



## Individual variation in spontaneous problem-solving performance among wild great tits

Ella F. Cole\*, Dominic L. Cram<sup>1</sup>, John L. Quinn

Edward Grey Institute, Department of Zoology, University of Oxford

### ARTICLE INFO

#### Article history:

Received 13 April 2010

Initial acceptance 8 June 2010

Final acceptance 22 November 2010

Available online 28 December 2010

MS. number: 10-00255R

#### Keywords:

cognition  
consistency  
exploration behaviour  
great tit  
individual variation  
innovation  
neophobia  
*Parus major*  
personality  
problem solving

Behavioural traits generally and cognitive traits in particular are relatively understudied in an evolutionary ecological context. One reason for this is that such traits are often difficult to characterize among large numbers of individuals, without the influence of diverse environmental effects swamping intrinsic individual differences. We conducted standardized assays on a natural population of great tits, *Parus major*, to quantify and characterize individual variation in problem-solving performance, a simple cognitive trait often linked to innovative foraging ability. Forty-four per cent of 570 birds solved a food-motivated, lever-pulling problem and this proportion was consistent across three seasons. Individual performance was consistent within and across captivity sessions, across seasons, and between two different problem-solving tasks (lever and string pulling). Problem-solving performance was not explained by differences in latency to approach the empty task, nor latency to feed after human disturbance. Variation was unrelated to body condition, while age and natal origin explained significant but minimal amounts of variation, the importance of which varied between seasons. Problem-solving performance did not covary with exploration behaviour of a novel environment, suggesting that individual differences in problem solving represent an independent source of behavioural variation in our population. Rather than simply reflecting covariance with state or with other behavioural traits, our results suggest that variation in problem-solving performance represents inherent individual differences in the propensity to forage innovatively. We suggest that standardized problem-solving assays may prove ideal for studying the evolutionary ecology of simple cognitive traits.

© 2010 The Association for the Study of Animal Behaviour. Published by Elsevier Ltd. All rights reserved.

The link between cognition and ecology has received growing interest in recent years (see Healy & Braithwaite 2000; Dukas 2004; Biernaskie et al. 2009; Roth et al. 2010). Cognitive processes are likely to have considerable ecological importance because they fundamentally influence how individuals acquire and manage resources, avoid predation, invade new habitats, and maintain social relationships (Cheney et al. 1986; Curio 1988; Pravosudov & Clayton 2002; Sol et al. 2002; Turner et al. 2006; Keagy et al. 2009). Individual variation in cognitive traits is therefore likely to influence survival and reproductive success (Gailey et al. 1985; Morse & Stephens 1996; Egas & Sabelis 2001). Little is known about the underlying causes of such variation in wild populations (Roth et al. 2010). One reason for this is that behavioural traits are influenced by a great variety of environmental factors making it difficult to identify intrinsic causal factors (Merilä & Sheldon 2001). Another is that the large sample

sizes needed for the study of individual variation are often difficult to obtain, especially for cognitive traits, the measurement of which commonly requires extensive subject training or repeated trials (e.g. Weir et al. 2002; Tebbich & Bshary 2004; Heinrich & Bugnyar 2005). Here we attempted to overcome these difficulties by examining a variety of sources of individual variation in a simple cognitive trait, problem-solving performance, using rapid assays among large numbers of wild-caught great tits, *Parus major*, temporarily held in captivity under standardized conditions.

In recent years a growing number of studies have quantified repeatable or consistent behavioural differences between individuals from natural populations (Bell et al. 2009). However, we know of no similar repeatability estimates for cognitive traits. Repeatability is defined as the proportion of phenotypic variation explained by differences between individuals (Lessells & Boag 1987), which can be caused by a variety of factors: genetic, developmental and environmental (Réale et al. 2007; Bell et al. 2009). Selection experiments and common garden studies have provided considerable evidence that genes play an important role in shaping cognitive abilities (McGuire & Hirsch 1977; Lofdahl et al. 1992; Galsworthy et al. 2005; Roth et al. 2010). Developmental factors also affect cognitive performance (Vince 1958, 1960; Laland & Reader 1999; Reader & Laland 2001;

\* Correspondence: E. F. Cole, Edward Grey Institute, Department of Zoology, University of Oxford, Oxford OX1 3PS, U.K.

E-mail address: [eleanor.cole@zoo.ox.ac.uk](mailto:eleanor.cole@zoo.ox.ac.uk) (E.F. Cole).

<sup>1</sup> D. L. Cram is now at the Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Cornwall Campus, Penryn TR10 9EZ, U.K.

Botero et al. 2009). For example, juvenile birds direct more attention to novel problems than adults (Vince 1958, 1960; Greenberg 2003) and female guppies, *Poecilia reticulata*, are more likely to forage innovatively than males (Laland & Reader 1999). In addition, environmental conditions can also influence cognitive traits (Cooper & Zubek 1958; Seibt & Wickler 2006; Arnold et al. 2007). For example, the diet of blue tit, *Cyanistes caeruleus*, nestlings has been shown to influence their spatial-learning ability as adults (Arnold et al. 2007). Social environmental factors can also be important. High cognitive performance is often more prevalent among subordinates, which frequently lose out in competition for limited resources (Laland & Reader 1999; Reader & Laland 2000), and drops in social rank can be associated with an immediate improvement in problem-solving performance (Bunnell & Perkins 1980). Empirical data therefore suggest that consistent individual differences in cognitive traits can be caused by a wide range of factors.

Individual variation in cognitive ability may also covary with other behavioural traits. Correlated suites of behaviours, also called behavioural syndromes or personality, have been documented in a wide variety of taxa (reviewed in Gosling 2001; Sih et al. 2004; Réale et al. 2007). For example, in the great tit, in contrast to 'proactive' individuals, 'reactives' are relatively neophobic (Verbeek et al. 1994), less aggressive (Verbeek et al. 1996), explore new environments more slowly and thoroughly (Verbeek et al. 1994), are more responsive to their environment (Verbeek et al. 1994), are less likely to form routines and readily explore new feeding options (Drent & Marchetti 1999). It has been suggested that because 'reactive' individuals explore their environment more thoroughly than 'proactive' individuals, and are better able to adjust their foraging behaviour when faced with environmental change, they may perform better in some cognitive tasks (Benus et al. 1987; Verbeek et al. 1994; see Sih & Bell 2008 for discussion). In contrast, it has also been proposed that bolder, fast-exploring individuals may readily acquire information about novel situations and learn novel tasks more quickly than shy, slow explorers (Sneddon 2003). Few studies have investigated cognitive performance in the context of personality, and those that have report conflicting results, so the generality of this relationship remains unclear (see Carere 2003; Sneddon 2003; Guillette et al. 2009). Evidence from a variety of taxa suggests that neophobic individuals are less likely to engage in novel feeding situations and consequently are unlikely to solve problems or innovate (Searle 1949; Seferta et al. 2001; Webster & Lefebvre 2001; Greenberg 2003; Bouchard et al. 2007). However, several studies also demonstrate that a significant amount of variation in learning ability remains after controlling for neophobia and exploration behaviour (Galsworthy et al. 2002; Matzel et al. 2003; Bouchard et al. 2007).

We used a wild population of great tits to quantify and characterize individual variation in spontaneous problem-solving performance. Individual variation in novel problem solving is poorly understood but may reflect general cognitive ability (Roth & Dicke 2005) and innovativeness (Laland & Reader 1999; Webster & Lefebvre 2001). The great tit is a generalist species with an extensive geographical range (Gosler 1993). Great tits frequently investigate novel objects in the wild (Gibb 1957) and anecdotal evidence suggests considerable innovative foraging behaviour; examples include the opening of milk bottle tops (Fisher & Hinde 1949; Hinde & Fisher 1951), the tapping of acorns to determine the presence of hidden larvae (Ennion 1962), the use of a pine needle to extract larvae from bark (Duyck & Duyck 1984), and predation of pipistrelle bats, *Pipistrellus pipistrellus* (Estók et al. 2009). Food-related problem solving may therefore be an ecologically relevant trait for this species.

Our aims were (1) to determine whether problem-solving performance was consistent within individuals, across short and long

time periods, and between two different tasks; (2) to establish whether our assay measured goal-oriented problem-solving propensity, rather than quantifying general activity, neophobia or motivational differences; (3) to examine the relationship between a well-studied personality trait, exploration behaviour of a novel environment (henceforth, exploration behaviour), and problem-solving performance; and (4) to determine whether state variables such as sex, age and natal origin could account for observed individual differences in problem-solving performance.

## METHODS

### *Study Site and Catching Procedure*

All behavioural assays were carried out on great tits caught from a wild population in Wytham Woods (51°46'N, 1°20'W), Oxfordshire, U.K. We caught 662 individuals using mist nets at temporary feeders erected at sites throughout the wood during the winters of 2006–2007, 2007–2008 and 2008–2009, between November and March. From here onwards these three winter catching periods are referred to as seasons. Additionally, birds were caught in the final week of each season by removing them from their nestboxes after dusk. All birds were caught under ringing licences from the British Trust for Ornithology (BTO). Birds were aged (adult or juvenile if less than 1 year old) and sexed based on plumage (Svensson 1992), and biometrics (wing length, mm, and body mass, g) were taken. All unringed individuals were fitted with a unique BTO metal leg-ring. During the 2007–2008 and 2008–2009 seasons all great tits were also fitted with a unique passive integrated transponder (PIT, EM4102 tag, HID Global GmbH, Walluf, Germany) measuring 12.4 mm × 2.1 mm, which was attached to a celluloid split colour leg-ring. Up to 16 birds per catching session were transported in individual bird bags to the nearby John Krebs field station. Great tits were taken into captivity under Natural England licence.

On arrival at the field station, usually mid-afternoon, birds were housed singly in wire cages (45 × 45 cm and 68 cm high) and were visually isolated from one another. Two housing rooms were used, with a minimum of two and a maximum of eight occupied cages per room. Each cage contained three dowel perches, the unset problem-solving devices and bowls containing fresh water, husked sunflower seeds and mealworms, *Tenebrio molitor*. The birds were kept under a natural light regime using automated timers and the housing rooms were kept at ambient temperature (ranging from 3 to 16 °C) and ventilated using an air conditioning system. All birds were released within 24 h with the exception of a subsample of 80 birds during the 2007–2008 season that were kept in captivity for 4 days to carry out a battery of repeat trials and an object neophobia assay. All birds were released at the catching site.

### *Problem-solving Assay*

All individuals (with the exception of 92 birds from the 2006–2007 season that were used in separate experiments, see below) were presented with a lever-pulling task on the afternoon they were housed ( $N = 570$ ). The device used in this task consisted of a vertical transparent Perspex tube containing a platform, which was supported by a horizontal lever (Fig. 1a, b). The device was baited with four waxworms, *Pyralis farinalis*, placed on the platform. To solve the task, birds had to remove the lever from the device, causing the platform to drop and the waxworms to fall into a feeding dish. When the task was set, a single waxworm was placed in this dish to attract the bird to the device. This waxworm was eaten by the vast majority of birds (99% of birds,  $N = 298$ , ate the freely available waxworm in winter 2010). All birds were exposed to this task for approximately 3 h without being disturbed: 1 h before the aviary lights went off in

Download English Version:

<https://daneshyari.com/en/article/10971191>

Download Persian Version:

<https://daneshyari.com/article/10971191>

[Daneshyari.com](https://daneshyari.com)