Behavioural Processes 120 (2015) 128–134

Contents lists available at ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

The role of body size in predator recognition by untrained birds

Jana Beránková, Petr Veselý*, Roman Fuchs

Faculty of Science, University of South Bohemia, Branišovská 31a, 37005 České Budějovice, Czech Republic

ARTICLE INFO

Article history:
Received 2 July 2015
Received in revised form
24 September 2015
Accepted 28 September 2015
Available online 9 October 2015

Keywords:
Predator
Body size
Colouration
Recognition
Categorization
Untrained birds

ABSTRACT

It is supposed that body size serves as an important cue in the recognition of relevant stimuli in nature. As predators of varying body size pose differing levels of threat, their potential prey should be able to discriminate between them. We tested the reaction of great tits (*Parus major*) to the dummies of their common predator (the European sparrowhawk—*Accipiter nisus*) in natural and reduced body sizes under laboratory conditions. All of the tested dummies possessed local raptor-specific features (hooked beak, claws with talons, and conspicuous eyes), but differed in global species-specific features: body size (large – the size of a sparrowhawk, small – the size of a great tit) and colouration (sparrowhawk, great tit, robin, and pigeon). The sparrowhawk-coloured dummies evoked fear regardless of their size while both great tit- and pigeon-coloured dummies evoked no fear reaction. The body size was used as the cue only for the discrimination of the robin-coloured dummies. The differences in reactions to the dummies with robin colouration (species unimportant to the great tits) could be explained as that the tits are able to recognize these birds in nature, but not so undoubtedly as the predator or the conspecific.

1. Introduction

Object recognition and categorization play an important role in animal life as it allows for an effective, fast, and appropriate reaction to objects (Shettleworth, 1993, 2010). Animals in the wild possess the ability to recognize objects that are in some way relevant to them (Shettleworth, 2010). Such objects usually represent food, sexual partners, or predators (Strnad et al., 2012; Veselý and Fuchs, 2009; Veselý et al., 2013). The animals can use either local or global features for precise object recognition (Jitsumori and Delius, 2001).

The largest portion of our knowledge on the usage of these two types of features comes from experiments with captive animals that were trained to discriminate modified pictures of conspecifics (e.g. Marsh and MacDonald, 2008), humans (e.g. Aust and Huber, 2002), or other objects (e.g. Kirkpatrick-Steger et al., 1998; Goto et al., 2004; Matsukawa et al., 2004). Partial local features typical for natural stimuli (e.g. eyes, head, or hands of animals or humans) were shown to play an important role in natural stimuli recognition, whereas more conspicuous, global features (such as overall body shape) were important for artificial stimuli recognition. However, it seems that animals are able to use both local and global features and switch between them when needed (Fremouw et al., 1998; Fremouw et al., 2002).

Some experiments were also conducted with untrained animals, either in natural (e.g. Curio, 1975; Gill et al., 1997; Thorogood and Davies, 2012; Trnka et al., 2012), or laboratory conditions (e.g. Karplus and Algom, 1981; Patton et al., 2010; Beránková et al., 2014).

These studies found that local features like the colour of eyes, shape of beak and mouth, or conspicuous components in colouration are essential for the proper recognition of a predator (e.g. Curio, 1975; Karplus and Algom, 1981; Gill et al., 1997; Beránková et al., 2014), nest parasite (e.g Thorogood and Davies, 2012; Trnka et al., 2012) or conspecific (e.g. Patton et al., 2010). Moreover, some studies imply that birds are able to use a combination of features in object recognition (e.g. Trnka and Prokop, 2012; Beránková et al., 2014). If the local features are not available for recognition, birds can do without them and use only global features. An example is the recognition of raptor silhouettes (e.g. Evans et al., 1993).

Another possible global feature used in predator recognition is body size. Predators of different body size should be discriminated between because they can pose different levels of threat to the potential prey in invertebrates (e.g. Binz et al., 2014) as well as vertebrates (e.g. Swaisgood et al., 1999). Body size is especially important in birds of prey because they are quite similar in overall appearance as well as body shape, but their size provides a reliable indicator of the level of threat they pose to the potential prey. A small raptor is more dangerous for small prey, while a large raptor is a greater threat to large prey.

* Corresponding author. Fax: +420 385310366.
E-mail address: petr-vesely@seznam.cz (P. Veselý).

http://dx.doi.org/10.1016/j.beproc.2015.09.015
0376-6357/

It has been repeatedly showed that various bird species can distinguish between raptors differing in size. Domestic hens (*Gallus gallus f. domestica*) react differently to the variously sized trained live raptors (Palleroni et al., 2005). Wild Carolina chickadees (*Poecile carolinensis*), tufted titmice (*Baeolophus bicolor*), and captive black-capped chickadees (*Poecile atricapilla*) react differently to stuffed raptors of various sizes via differing the intensity of their warning calls (Soard and Ritchison, 2009; Courter and Ritchison, 2010; Templeton et al., 2005). Chickens (*Gallus gallus f. domestica*) as well as blue tits (*Cyanistes caeruleus*) can even recognize differences in the size of flying silhouettes (Evans et al., 1993; Klump and Curio, 1983).

All of the stimuli used in the studies mentioned above were either real or created to simulate real raptors. These results show that birds are able to distinguish between raptors differing in size, but they do not answer the question of whether size is an important feature in the recognition of particular raptor species. In other words, if the particular raptor species can be recognized in its "proper" as well as its "wrong" size.

The fact that birds are able to use size as a cue in object recognition was supported by experiments testing trained animals. It was shown that European starlings (*Sturnus vulgaris*) can perceive a difference of as little as 5% in size asymmetry (Swaddle and Johnson, 2007). Pigeons (*Columba livia f. domestica*) are also able to notice a size change in the stimuli. On the other hand, this change does not disrupt the birds' ability of discriminate regarding the sameness or differentness of the multi-item array (Castro and Wasserman, 2010). Pigeons are also able to generalize their object discrimination of smaller and larger versions of objects familiar to them through training, but their performance drops as the size increases or decreases relatively to the trained size (Peissig et al., 2006).

We decided to test how untrained birds (great tits) generalize the most dangerous predator of small passerines in Europe (the European sparrowhawk, *Accipiter nisus*) using a smaller dummy of the species, which they have no experience of. The sparrowhawk is characterized not only by raptor specific features (eye, beak and claws) but by a species specific features (size, overall colouration) as well. Raptor specific features are typical local features. On the other hand, overall colouration pattern composed of the set of the partial local features (e.g. barred under-part, greyish back) can be considered as a global feature (Aust and Huber, 2001) the same way as the size. Therefore, we used dummies with the colouration of three harmless birds: a pigeon (comparable in body size to the sparrowhawk), robin (comparable in body size to the great tit) and great tit (conspecific colouration) as well as the dummies with sparrowhawk colouration. The dummies possessing the above-mentioned colourations were made in the sizes of a sparrowhawk as well as in the size of a great tit. Behaviour of the tits without the presence of any dummy was used as a control condition.

Null hypothesis of our experiments states that recognition is based on the raptor specific features and all of the dummies would induce fear (the same amount) in the tits. Falsification of this hypothesis means that recognition is based also on the coloration and/or size. Then we can predict that: (1) only larger dummies would induce fear in the tits—the recognition is based on the presence of raptor-specific features on the dummy of the size of a sparrowhawk, (2) only the dummies with the sparrowhawk colouration would induce fear in the tits—the recognition is based on the presence of raptor-specific features and sparrowhawk colouration, (3) only the unmodified, realistic sparrowhawk dummy would induce fear—the recognition is based on the presence of raptor-specific features and body size as well as the colouration of the sparrowhawk, (4) all but the dummies with conspecific (great tit) colouration would induce fear—the recognition is based only on the presence of raptor-specific features, but the conspicuous conspecific colouration cancels out their effect.

1.1. Terminological comment

We often use a term "recognition" that unfortunately has no unambiguous meaning. It is the term connected to the memory in psychological research and refers to the successful recalling of the previously learnt stimuli. However, recognition can also refer to classifying objects or other animals appropriately on the first encounter by means of some distinctive feature (Shettelworth, 2010). This meaning is common in behavioural ecology and we use it for purposes of our study. The reason is that experiments with untrained animals do not allow testing the recognition based on previous learning. The ability to recognize presented stimuli in behavioural studies is evaluated on the basis of appropriate reaction to the biologically meaningful stimulus (Krebs and Davies, 2009).

2. Methods

2.1. Subjects

The great tit was chosen as a model species. Great tits are very adaptable to laboratory conditions (e.g. Dingemanse et al., 2002). Moreover, no neophobic reaction that could negatively influence their behaviour in the presence of an unfamiliar stimulus has been found in this species (Cole et al., 2011).

The birds were trapped in mist-nets in the suburban areas of České Budějovice (Czech Republic) during the winter seasons of the years 2011–2012 using the same procedure as in Beránková et al. (2014). Experiments conducted during the winter season ensure that yearlings are already able to recognize the sparrowhawk properly (Kullberg and Lind, 2002). Each bird was tested only once. One hundred eighty individuals were used for all the experiments (20 tits for each dummy, with eight dummies presented and 20 control tits). Sex ratio in our experiments was balanced and had no significant effect on great tits reactions to the presented dummies ($p = 0.677$).

Authors have complied with APA ethical standards. Experiments carried out in this research comply with the current laws of the Czech Republic.

2.2. Experimental stimuli

The European sparrowhawk is the main predator of small passerines in Europe (Zawadzka and Zawadzki, 2001; Bujoczek and Ciach, 2009; Chamberlain et al., 2009). It has already been established that wild great tits are able to recognize a sparrowhawk and distinguish it from less dangerous raptor species (Tvardíková and Fuchs, 2011).

Plush dummies were made of hollow textile fibres on a wire skeleton. The plush surface was painted with acrylic colours to imitate the bird's feathers. The beak and claws were made from modelling clay; the eyes were made of glass. The efficiency of such dummies in experiments with passerines has already been demonstrated by Němec et al. (2015). In our study, we used four different colour modifications of the sparrowhawk (Fig. 1). As well as for the unmodified, realistic sparrowhawk colouration (indexed as H), we used the colourations of a pigeon (P) and a robin (R) as they are harmless birds approximately of the same body sizes of a sparrowhawk and a great tit respectively. The last colouration used was that of a conspecific great tit (T). One set of dummies was larger (indexed as L—LH, LP, LR, LT)—the size of a female sparrowhawk (body length 35 cm), and the second set was smaller (indexed as S—SH, SP, SR, ST)—the size of a great tit (body length 15 cm). All of the dummies we made to imitate a sparrowhawk resting on a perch. There is no raptor with a body size similar to that of the