Supporting Information

Bird and Emery 10.1073/pnas.0901008106

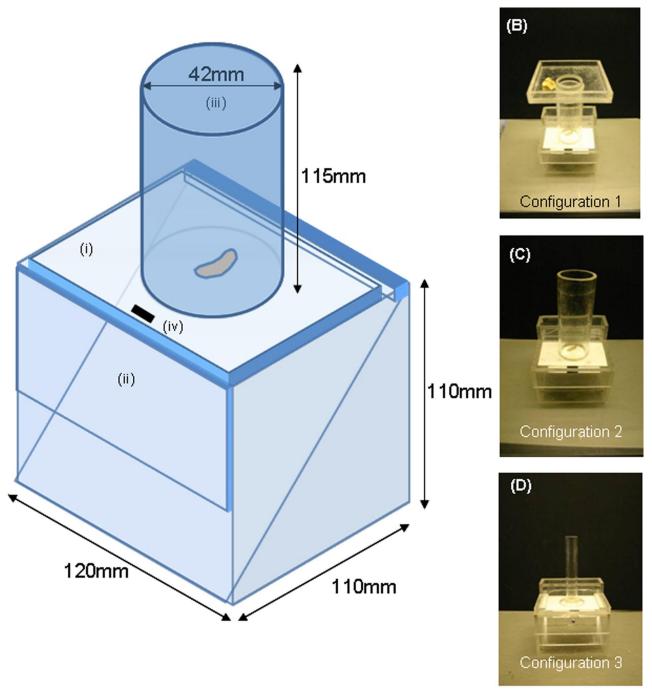


Fig. S1. (A) Diagram of apparatus. Supporting platform (i) made from white Perspex. All other sections (ii) made from clear Perspex. Tube (iii) interchangeable sizes, made from clear Perspex. Supporting mechanism (iv) consists of magnetic strip. (B) Configuration 1 shows photograph of apparatus with attached ledge. (C) Configuration 2 shows photograph of apparatus with large tube (42 mm). (D) Configuration 3 shows photograph of apparatus with small tube (16 mm diameter).

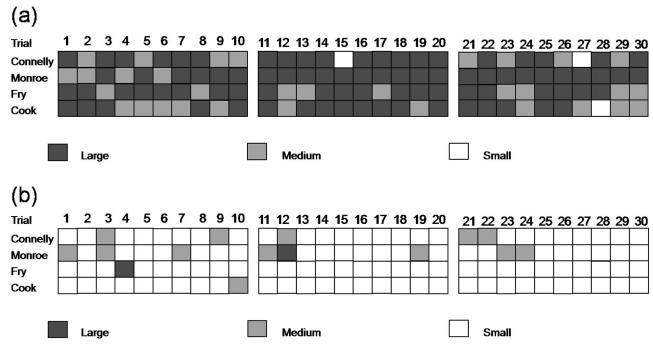


Fig. S2. Stone size test. Trial by trial description of behavior. Choice of stone size for use with (a) large diameter tube and (b) small diameter tube.

(B)

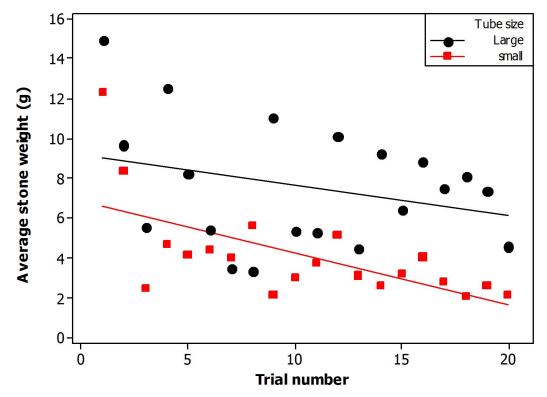


Fig. S3. Stone retrieval test. Size of stones selected and transported from aviary when not provided with a choice, for use with large and small diameter tube. (A) Photograph of stones selected by Monroe. (B) Graph of mean stone weights across trials along with lines of best fit (regression analyses: large tube: $r^2 = 0.09$, $F_{1,18} = 1.71$, P = 0.207; small tube: $r^2 = 0.40$, $F_{1,18} = 11.89$, P = 0.003).

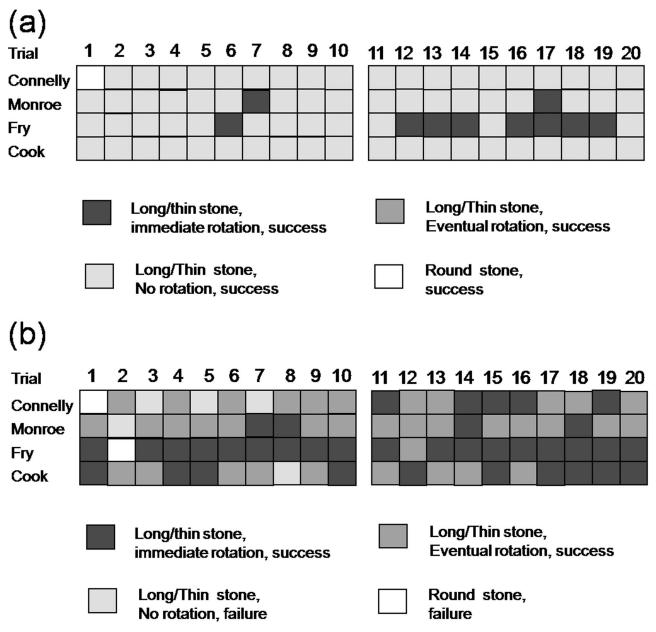


Fig. S4. Stone orientation test. Trial by trial description of behavior. Choice of stone, manipulation of stone (immediate rotation, eventual rotation, or no rotation) and success with (a) large diameter tube and (b) small diameter tube.

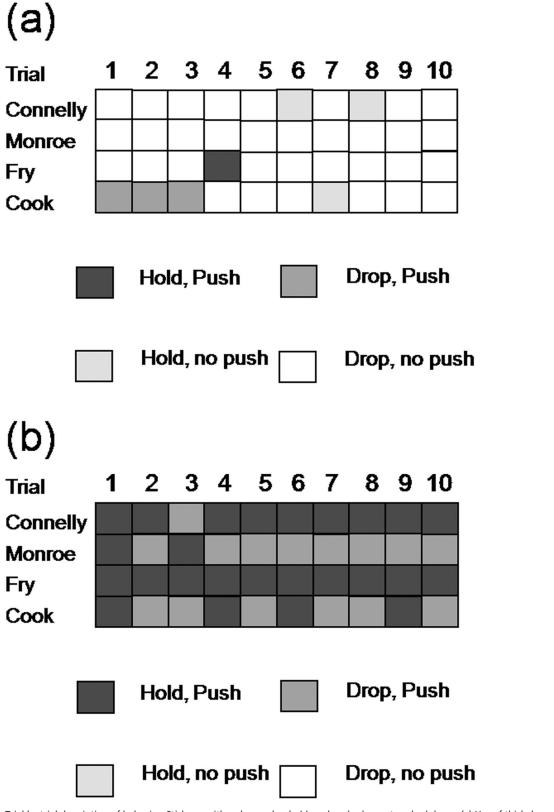


Fig. S5. Stick use test. Trial by trial description of behavior. Stick was either dropped or held, and pushed or not pushed down. (a) Use of thick, heavy stick. (b) Use of thin, light stick.

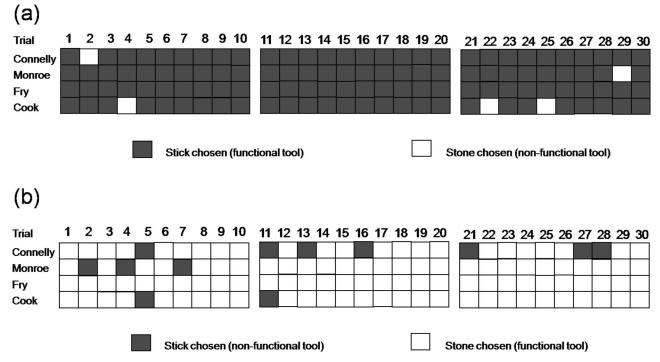


Fig. S6. Functional tool type test. Trial by trial description of behavior. Choice of stick or stone. (a) Combination 1: functional stick, non-functional stone. (b) Combination 2: nonfunctional stick, functional stone.

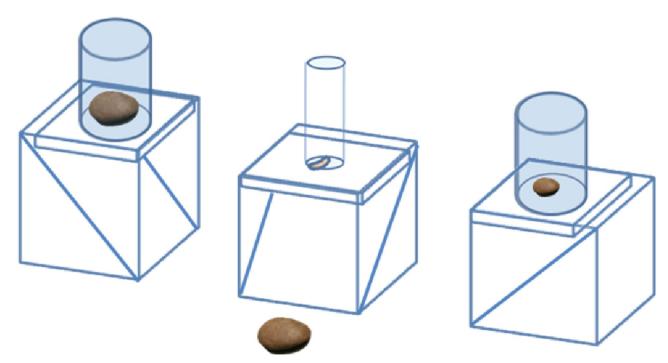


Fig. S7. Metatool task. Schematic of apparatus layout. Position of 2 choice stones pseudorandomized between 2 large stones.

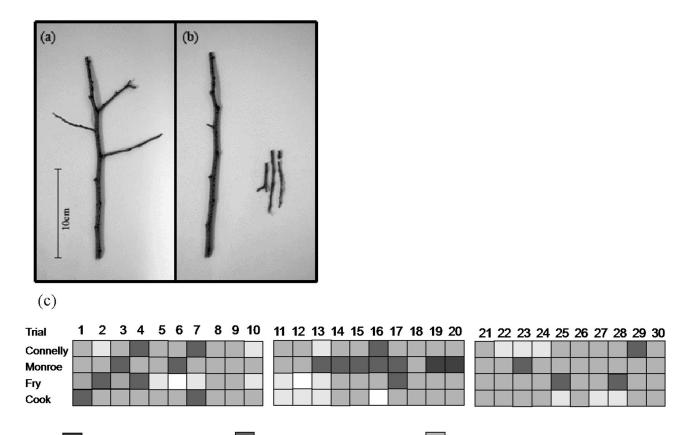


Fig. S8. Stick modification test. Example of stick (a) before and (b) after modification. Figure chosen shows result of Monroe trial 20. (c) Trial by trial description of behavior. The stick was either modified appropriately, inappropriately, or not modified. When the stick was modified, modification was either inside tube or outside tube. When modified outside the tube the modification was either done before or after first trying the stick in the tube.

All modifications in tube,

success

Modified outside tube

after first attempt,

No modification,

success

Modified outside tube

Inappropriate modification,

before first attempt,

success

failure

30mm**√**

Fig. 59. (A) Diagram of hook apparatus. Sections (i) and (ii) made from clear Perspex. Bucket (iii) made from cardboard, bucket handle (iv) made from wire (experiments using stick hook) or cardboard (experiment using wire hook). (B) Photograph of hook choice presented in second hook experiment. Tool on left shows functional hook; tool on right shows nonfunctional hook. (C) Photograph of straight wire provided in wire bending experiment.

160mm

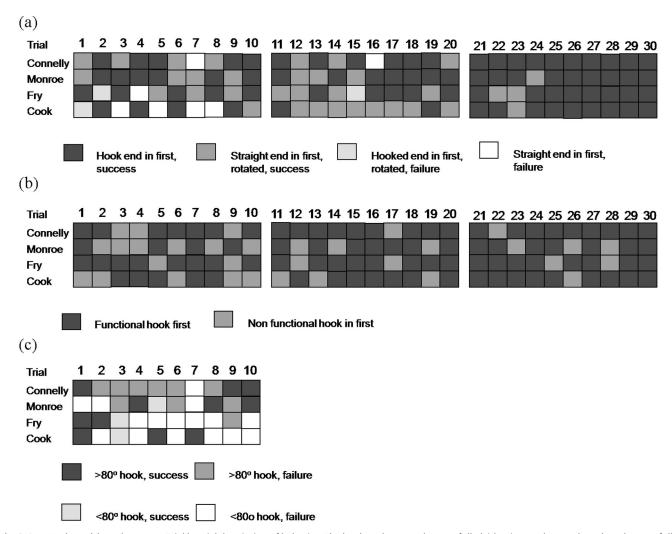


Fig. S10. Hook use (a) Hook use test. Trial by trial description of behavior. The hook tool was used successfully (either inserted correctly and used successfully, inserted incorrectly and subsequently rotated) or unsuccessfully (inserted correctly and rotated or inserted incorrectly and not rotated). (b) Functional hook test; trial by trial description of behavior. Subjects were either immediately (correct initial choice of hook) or eventually successful (incorrect initial choice of hook but later inserting correct hook) on every trial. (c) Hook manufacture test. Trial by trial description of behavior. Subjects made hooks either greater or less than 80° and were either successful or not in lifting out the bucket. (All hook manufacture was performed in tube).



Movie 51. Initial stone dropping behavior in the aviary, Cook. The video shows the first occasion where the stone was placed at the base of the apparatus (following 5 successful times of nudging the stone from the apparatus ledge). Cook flies to the feeding platform, picks up the stone, drops it into the tube, and subsequently eats the worm.



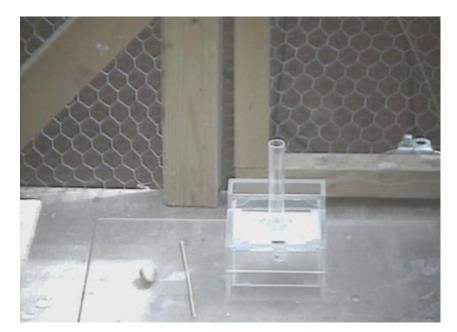
Movie 52. Choice of stone size, Connelly, first trials. The first part of video shows Connelly's initial preference for the large stones. The second part of the video shows Connelly's immediate transfer to choosing the small stone when the diameter of the tube is reduced.



Movie 53. Stone shape and orientation, Fry, first trial. The video shows Fry choosing the long, thin stone rather than a round stone. Fry successfully fits the stone into the tube by rotating the stone so that it is held and dropped lengthways. Note that the stone does not touch the apparatus before fry makes the rotation.



Movie S4. Stick use, Monroe, second trial. The first part of the video shows Monroe using a thick, heavy stick. Monroe picks up the stick and drops it into the tube inserting the held end first. The second part of the video shows Monroe using a thin, light stick. Monroe inserts the stick, holds onto the top and pushes down to provide the necessary force to collapse the platform. Note, the birds are not tall enough to insert the stick using the method of inserting the nonheld end first.



Movie S5. Tool type choice, Connelly, first trials. The first part of the video shows combination 1, the choice of a functional stick and a nonfunctional stone. Connelly chooses the stick. The second part of the video shows combination 2, a nonfunctional stick and a functional stone. Connelly chooses the stone.



Movie S6. Metatool use, Cook, first trial. The video shows the experimenter setting up the apparatus by placing the 2 choice stones into the outer large diameter tubes (small stone placed in right hand tube, large stone placed in the left hand tube) and placing the worm into the central small diameter tube. Note that Cook watches closely the set-up process. A large stone is then placed in front of the small diameter tube. Cook uses the large stone to acquire the small stone, then uses the small stone to acquire the worm.



Movie 57. Stick modification, Monroe, trial 20. Monroe is given a stick requiring 3 modifications. Monroe initially makes 2 modifications to the stick outside the tube. She then inserts the stick and makes a further 3 modifications to refine the stick, before pushing the successfully modified stick down and collapsing the platform.



Movie S8. Hook use, Monroe, second trial. The video shows Monroe using a premade hook tool to lift the bucket from a clear Perspex tube.



Movie S9. Hook manufacture, Cook, first trial. The video shows Cook inserting a straight piece of wire into the tube, bending the wire over the side of the tube to form a hook and refining the hook before flipping the tool around, hooking the wire onto the bucket handle and lifting the bucket out of the tube.