and winter times when birds are not migratory. We then identified the straight-line path for each migration event linking consecutive summer and winter (or winter and summer) ranges for each bird. We calculated the deviation of each migratory relocation from the straight-line path and used this as a simple proxy for migratory performance. Variation in data availability over the 8 years of the study precluded application of more complex measures of deviation, such as those based on full trajectories that might take into account heterogeneity in wind strength and direction, topography, and the availability of suitable stopover sites. (**B**) Typical migratory pattern for two 1-year-old individuals migrating in spring 2005 traveling without (red) and with (blue) older birds.

Social learning of migration routes in endangered whooping cranes (*Grus Americana*)

Courtesy of www.operationmigration.org

Mueller et al. (2013) Science

# 2d. Cultural inheritance: across species cross-fostering


"Learning the ecological niche"
Series of studies from Slagsvold *et al.* cross fostering great tits (*Parus major*), blue tits (*Cyanistes caeruleus*) and pied flycatchers (*Ficedula hypoleuca*)

Johannessen et al. (2006) Effects of social rearing conditions on song structure and repertoire size. *Anim Behav;*
Slagsvold & Wiebe (2006) Learning the ecological niche. *Proc Roy Soc B*

# 2d. Cultural inheritance: across species cross-fostering

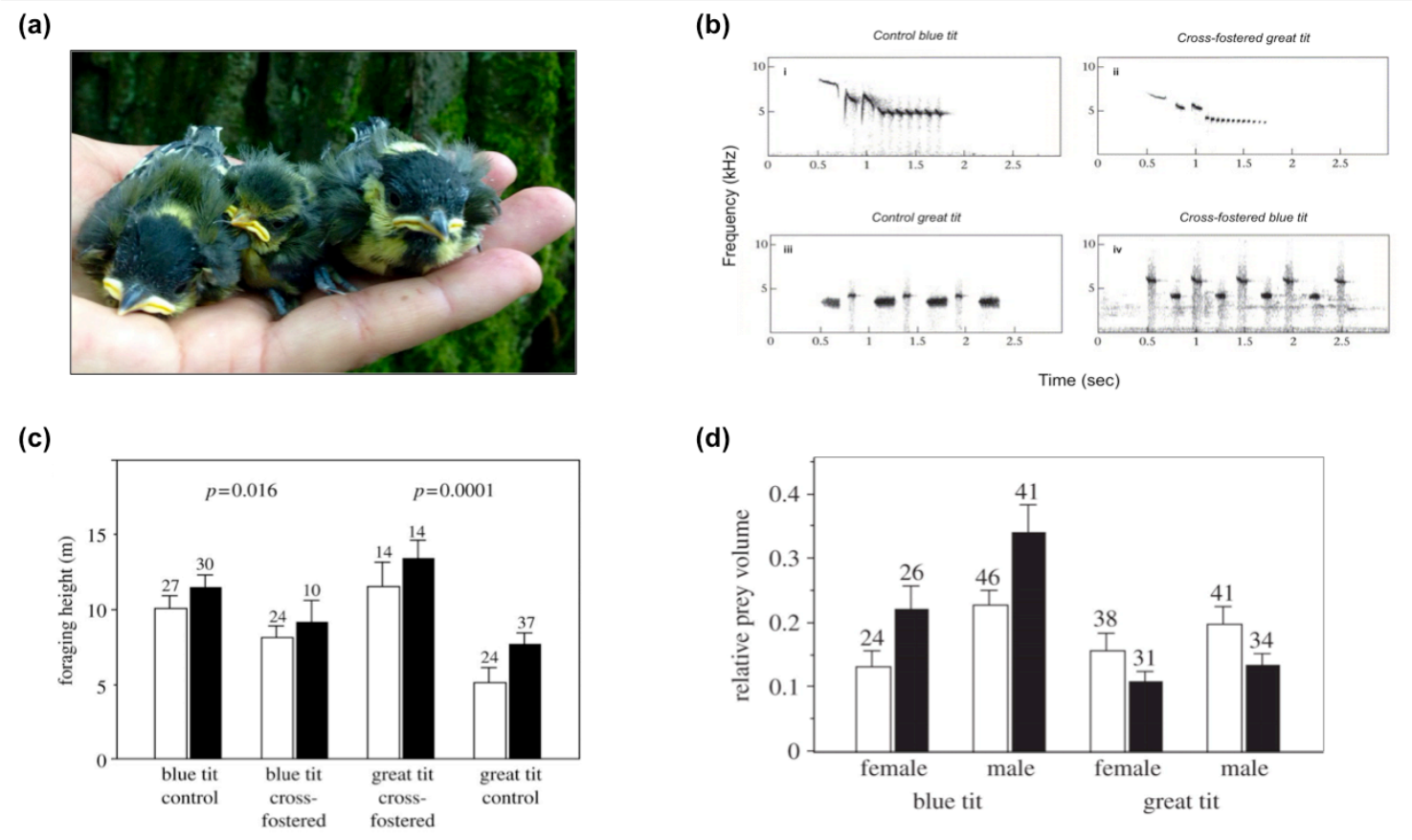



**Figure 1 (a)** Photograph showing mixed brood of great tits and a blue tit. **(b)** Graph adapted from Johannessen et al. [53] comparing example sonograms of control song (i,iii) to the song of cross-fostered birds (ii,iv). **(c)** Graph adapted from Slagsvold & Wiebe [5] comparing the foraging height of juveniles (open bars) and adults (filled bars) in August-September after differ rearing conditions. **(d)** Graph adapted from Slagsvold & Wiebe [6] comparing prey volume relative to body size that were fed to chicks by birds that were previously themselves cross-fostered (filled bars) or not (open bars).

Johannessen et al. (2006) *Anim Behav; ;* Slagsvold & Wiebe (2006) *Proc Roy Soc B; Aplin (2016) Current Opinions*

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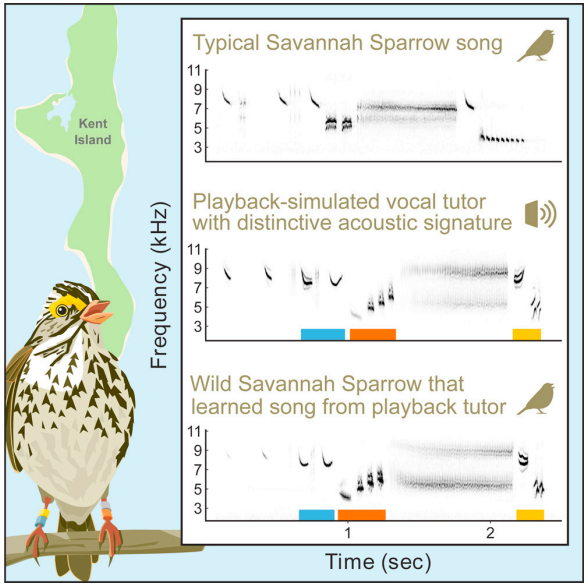
3. **Wild cultures?**
    - Vocal cultures: song and dialects
    - Tool use in New Caledonian crows

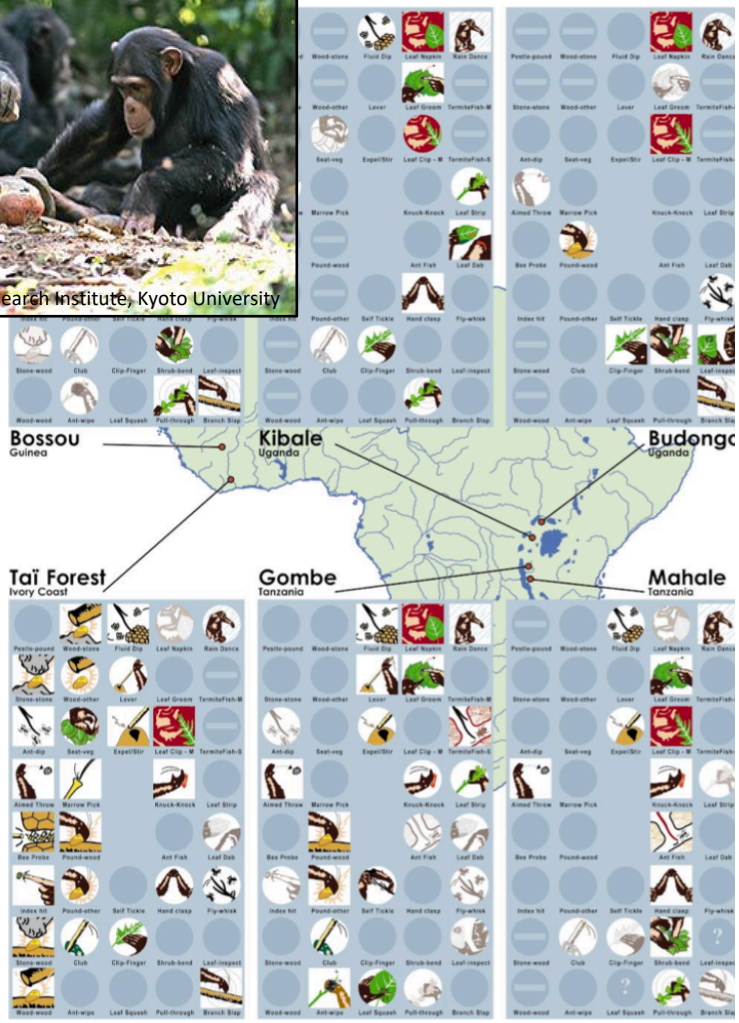
# 3. Cultural Variation in the Wild?

1.




Mennill et al. (2018) Current Biology

Primate Research Institute, Kyoto University

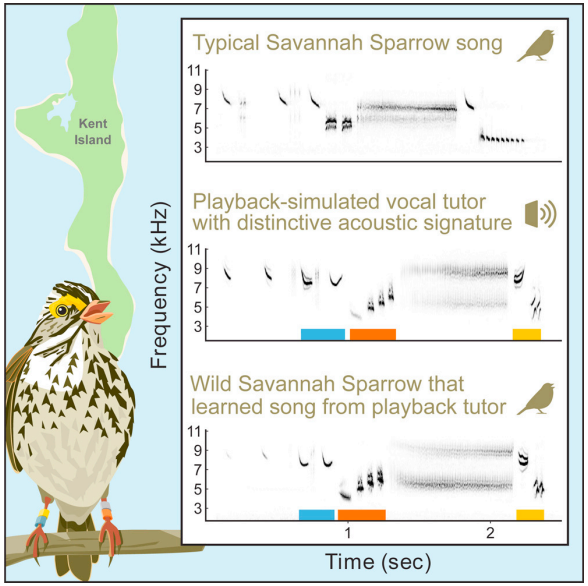



Whiten et al. (1999) *Nature*

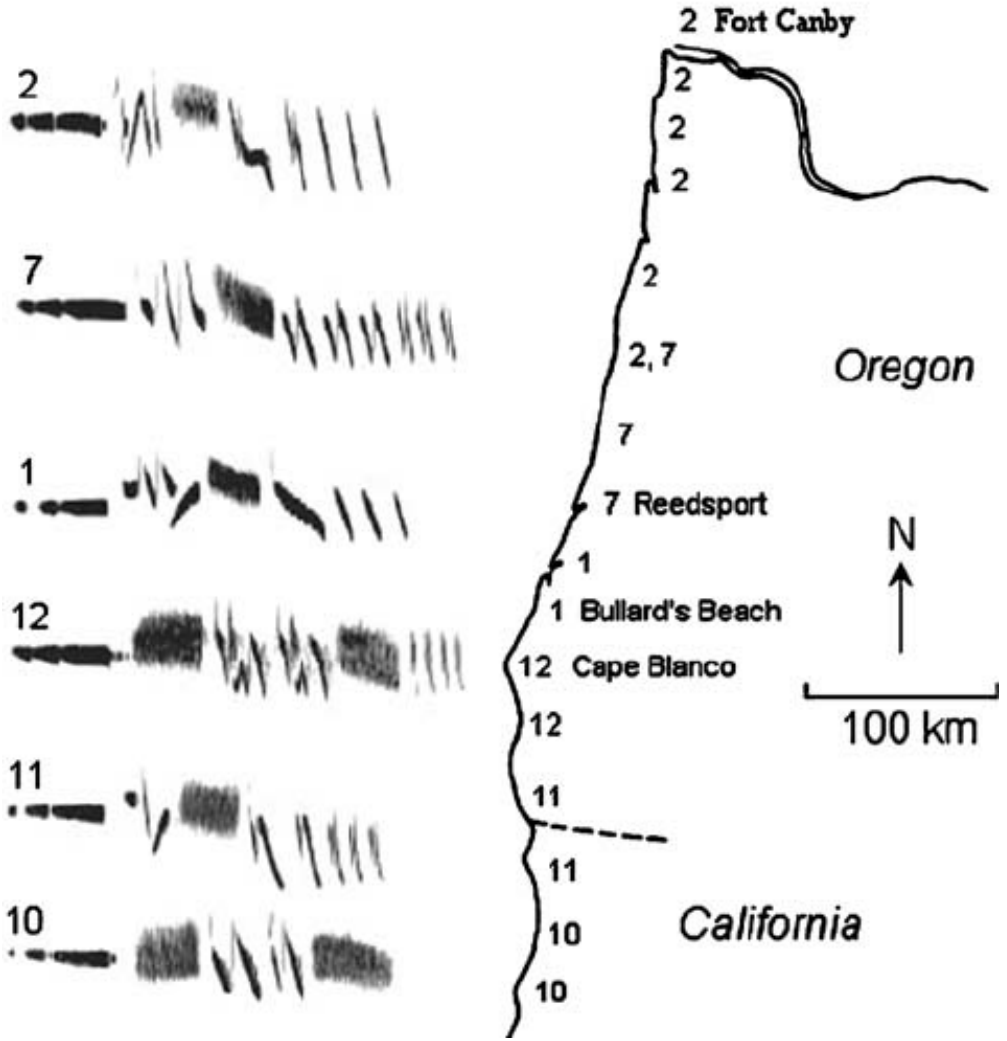
2.

© Kerry Lukowski

# 3a. Vocal culture: song and dialects



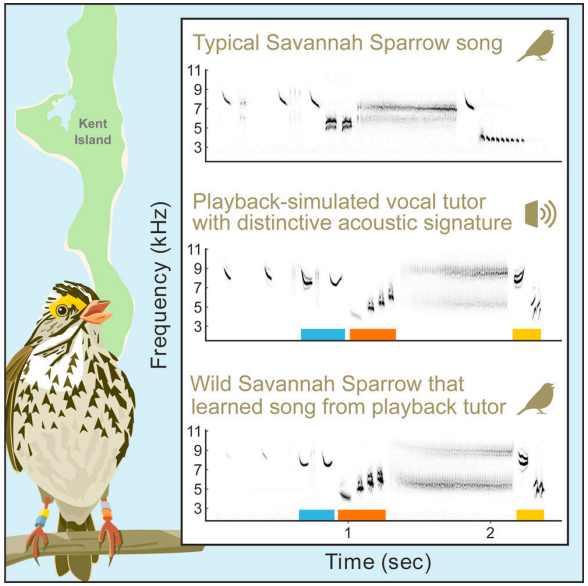





Map of the Pacific Northwest coast showing 6 out of 13 song dialects in the Puget Sound white-crowned sparrow (**Nelson et al. 2004**). Numbers refer to locations where different dialects derive . These are shown on sonograms to left.

Nelson (2000) *Animal Behav*, Nelson et al. (2004) *Ethology*

# 3a. Vocal culture: song and dialects






Swamp sparrows, *Melospiza georgiana* appear to exhibit conformist bias. A simple mechanism of overproduction and selective attrition can allow for stable traditions over centuries

Lachlan et al. (2018) *Nat Comm*

# 3a. Vocal culture: song and dialects

What about other kinds of vocalisations, and about birds which exhibit life-long vocal learning?
- Vocal dialects in parrots…

# 3a. Vocal culture: song and dialects

Regional dialects in the contact calls of the yellow-naped amazon (*Amazona auropalliata*)

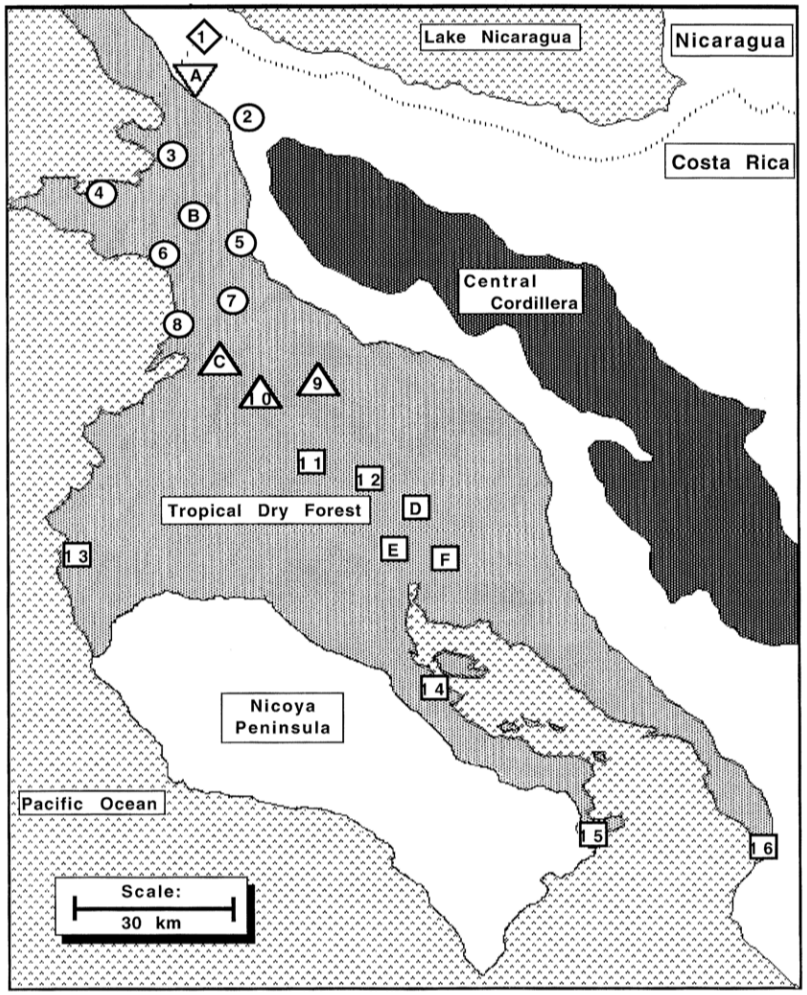




Figure 1. Map of northwestern Costa Rica showing the distribution of roosts and dialects. The circles indicate Northern dialect roosts, the squares Southern roosts, triangles Border roosts, and the diamond the single Nicaraguan dialect roost discovered. The 16 numbered roosts were used in the spectrogram correlation analysis: 1-Penas Blancas

Wright (1996) *PRSB;* Wright & Wilkinson (2001) PRSB; Wright et al. (2008) Animal Behaviour; Salinas-Melgoza (2012) *Plos One*

# 3a. Vocal culture: song and dialects

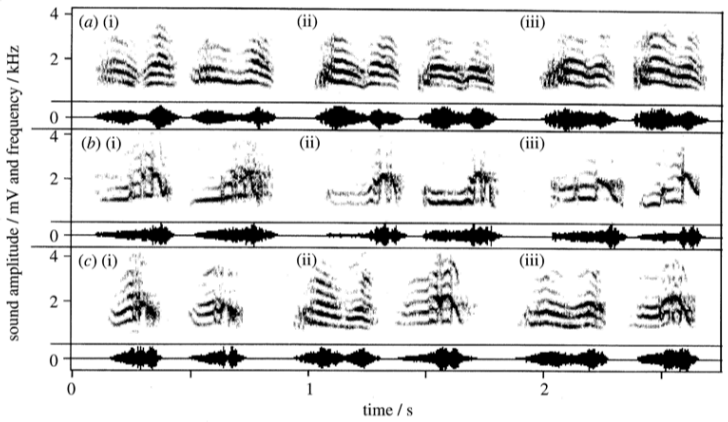
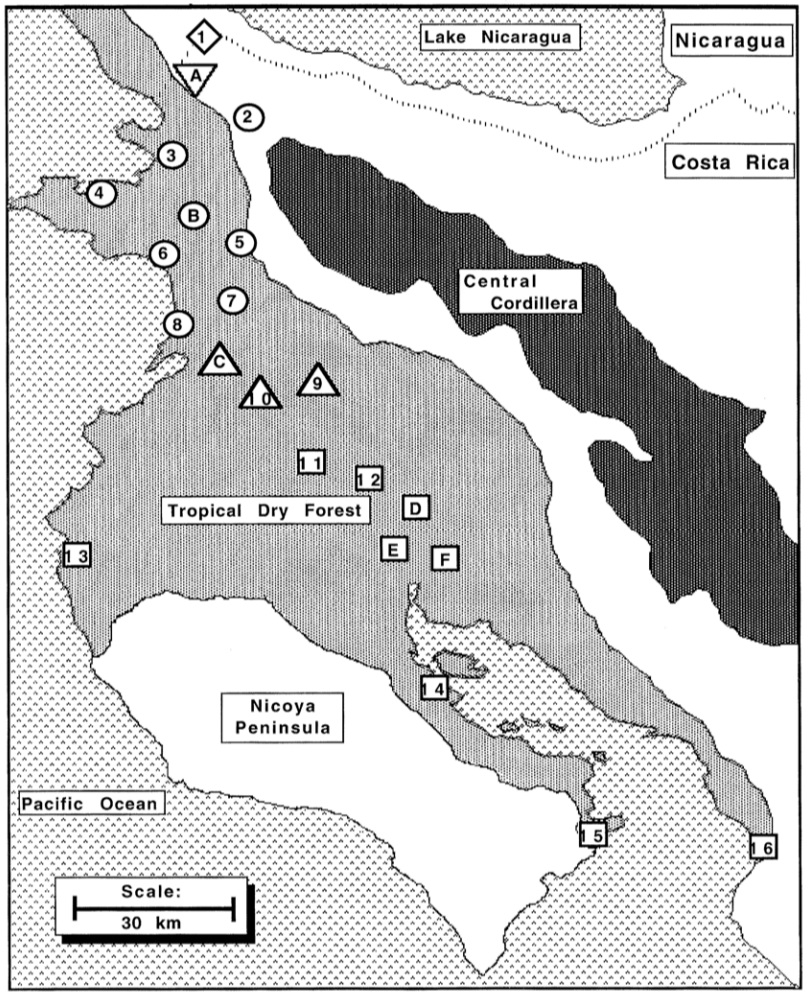



Figure 2. Spectrograms and waveforms of yellow-naped amazon contact calls. (*a*) Calls from two different birds at each of three separate Northern dialect roosts ((i) roost 2; (ii) roost 5; and (iii) roost 8). (*b*) Calls from two different birds at each of three Southern dialect roosts ((i) roost 12; (ii) roost 13; and (iii) roost 16). (*c*) Calls from: (i) two different birds at Nicaraguan dialect roost; and Northern and Southern dialect calls from (ii) a bird at Border roost 10 and a different individual at Border roost 9.

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Wright (1996) *PRSB;* Wright & Wilkinson (2001) PRSB; Wright et al. (2008) Animal Behaviour; Salinas-Melgoza (2012) *Plos One*

# 3b. Cultural Variation in the Wild – Foraging Cultures?

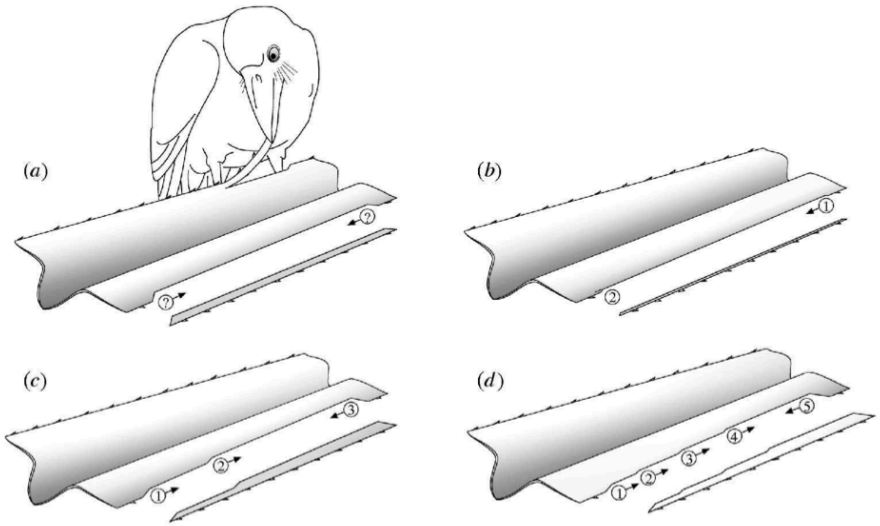
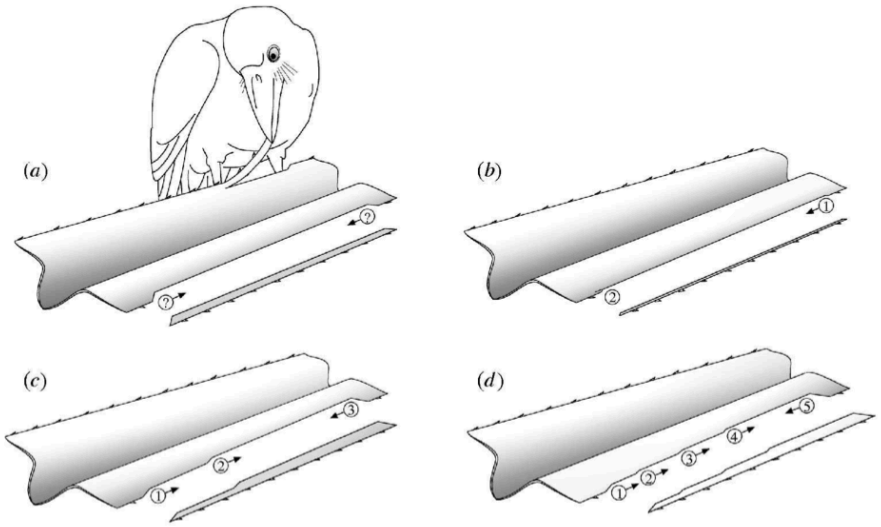



Figure 1. (summarised) Principal manufacture technique for each pandanus tool design (*a*) A crow making a basic cut and rip with the bill…Numbers inside the circles give the temporal sequence of cuts (see *b*–*d*); question marks indicate that the sequence of cuts cannot be inferred. An arrow attached to a circle indicates an associated rip and its direction. (*b*–*d*) The same symbols and leaf section as in (*a*) describe the techniques used to manufacture a narrow tool, a one-step tool and a three-step tool, respectively.



Hunt G. R. & Gray R.D. (2003) PRSB

# 3b. Cultural Variation in the Wild – Foraging Cultures?

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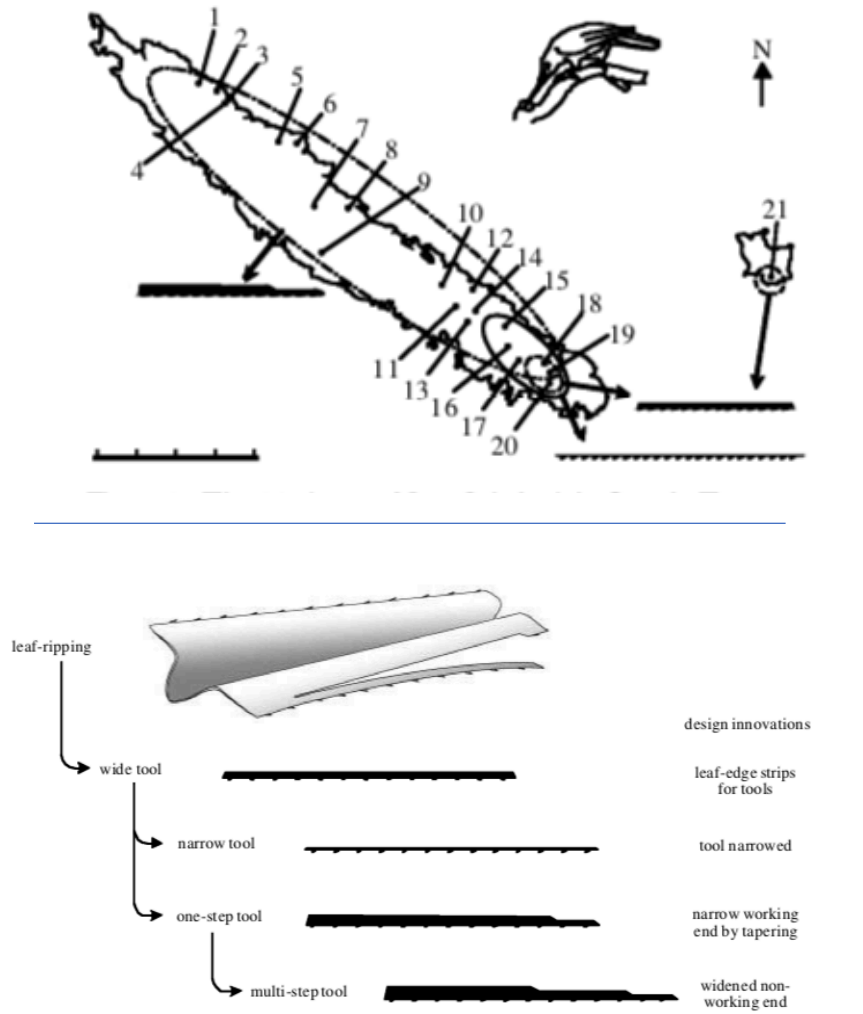


Figure 4. Proposed evolutionary history of the diversification and cumulative change in pandanus tool designs. Design innovations associated with the initial use of pandanus leaf as tools (wide design) and subsequent design changes (narrow and stepped designs) are briefly described at right of each tool. The section of pandanus leaf is *ca.* 5 cm wide.

Hunt G. R. & Gray R.D. (2003) PRSB

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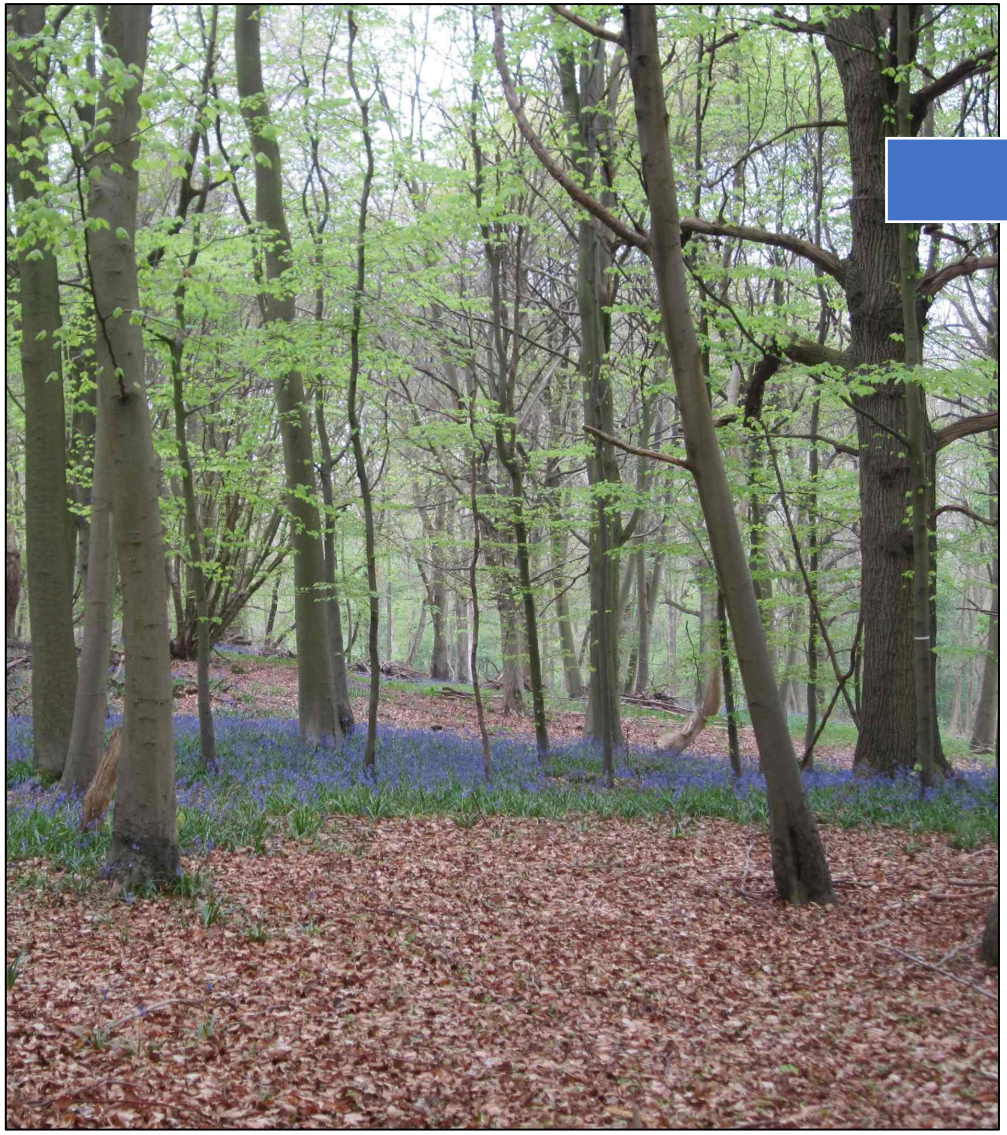
# 4. Spread of Innovation and cultural change



# 4a. Spread of Innovation: observations

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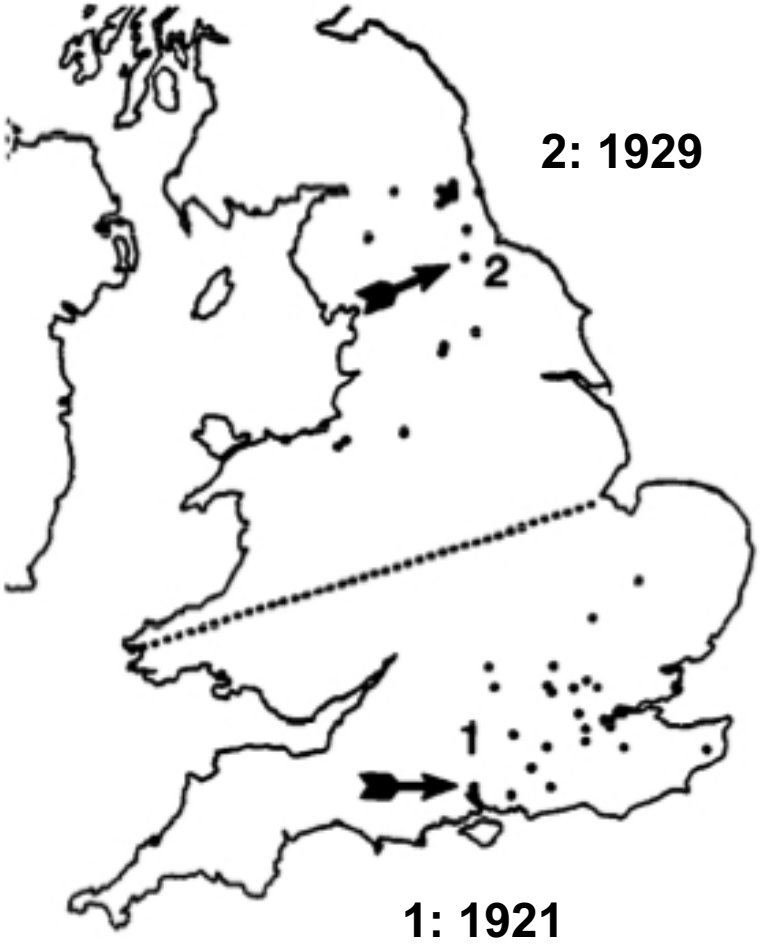
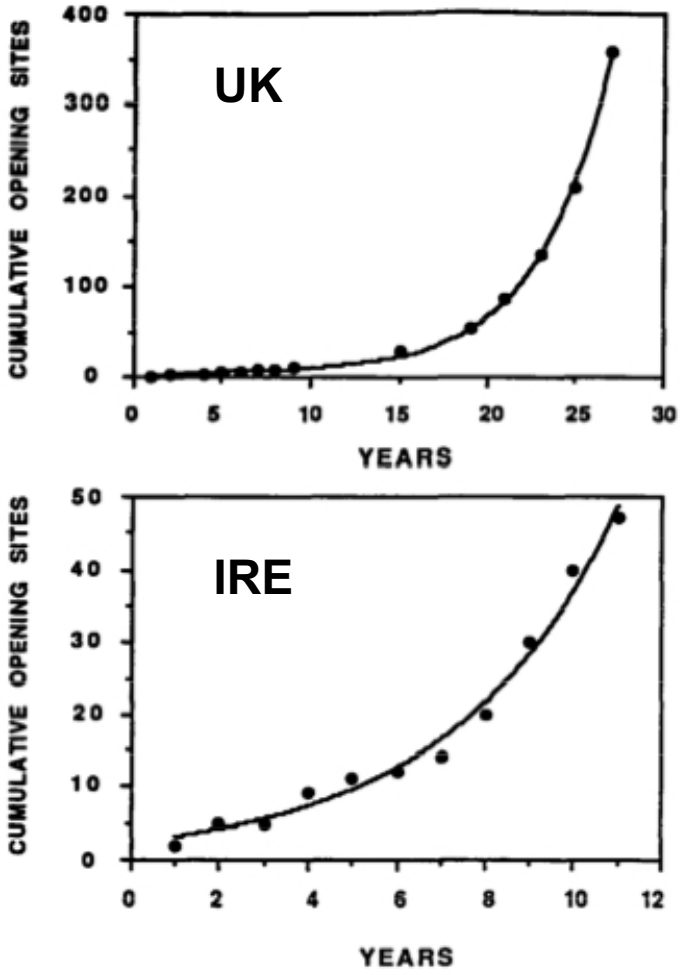
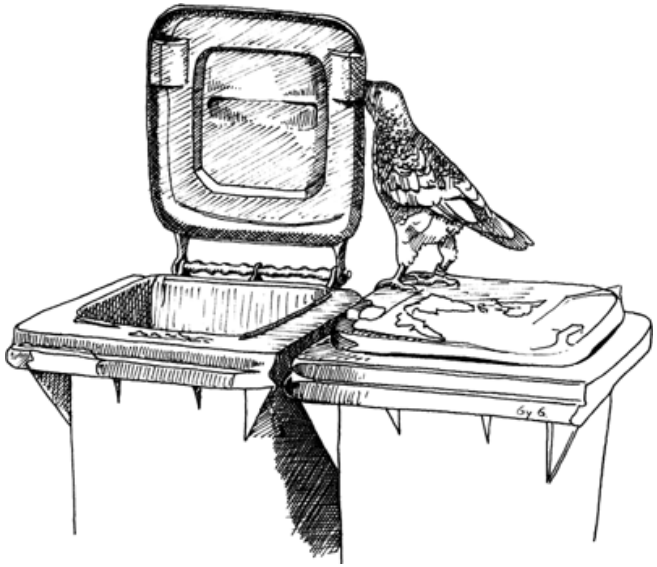



Lefebvre (1995) *Behavioural Processes*; Fisher & Hinde (1949) *British Birds*

# 4a. Spread of Innovation: observations


Estok et al. (2009) Biology Letters



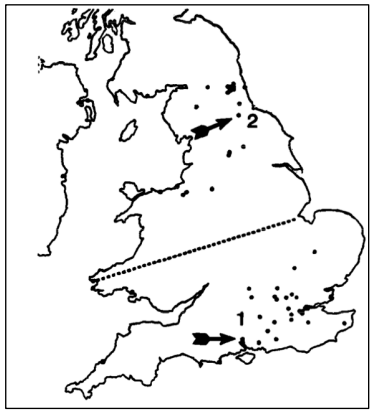
Gajdon et al. (2006) Animal Cognition

**Fig. 1** Kea engaged in bin opening (drawn from a photo)

Sironi et al. (2009) I Whaling Commission


Klump et al. *in prep*

# 4a. Spread of Innovation: observations




Novel challenge or opportunity

↓

An innovation in behaviour

↓

Social learning & transmission

↓

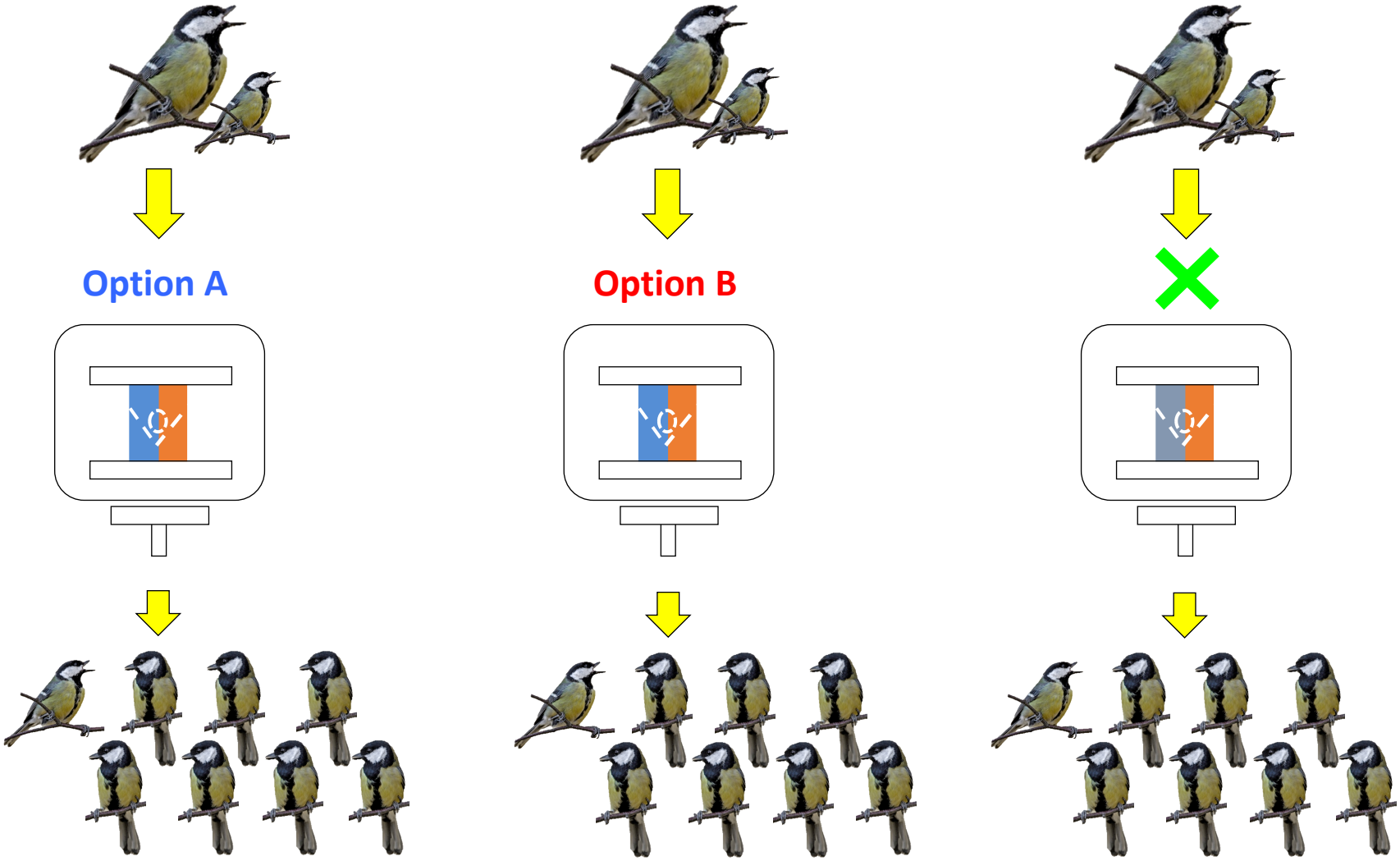
Persistent group-level change → **Animal Culture**

Fisher & Hinde (1949) *British Birds*; Aplin et al. (2016) *Current Opinions*

# 4b. Spread of Innovation & Culture: experiments in tits


Aplin et al. (2015) Nature

# 4b. Spread of Innovation & Culture: experiments in tits




Aplin et al. (2015) Nature

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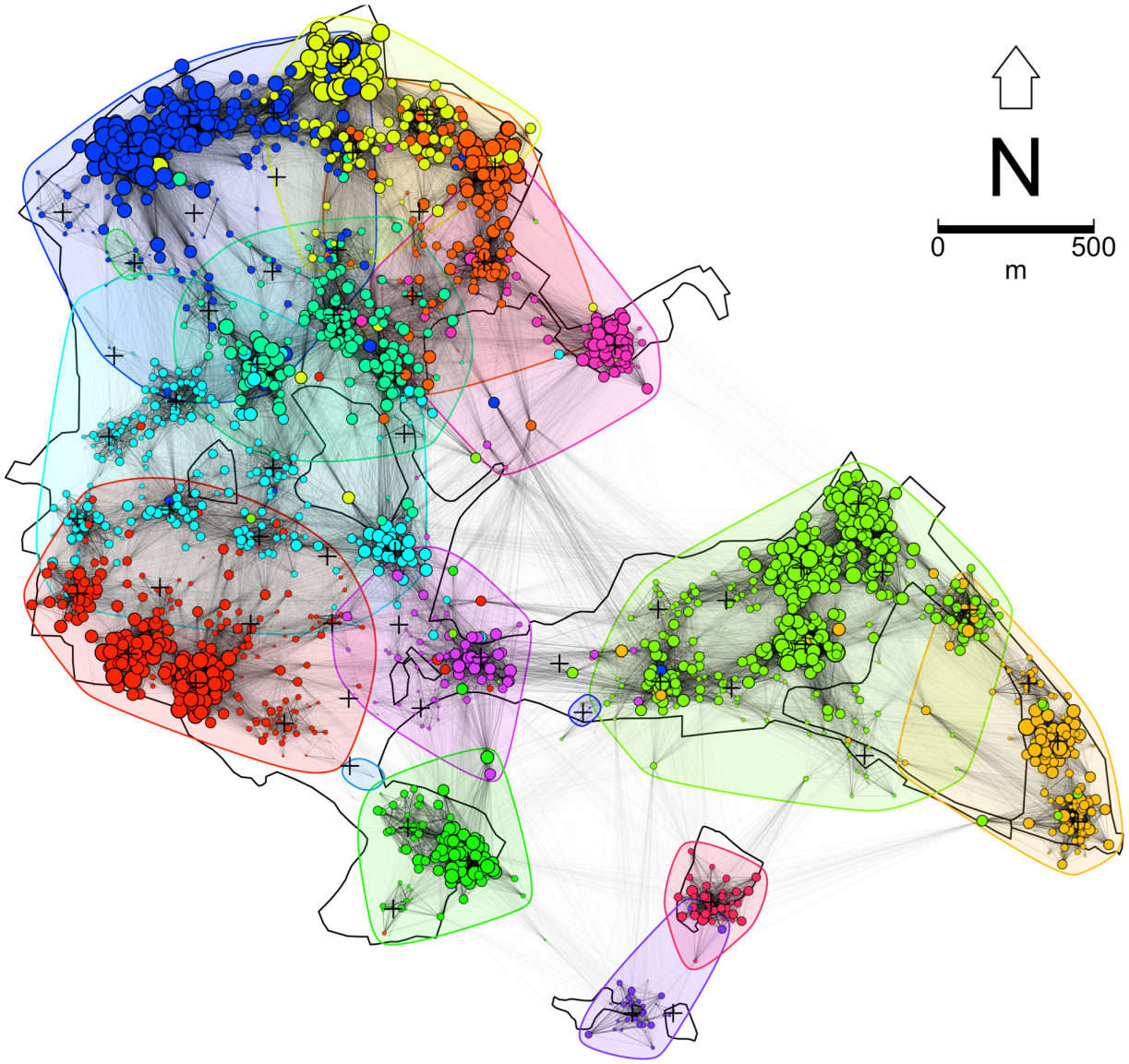


Aplin et al. (2015) Nature

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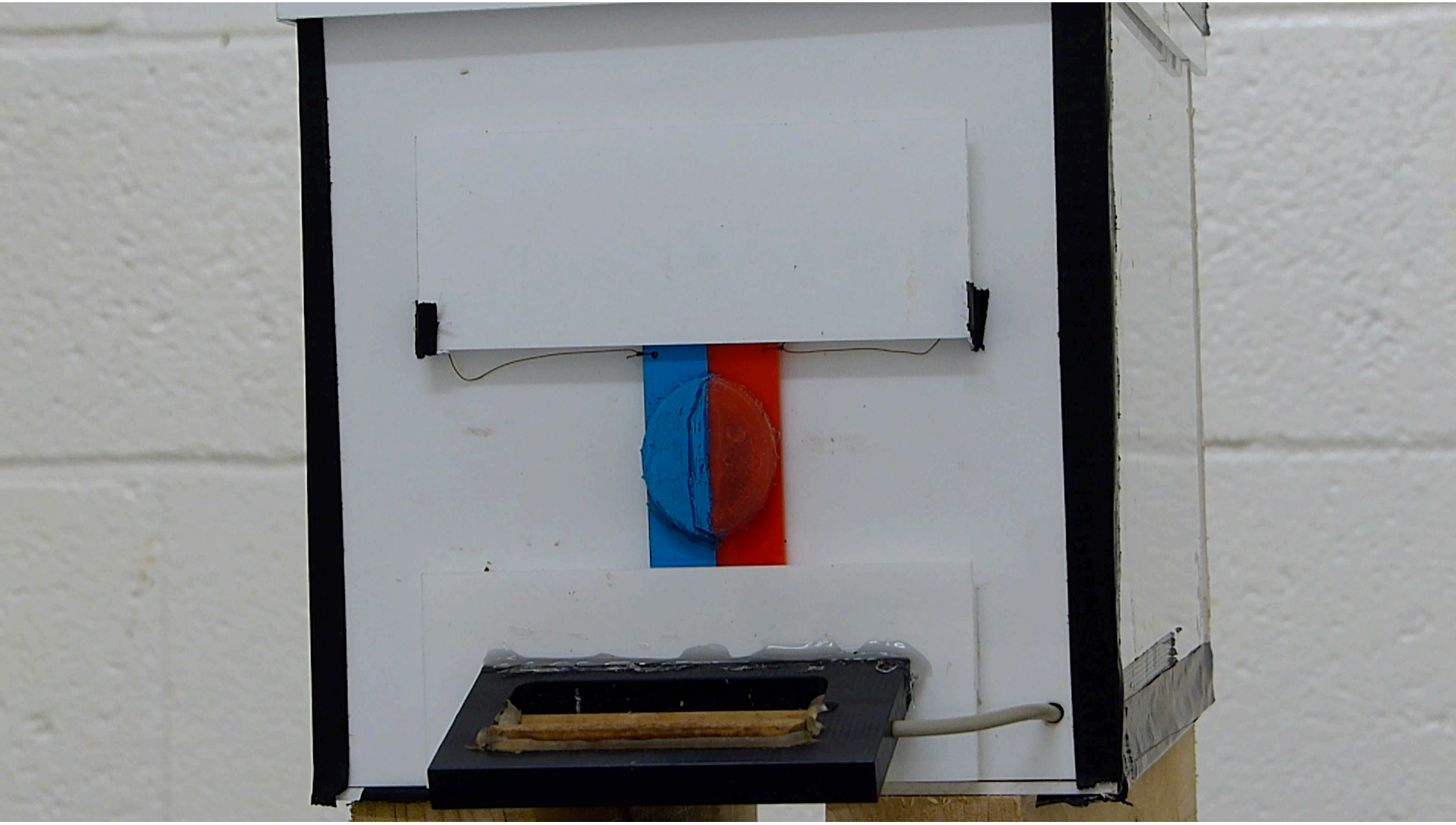

Aplin et al. (2015) Nature

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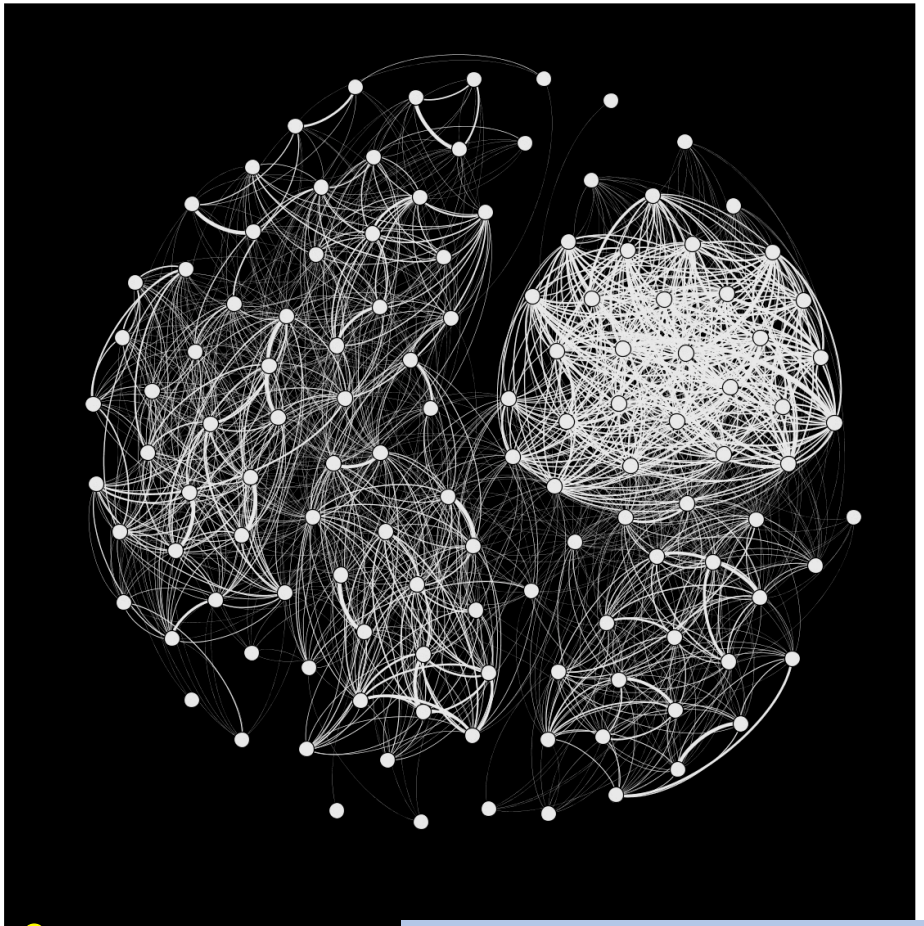
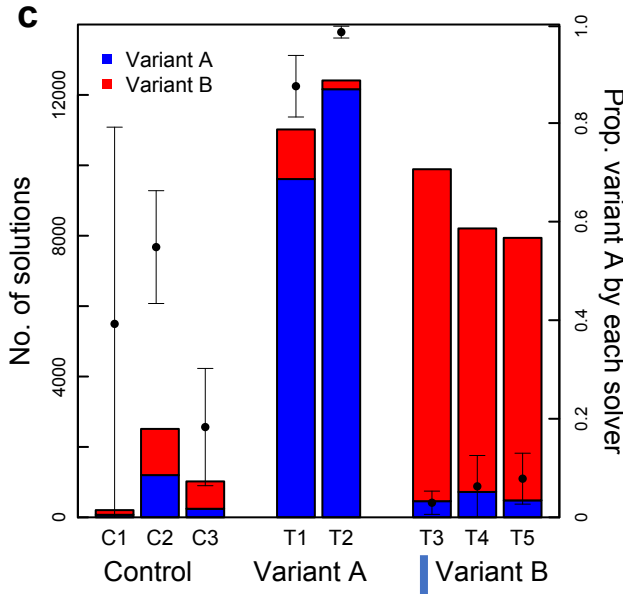
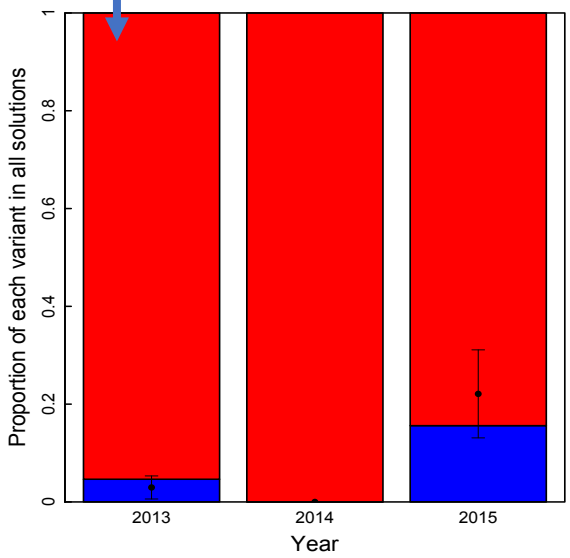


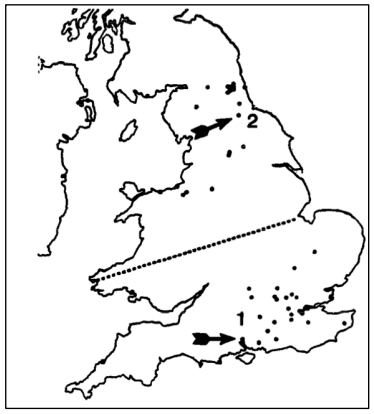




A single "innovator" is sufficient to establish a **persistent**, arbitrary behaviour, performed by the **majority**, transmitted to the next **generation**.

Aplin et al. (2015) Nature

# 4b. Spread of Innovation & Culture: experiments in tits




Novel challenge or opportunity

↓

An innovation in behaviour

↓

Social learning & transmission

↓

Persistent group-level change → **Animal Culture**

Fisher & Hinde (1949) *British Birds*; Aplin et al. (2016) *Current Opinions*

# 4c. Cultural Evolution in Vocalisations

Experiments in zebra finches – colonies started by "acoustic isolates" produce different songs than natural colonies, but evolve towards the wild type over 3-4 generations

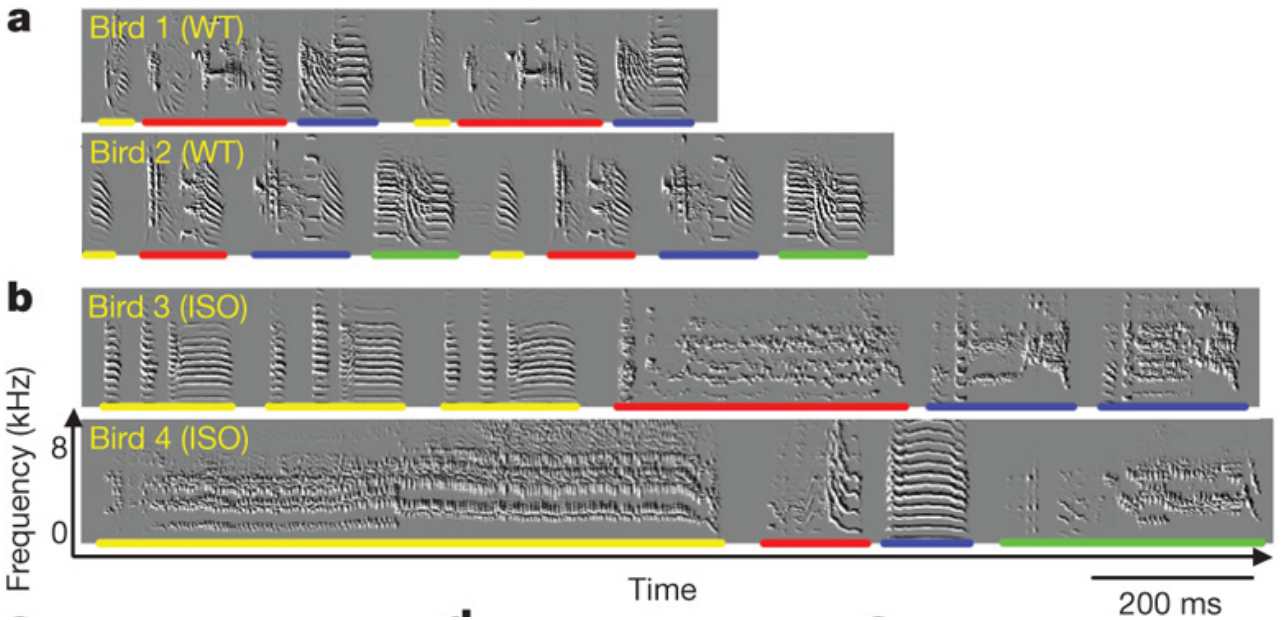



**Fig. 1: Wild-type songs versus isolate songs.**

O Fehér *et al.* (2009) *Nature*

# 4c. Cultural Evolution in Vocalisations

Experiments in zebra finches – colonies started by "acoustic isolates" produce different songs than natural colonies, but evolve towards the wild type over 3-4 generations

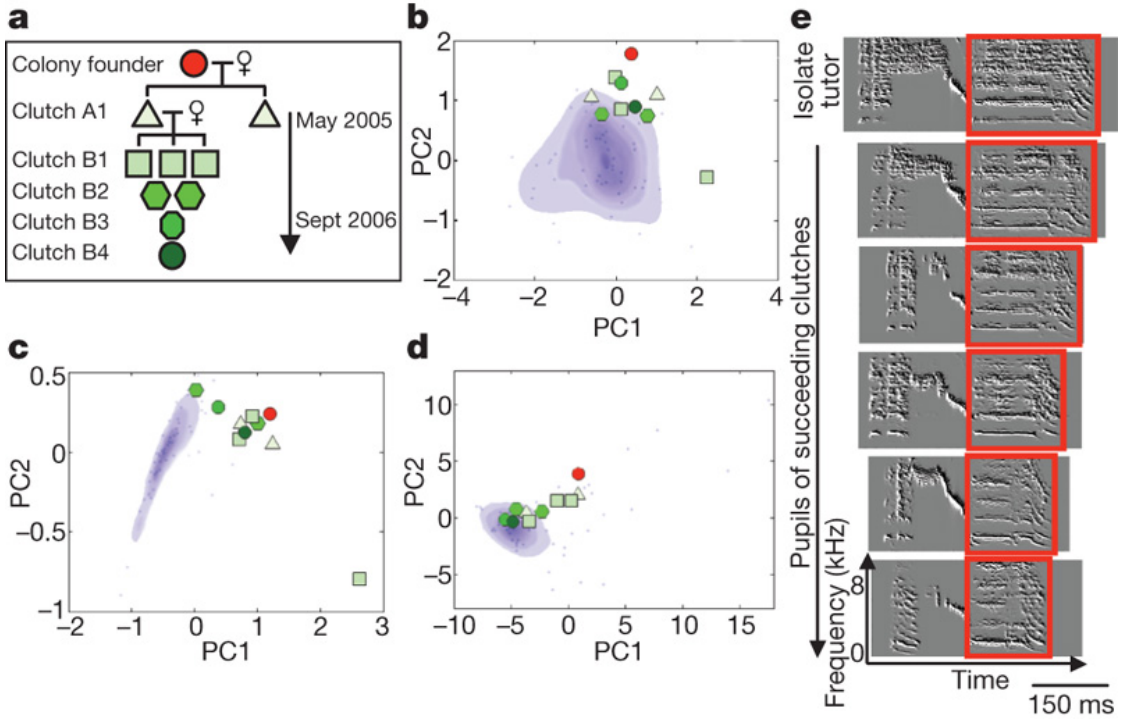



**Fig. 2: Progression of song over generations of isolated colonies**

O Fehér *et al.* (2009) *Nature*

# 4c. Cultural Evolution in Vocalisations

In wild birds, songs can also change over generations, driven by processes such as drift, founder-effects and population bottlenecks (cultural evolution). Example 1: saddlebacks (*Philesturnus rufusater*) song loses diversity and variability after translocation, and then gradually regains it over time while also becoming more distinct.



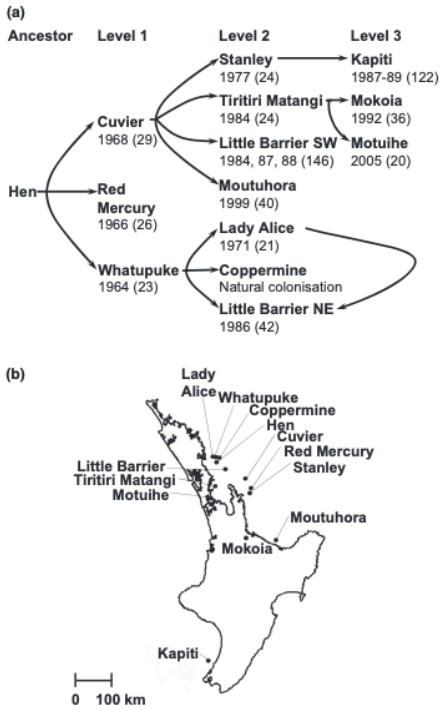



**Figure 1** The translocation history of the NI saddleback in New Zealand showing the year of translocation, the size and source of each founding population (a) and the geographical location of each population (b).

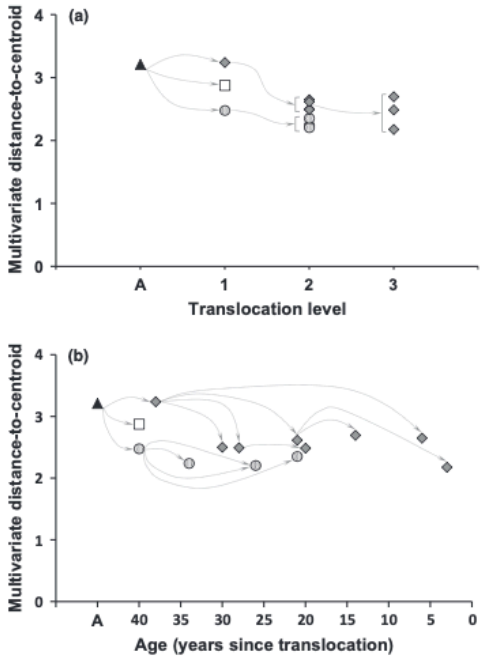
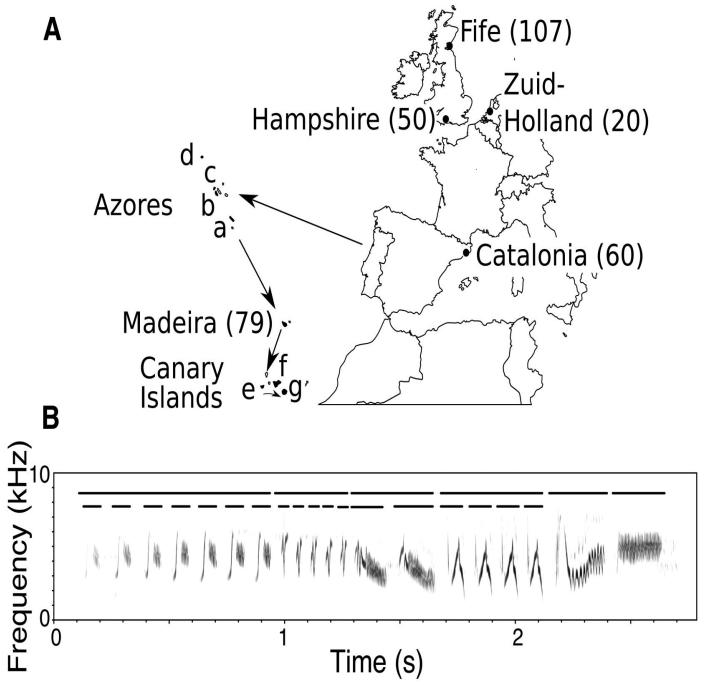



**Figure 3** Song variability (multivariate distance-to-centroid based on physical acoustic variables) within islands decreased with increasing translocation level (a) and also decreased with decreasing population age in years since translocation (b). Note the reverse ordering of the *x*-axis denoting population age since translocation in panel (b), which was done to reflect translocation history. Symbols for lineages are as given in Fig. 2.

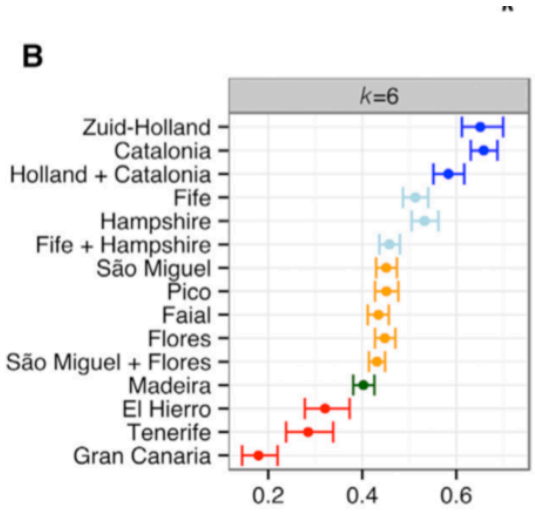
Parker *et al.* (2012) *Ecology Letters*

# 4c. Cultural Evolution in Vocalisations

In wild birds, songs can also change over generations, driven by processes such as drift, founder-effects, population bottlenecks and relaxed selection (cultural evolution). Example 2: chaffinch song progressively loses syntactical structure during island colonization, likely because of relaxed selection on learning biases.

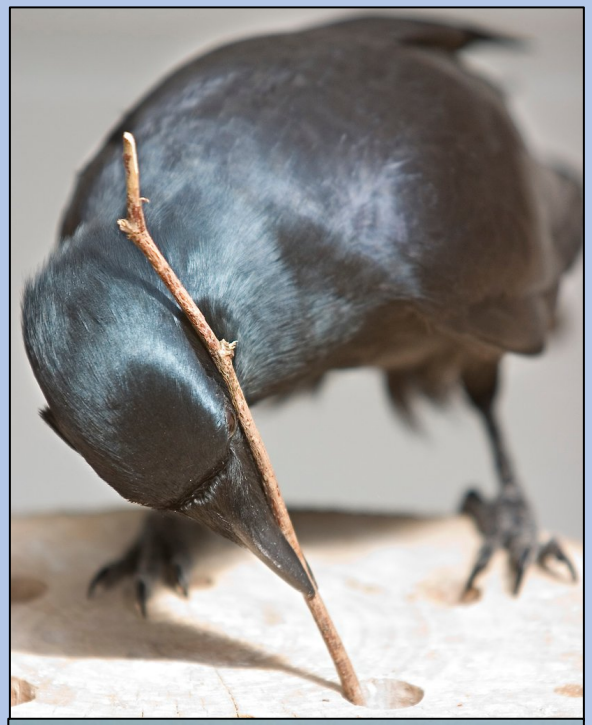

(A) Map of the recording locations used in this study (with number of males recorded in parentheses) and the route of island colonization by chaffinches… (B) Spectrogram of a chaffinch song from the Catalonia population.




(B) Comparisons of syntactical structure across populations

Lachlan *et al.* (2013) *Current Biology*

# Birds

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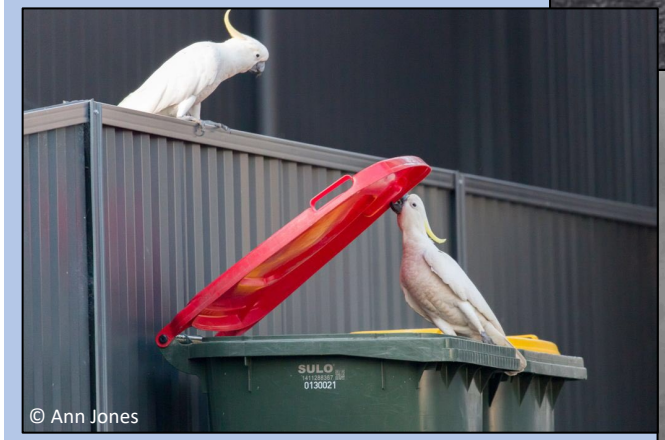
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Fisher & Hinde (1949)


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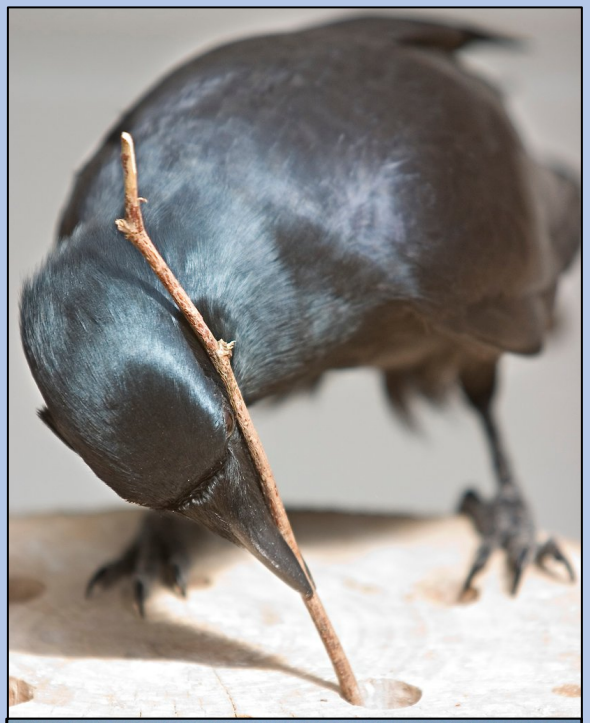
# Birds




Courtesy of www.operationmigration.org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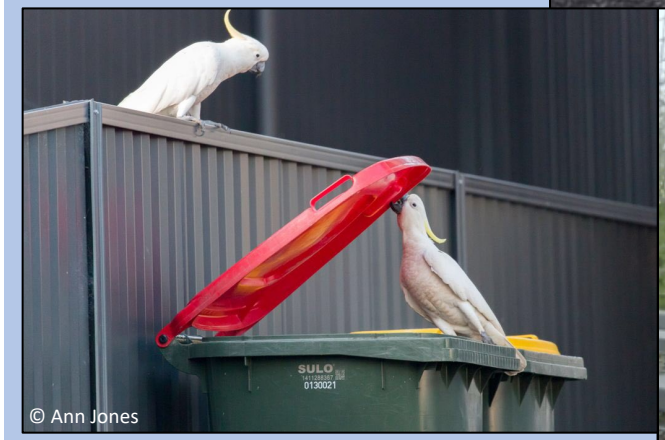
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Feher et al. (2009)


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# Suggested Reading


1. Slater, P. J. B. (2003) Fifty years of bird song research: a case study in animal behaviour. Animal Behaviour. **65**: 633-639.

2. Wright, T. F. & Dahlin, C. R. (2017) Vocal dialects in parrots: patterns and processes of cultural evolution. Emu – Austral Ornithology. 118: 50-66.

3. Aplin, L. M. (2016). "Understanding the multiple factors governing social learning and the diffusion of innovations." Current Opinion in Behavioral Sciences. **12**: 59-65.

4. Aplin, L. M. (2019). "Culture and cultural evolution in birds: a review of the evidence." Animal Behaviour. **147**: 179-187.

5. Slagsvold, T. and K. L. Wiebe (2011). "Social learning in birds and its role in shaping a foraging niche." Philosophical Transactions of the Royal Society. **366**: 969-977.

6. Aplin, L. M., Farine, D. R., Morand-Ferron, J., Cockburn, A., Thornton, A., & Sheldon, B. C. (2015). Experimentally induced innovations lead to persistent culture via conformity in wild birds. Nature. **518:** 538-541.

7. Hunt, G. R. & Gray, R. D. (2003) Diversification and cumulative evolution in New Caledonian crow tool manufacture. Proceedings of the Royal Society B. **270**: 867-874.