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Fieldwork results, anonymity, rare observations and cognition-questions of method, biases and interpretations

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QUESTION

When are data acceptable in field research?

ABSTRACT

The study of birds in the natural environment largely falls into two disciplines: ecology and ethology. At this time of substantial decline of bird species and numbers, it is argued that ecology cannot do without ethology, especially cognitive ethology, if real progress of saving species is to be made. The paper is concerned with problems of methodology, partly to do with lack of familiarity with behaviour and characteristics of the species (the anonymity problem) on one hand and partly to do with an underestimation of the effects of 'an ecology of fear'. It will raise the question of sampling bias, express concern about the use of technological gadgets that may produce large data sets but often too little of value. It is not just an argument of quantitative versus qualitative data but of distortions, oversights, and insights that are not used. Studying cognition and emotional intelligence are as important hallmarks of an animal's ability to cope in the current wildlife crisis as are knowing about migration routes. Moreover, there is little doubt that systematic discussions in ethology rarely prepare one on how to respond to unexpected or incidental behaviour and to discuss the future of ethological fieldwork and cognitive studies. Examples of rare behaviour will also be provided to show how they can be pivotal in good science when momentary surprises in witnessing unusual behaviour can lead to new insight, and then to experiments and data. The paper will suggest, however, that new insights may only be possible when a robust methodology used in field research reflects a positive, non-invasive approach.

Keywords: field methods, tracking technology, telemetry, bias, rare observations, cognitive research, birds, Australian magpies

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INTRODUCTION

The Anthropocene has created conditions in which most living organisms – apart from humans, some rodents and a smattering of other species and plants – are in decline [1][2].

One of the most pronounced interests in bird behaviour in recent decades is cognition, with special interest in the avian brain, social behaviour and exploration, and the other is in conservation, due to perception that slowing down or halting decline has become an urgent task worldwide now. The former is of interest specifically to ethology, the latter, so it seems, has been largely assigned to ecology. Ethology, a separate discipline, is often practised in conjunction with other relevant disciplines such as neuroethology, endocrinology and comparative psychology as a form of behavioural biology including also cognitive studies. Many topics of interest may overlap but less so the methodology.

Fieldwork has perhaps never been so important, but some conservationists have doubted that cognition in birds is a subject of any interest at this time, and that all efforts should be poured solely into endeavours to save species. On one hand, these debates led to the sensible arguments provided by restoration ecology that habitat destruction should be stopped or mitigated [3] but emphasis on rehabilitation or on relocation of native animals involves consideration of species behaviour in general and on life histories and information or, as Greggor et al. put it, "*the decisions animals make are driven by their perceptual abilities and attentional biases, as well as the value animals attribute to current stimuli and past learned experiences*" [4].

Herein, in those two contrasting positions, lies a near-tragic misunderstanding. For birds, one needs to have information that requires both ecology and ethology. One needs to know, of course, where they move from and to and how they reproduce in changing environments, understand physiological limits, such as the limits of thermal resilience for instance [5]. One also needs to consider how cognitively and emotionally prepared species and individuals may be for encounters with unfamiliar physical and structural alterations in the environment, be these changes in heterospecific population composition or new potential food sources [6]. All these considerations are important, given that current climate and associated changes can occur in short timespans and in often unexpected ways [7].

This paper deals particularly with fieldwork and the data it produces. In a recent paper, I discussed a highly problematic area of ecological fieldwork from the point of view of animal welfare [8]. Here, I look at the data produced as a result of remote and nearly anonymous collections of data – an area of scientific endeavour that has had far too little critical and impactful reflection and, instead, has created its own and, in some instances, possibly undeserved nimbus of authority via an ever-growing citation network [9].

Further, the paper addresses so-called anecdotal findings in ethological field research that, by contrast, have been and regularly come under scrutiny. In either field practice or data collection, some careful rethinking might be needed. The question is under what circumstances data are scientifically acceptable and robust, especially if the results are to be used in conjunction with certain conservation goals. Perhaps it is also necessary to ask, how one can best explore complex cognition within the context of a bird's life history and in the natural environment and whether we employ the best techniques, have reliable methods, and do not introduce sampling biases [10]. Of particular concern are rare observations in the field that may appear puzzling, or even extraordinary. Such rare observations usually fall into the category of behaviours that are either celebrated as discoveries of complex cognition or dismissed as useless anecdotes.

Finally, the paper will argue that cognitive research in birds, while progressing at a remarkable pace particularly via establishing biologically verifiable attributes in avian brain function, is as important to undertake in the field as it is in the laboratory. Of course, such comparative work is well established in biology and in soil, water and toxicology studies [11][12].

The question is, thus, how and whether one can do effective cognitive research in the field and whether specific cognitive abilities and skills of avian species have explanatory power for species survival in their natural environment. Fieldwork, whether done in ecology or ethology, can be a relatively 'messy' business with many unexpected (or unwanted) possible variables. Norris wrote in his book on spinner dolphins: "*Science is tinkery business. One must conceptualize, design, test, repair and modify, discard, and above all try to perceive without bias what nature has to say as a result of the test. And it all takes a lot of time*" [13]. Indeed, in these short sentences the contradictions in the practice of science in fieldwork are all too obvious- on one hand, it is reductionist (simplify the elements for testing as much as possible so they are not confounding the interpretation) but then observe without intervention, leaving it up to the dynamics of unfolding events, and repeating the same set of experimental interventions over and over again with different groups and at different times. The latter is utterly time-intensive and perhaps the most discouraging element of good observational fieldwork (examples will be given in '*Means-ends test in the field*' section).

By contrast, the latest technology (geotrackers, any GPS devices) that one can attach to animals makes getting data so much easier, substantially increases the number of data one is likely to collect, radically reduces the time in the field and also seems to provide more information that is normally beyond pure observational reach -*i.e.* when the subject of one's study moves out of sight from an established position of the human observer. Because of all these alleged advantages, such technology has become very attractive and often standard method. The use of telemetry in avian studies alone is constantly increasing and there are now thousands of papers using it [14], often without methodologically justifying its use and without elaborating on possible negative side effects, not just for ethical reasons but for scientific reasons of data distortions and potential misinterpretations of results [14]. More will be said of this later (see sections of '*Research geared to protection, translocation or reintroductions of endangered species*').

As late as 2007, it was argued with some justification that there has been very little research on the practice of fieldwork [15] and this is something that is still awaiting review and broad coverage. In the absence of such a framework, some data collection methods in ecological fieldwork studies will be examined, especially concerning problems in data distortions and its probable causes. In cognitive research, a question posed here is how one can best explore complex cognition within the context of a bird's life history and in the natural environment and, secondly, how comparable are the results obtained in laboratories with those in field studies? What status is to be assigned to rare observations in the field that may appear puzzling, surprising, or even extraordinary? Rare observations usually fall into the category of behaviours that are either celebrated as complex cognition or dismissed as useless anecdotes.

TESTING COGNITION AND WHAT IS IT?

The concept that birds have cognitive abilities now requires little elaboration. While the idea was still somewhat controversial at the turn of the 21st century [16], the evidence is now overwhelming that some avian species can do a range of cognitively complex tasks, engage in behaviour that is recognisably complex and have forebrains that biologically underpin such abilities [17][18][19]. Some cognitive processes are domain-specific, and these are usually referred to as modules [20][21]. All studies on animal cognition in general have tended to be modular to some extent, *i.e.*, observed skills in one domain followed by testing such specific abilities [22][23][24]. Inevitably, research had to concentrate on very targeted questions and slowly assemble a picture of the birds' cognitive world [22]. Some investigations started with natural behaviour associated with food acquisition and reproduction, two of the most basic abilities for survival in an individual and the species.

To take cognitive studies beyond basic skill sets required new theoretical considerations. The social brain hypothesis largely filled this need. Dunbar had argued that large brains first and foremost had to do with social bonds and bonded relationships [25]. The concept of the 'social' brain arose out of the view that more complex cognition was needed when animals lived in groups because of their need for communication and possibly even negotiation, arguing that the major functional role of the vertebrate telencephalon is the regulation of social interaction leading to social complexity, an argument that has been debated for the past twenty or so years and often confirmed [26][27]. Most affirmative results of complex cognition have arisen from laboratory experiments but, of course, the evolution of such traits occurred in the natural environment and proving that can be problematic if there are no fieldwork data to support such claims.

The claims for acquiring greater brain power rested on the assumption of social complexity [26], its evolution should hold for entire species and across species and this may not be so. Insights and innovations may remain specific to a group and even be instigated by just one individual and copied by other members of the group. In Japanese macaques (*Macaca fuscata*), for instance, potato washing spread from one group to others and then expanded from potato to food washing [28]. Innovative hunting techniques of some killer whale pods may not spread to other groups. One such strategy, risky for the orcas (*Orcinus orca*), is called 'stranding' to capture seals, a technique that seems to have remained an innovation confined to a small population but not across all killer whale populations [29].

Can the theory of cognitive complexity be upheld when the same conclusions are applied to avian species that might not be considered as the brightest and best in the cognitive domain but live in complex groups and show group-specific behaviour? In several interesting studies of superb fairy-wrens (*Malurus cyaneus*), Langmore and colleagues investigated why some nest sites were heavily parasitised while others were rarely parasitised by cuckoos even though, geographically, the sites were not far apart [30][31][32]. The researchers found that the ability of one group and not the other, to successfully avoid being parasitised, was achieved by learning and, more broadly, by social transmission [33]. As in the orca example, the specific behaviour (anti-parasitising in case of the wrens) did not spread to other groups.

Some neuroscientists and developmental biologists have raised doubt recently about calling too many behavioural expressions 'cognition'. Levin et al. [34] wrote recently that one cannot be certain when biological information of essential features of the brain turns into a justification for seeing such behavioural evidence as a "canonical 'instantiator' of cognition". They asked what was needed in an organism to become familiar with all relevant features of an environment to keep itself alive, growing and (with luck) reproducing? And they cite "a-neural" systems showing that "*the cognitive operations we usually ascribe to brains — sensing, information processing, memory, valence, decision making, learning, anticipation, problem-solving, generalization and goal-directedness — are all observed in living forms that don't have brains or even neurons.*" [34].

Indeed, looking at phylogenetic data, it can be shown that neurotransmitters, synaptic proteins, networks and circuits exist across a wide spectrum of organisms [34]. Even some invertebrates, that may not have a brain as we identify it in vertebrates, can also have cognitive capacities once solely ascribed to humans and primates and, very occasionally, to birds. The octopus is a prime example of this [35].

Similar traits can develop in orders in which there is no relatedness, such as the ability of vocal learning in songbirds (over 5000 extant species), parrots and some hummingbirds, cetaceans, and humans as well as some seals, elephants, and the horseshoe bat [36]. The point here is that convergent evolution [37] may also result in similar traits (including cognitive traits) in very dissimilar species. Equally, we know that some biological traits in animals are marginal or superficial (even though extremely complex biologically) in the sense that they can be dropped and reinstated in one species when needed, such as colour vision [38][39][40].

Whether or not Levin and colleagues [34] are right in suggesting that the great variety of such systems suggests not a binary dichotomy of cognitive versus mechanical but, rather, a continuum of cognition from modest to complex, is yet another question. I fear, that adopting such a viewpoint might lead us back to the Aristotelian scala naturae, a way of relegating some life to 'low' and others to 'high' in value according to the criterion of cognition and/or other abilities, or as Joan Silk called it "*Taxonomies of cognition*" in a review of Frans de Waal's book on the evolution of animal intelligence [41][42]. Or whether one embraces the conceptually/philosophically opposite position as Naess [43] had argued decades ago, that we are animals among others and not quite as unique as we would like to be. Rarely does it get pointed out that calling one species 'unique' (as the human species) is tautological: every species is 'unique' by definition.

However, against the critique by Levin and colleagues [34], cognitive behaviour in birds, cetaceans, and primates, also has a social and emotional dimension that may even be more important than had been realised when Dunbar formulated the social brain hypothesis [25]. The social brain requires not just memory, learning ability but the capacity to think of and respond to others, be this in terms of cooperation, affection, consolidated behaviour, partner commitment, or even altruism and empathy. Richard Lazarus argued from the 1960s onwards [44] that cognitive processes precede emotional ones, establishing a clear link between cognition and emotions well before neuroscience could confirm the brain processes involved. He argued that cognitive processes generate, influence, and shape the emotional response in every species that reacts with emotion, a theoretical position supported by Salovey and Mayer [45].

Emotions, after all, may be suppressed or expressed. They are regulated, and can be utilised in various ways, be this for planning or influencing motivations. Indeed, as has now been confirmed in countless papers in human and animal studies, emotions are under cognitive control [46]. However, there is little ever said about this variable when scoring behaviour of parrots or other avian species in laboratory tests designed specifically for cognitive abilities. What is the role of the experimenter? What is the personal relationship of the experimenter with the birds being tested? Our pet cockatoos responded very differently to different people, expressing strong likes and dislikes, affiliative behaviour or aggression and their performance in given tasks could be quite different (expressed, for instance, in latency to approach, completion of tasks, etc.) depending on the social context. One suspects that most laboratories are aware of this and make some adjustments as needed but, as far as I know, such awareness and possible adjustments in response to anticipated behaviour of the subjects are never mentioned. After all, the birds tested for specific skills have to be willing participants in the entire experiment.

Investigations into the possibilities that birds may be capable of showing altruism and empathy are still rare and very recent but show that even such subtleties of emotions are possible to test. This recognition opened the door for the study of the entire range of emotional and cognitive abilities in birds [47]. One of the most explicit papers on the topic of empathy in birds shows that a distressed member of a group of ravens gets consoled by another member

[48]. Consolation of a vanquished member may also be an integral part of keeping a group functioning.

Ideally, we should observe, record, and test as much as possible cognitive behaviour in the field in contexts in which birds/animals are likely to display context-appropriate and natural behaviour. Prosocial behaviour or empathy suggests a close link or insight into the other's physical existence: I move as you do and therefore I 'know' you better. In one theory, called the theory of social-cognitive transference, it is proposed that mental representations of attachment figures strongly influence how we judge others [49]. This may also be true in birds, even if individual participants are not aware of the influence other attachment figures might have had [50].

One set of testable behaviour conducted that combines emotions and cognition well is self-control and this has been tested in many studies [51]. Broadly speaking, self-control relates to one aspect of executive function that supports flexible adaptation to the environment [52][53] and a number of ingeniously simple tests have been devised for testing, such as qualities of motor-self regulation and delayed gratification [54] and other attributes of executive function in laboratories. Tests concerned with inhibitory control, such as motor self-regulation in a detour tasks (tested in standard cylinder tests) raised doubts as to the usefulness of some of these experiments.

A standard detour task uses the cylinder task. Typically, an opaque cylinder was used and subjects could find a piece of food inside if they went to the open end of the cylinder to retrieve it. In the second round, a transparent cylinder was used placing the food in the same position as before but now the subjects could see it from every angle, not just the open sides. Parrots did rather poorly at it, raising doubts what exactly the test measured [55][56]. My own preliminary field test with the cylinder was even more simplified (*i.e.* presenting only the clear tube and inserting food that could be reached from either side by even large birds). I watched every interaction — king parrots, *Alisterus scapularis*, kept trying to get the food by scratching the plastic material with their beaks at the site of the food in the middle of the tube. Even after a day, they did not use the detour. The same happened with bar-shouldered doves, *Geopelia humeralis*, pecking consistently at the food on the side. A male bowerbird, *Ptilonorhynchus violaceus*, appeared and made the detour at once and without hesitation and retrieved the food, so did an Australian magpie, *Gymnorhina tibicen*, and a Lewin's honeyeater, *Meliphaga lewinii*, but not the blue-faced honeyeater, *Entomyzon cyanotis*, and a pair of scaly-breasted lorikeets, *Trichoglossus chlorolepidotus*. However, since the food was displayed in the natural environment, it was potentially open to any wildlife. On day 2, the wildlife visiting the tube were also two lizards, a skink, and a water dragon, as well as a brown rat. The amphibians and the rat detoured immediately and without hesitation and one wonders indeed how many other vertebrates and even invertebrates could have solved such a problem and what this means for our assessment of 'complex cognition' in birds and in animals generally? The idea of an experiment in the natural environment had to be abandoned largely because of the appearance of the rat that could quite easily have killed one or the other visitors, no matter how well the site was protected. Even in this brief preliminary test, it seemed more than evident that this kind of detouring ability was not specific to a) particularly large-brained animals or b) to a single class of animal.

Likewise, eye-gaze following was once considered special to humans and primates. However, chickens, *Gallus gallus* [57], African grey parrots, *Psittacus erithacus* [58]; bobwhite quails, *Colinus virginianus* [59]; bee-eaters, Meropidae [60], Northern bald ibises, *Geronticus eremita* [61], jackdaws, *Coloeus monedula* [62], starlings, *Sturnus vulgaris* [63], and American crows, *Corvus brachyrhynchos* [64] have been shown to engage in eye-gaze following. Common ravens (*Corvus corax*), when caching a food item, use the ability to recognise direction of gaze to decide when they are being observed as they cache it [65]. Gaze following has also been studied in many primates and in wolves [66] as well as in domestic mammals, such as dogs, cats, horses and even goats [67] the latter largely with respect to cueing by humans. Social attentional cues as we now know are important across a wide range of species, be this as part of an imprinting process or as an ability to learn from observing behaviour of a conspecific (here: body or gaze orientation). Archerfish, *Toxotes chatareus*, soon assemble when one archerfish is lining up body and eyes for targeting a prey item above the water [68]. Fish cognition is now also an established field [69][70][71] suggesting that cognitive abilities of various complexities may be found across a wide range of vertebrates and even invertebrates [72][73][74][75].

We believed that eye-gaze following provided a window into social cognition (with emphasis on 'social' [76]. Perhaps this was a little premature. In some instances, it would seem more correct to refer to this as visual cueing, *i.e.* a very important adaptive behaviour since eye gaze following has so far both been observed and studied also in an asocial reptile, *Eublepharis macularius* [77] and in a red-footed tortoise, *Geochelone carbonaria* [78].

Finally, we now know that at least precocial birds hatch already equipped with a basic 'tool kit' of sensory perceptions, discriminatory abilities, and a set of basic cognitive skills as an important review in 2010 described it, after testing nearly newly hatched chickens [79]. Certain cognitive abilities appear to be part of this basic tool kit, including degrees of numeracy, geometry (spatial ability), physics (understanding gravity), and even psychology. 'Psychology' here refers to the ability to correctly interpret the behaviour of others and understand that objects and living things remain complete when half their body may be hidden, an ability referred to as object permanence [80]. Amodal completion, the ability to imagine a visible segment of a shape or body being part of a whole even when hidden, was once thought to be unique to humans but that soon proved not to be true – rodents, primates and birds can also do it [81]. For precocial species, such as geese, ducks, chickens, this makes a great deal of sense since it explains how they find their mother when she is half-hidden behind some natural object [82]. For altricial species, the same should largely hold since altriciality (*i.e.*

hatching at an earlier stage of development) potentially permits slower but more extensive development and growth of the brain. But results are by no means even. Amodal completion, for instance, has been shown in Bengalese finches, *Lonchura striata* [83], but when tested in pigeons, it was not mastered. Pigeons seemed unable to complete the disappearing object [84].

Knowing all this from laboratory research, it may be more difficult to test cognitive skills in fieldwork, at least in some special tasks (as will be shown later), because the environment can simply not be as well manipulated as it can be in a laboratory.

However, regardless of the overwhelming success of laboratory studies, the question Calisi and Bentley asked some years ago (2009) was whether animals tested in laboratory and field experiments are really the same animals. In their review they concluded they are not [85], because captivity alters animals profoundly, be this in hormonal responses or even in brain morphology and function. For instance, Calisi and Bentley showed that Nuttall's white-crowned sparrows (*Zonotrichia leucophrys nuttali*) have seasonal changes in the volumes of the forebrain nuclei in the song system (HVC and robust nucleus of the archistriatum--both central for the avian song system). These nuclei were larger in spring than autumn in free-ranging birds than in captive ones; wild dark-eyed juncos (*Junco hyemalis*) furthermore had a larger hippocampal volume than captive birds; superb fairy-wrens (*Malurus cyaneus*) showed a decreased immune response in males in captivity compared to free-ranging birds [85]. In more than 20 songbird species, Calisis and Bentley [85] showed that testosterone levels are higher in response to social instability in free-living breeding birds than in captive birds.

All these, at times substantial, differences in some biological factors between laboratory and free-living birds may result in important changes in behaviour, making the extrapolation of data collected in the laboratory and field discordant and sometimes perhaps even questionable. Quite often, the circumstances and housing details are not described in detail in submitted papers. It is often also not stated for how long birds had been in captivity at the time of testing, noting here that birds, apart from those for domestic use, are generally not listed as companion animals because many have shared human company for very few generations, or they may have been bred in laboratories or are still taken directly from the wild. The latter has its own substantial risks: physical deterioration because of stress or capture myopathy. Climatic changes and stress during longer transport (from country to country or across climate zones) can cause significant mortality even when birds are imported legally and those that stay alive are dealing with significant trauma. Stress alone from handling raises corticosterone levels [86]. These details ought to be carefully examined and stated in laboratory behavioural tests, especially for something as sensitive to change as behaviour since behaviour depends on learning and experience. Some observational data presented can thus place doubt on the exclusivity of cognitive behaviour linked to the tested species, the circumstances of which might have been biased to begin with. At least such a bias should be known and considered although only very few research papers have done so [87].

FIELDWORK – METHODS AND ATTITUDES

One school of fieldwork in ethology seeks to understand natural behaviour and frame questions that can be answered within the limitations of fieldwork observations and naturalistic settings. Fieldwork here means going out to established avian communities, slowly habituating a specific group of animals, here birds, to one's presence and trying to do so without provisioning them. Some individual experiences in the field will be recounted here in as far as they raise questions.

Bearing witness to animal behaviour is not about 'results' but rather about experiences. If a scientist is honest, these experiences may very well change the way he or she views the objects of his or her study and may also alter the way a particular fieldwork project is conceived. This is certainly how Konrad Lorenz approached his subjects and many of his insights arose first out of such close encounters and the time he spent allowing these relationships between birds and human observers and avian participants to develop [88]. His intimacy with the birds of interest was not limited to ducks and geese [89] that imprinted on him [90] but involved other species such as jackdaws, genus Coloeus [91], a member of the European corvids. Intimacy here means not treating the subject as a pet but allowing free-roaming and wild-living birds the freedom to go about their lives or even interact with the observer while continuing to display the entire, context-appropriate range of natural behaviour.

In his method of fieldwork, a researcher presents in the field, usually alone, to make as small a footprint as possible and stays with the subjects over a designated number of hours and days, as the experimental or observational schedule requires, and does so without indirect or direct intervention. This form of ethological fieldwork is usually very time-consuming but has the distinct advantage that the researcher gains some insights into individual and group behaviour, may bear witness to unexpected behaviour or may be able to observe encounters with predators of the species under study and can record changes in behaviour [92][93].

There are also some issues arising that are rarely debated in research but are of some consequence in fieldwork; namely, how the researcher behaves and thinks while in the field. For instance: will he/she believe his/her eyes, note and record actions and behaviour seen or not record some that, to the observer, have little or no meaning. Might a researcher respond to observed behaviour by changing his/her own behaviour? Is it clear and certain that researchers do not assume universality of behaviour at a species level and bring to it a negative human bias or not?

One of the advantages and disadvantages of fieldwork, in almost equal measure, is the rare opportunity for researchers to observe and document behaviour in its natural environment and identify contexts in which they occur. Certain instances may capture the interest of the observer and may actually be suitable to be followed up by well-designed experiments. Other observations may appear fascinating but cannot be replicated.

Publishable projects (examples)

For field researchers, there are a few preferred characteristics when choosing a study subject: accessibility, stability and abundance. For over two decades, my own field research centred on one species: the Australian magpie [94], a species that belongs to the broader Corvoidea, but not related to the Eurasian (*Pica pica*) or the American black-billed magpie (*Pica hudsonia*). The advantages of studying Australian magpies (*Gymnorhina tibicen*) were obvious: in the areas of New South Wales, and close to the university, they are an abundant species, live in stable territories (open woodland) that can remain unchanged for as many as two decades. The parents usually form a strong bond and stay together even for life, usually getting offspring to leave when the next breeding season is about to begin. They sometimes use helpers, offspring from a previous year when breeding [95][96]. They are furthermore ground-feeders, are easily distinguishable individually by their wing markings and have a methodical way of foraging. As songbirds, they are unusual in several ways, apart from being accomplished and versatile songbirds (over 900 syllables), they are excellent mimics [97], life-long learners, and they also have the distinction that male and female sing alike and do so throughout the year [98].

For vocal studies, collecting songs and using playback is easily set up in the field. Their song carries a long distance and is readily recorded, and this was initially the topic of my main interest. The analysis of vocal behaviour eventually also led to the discovery of referential signalling in this species [98], but this took an inordinate amount of time: thousands of hours of recording, analysing, and preparing playbacks to test the hypothesis that some of their vocalisations were, in fact, ‘referential’, i.e., had a fixed meaning that other magpies understood immediately [99][100].

A similarly familiar type of project for fieldwork is to simulate natural encounters with predators. Magpies are a very good subject for such a project because of their known fearlessness and skill to drive even large aerial predators out of their territory [101]. On the basis of a few casual field observations, noticing that the birds seemed to use slightly different tactics in response to different aerial predators of different height, weight, talon strength and bodily manoeuvrability, our laboratory had taxidermic models made of the most abundant aerial predators in the region that were known to present real predatory threats to magpies, such as the little eagle, *Hieraetus morphnoides* [102], brown goshawk, *Accipter fasciatus*, [103] and the wedge-tailed eagle, *Aquila audax* [104]. By presenting these various predators in the field, we were able to produce a profile of the methods of attack of each predator which proved to be surprisingly sophisticated [105].

On another occasion, working on a different project, I noticed purely per chance that one magpie raised a very special alarm call, later dubbed 'eagle alarm call', while looking intently at some shrubs. There was indeed an eagle, half hidden by foliage on the ground and the magpie seemed to lean its body so hard in the direction of this wedge-tailed eagle that it nearly fell off the branch. That brief observation turned into a well-controlled field experiment, made possible by using a taxidermic model of a wedge-tailed eagle that was indeed very life-like. A set of 3 experiments were set up to evaluate the behaviour of the magpie in detail and assess the sequence of events once the taxidermic model was in position. The response was overwhelming, even dramatic: the entire family became involved, and a cacophony of eagle alarm calls rang through the air. In addition, they used their whole body to point towards the eagle [106]. The results were published, and this paper was the very first report of pointing behaviour in a bird in the natural environment and showing a well-rehearsed performance of a set of cognitively complex behaviour [106] followed that same year by a similar study of pointing in ravens [107].

In the magpie fieldwork project, it took a full three years, an entire team of field researchers and assistants to collect the original calls (those we thought might be referential) from a range of territories. Then we prepared playback alarm calls of these calls, using many different territorial sites of some geographical distance one from another to establish whether it was part of the species' repertoire or a locally specific vocal innovation in communication. The project yielded two papers [99][100]. Standard procedures were used for recording vocalisations and using playback of their own calls to elicit behaviour (see *Figure 1*). These steps were extremely time-consuming but, in the end, scientifically reliable.

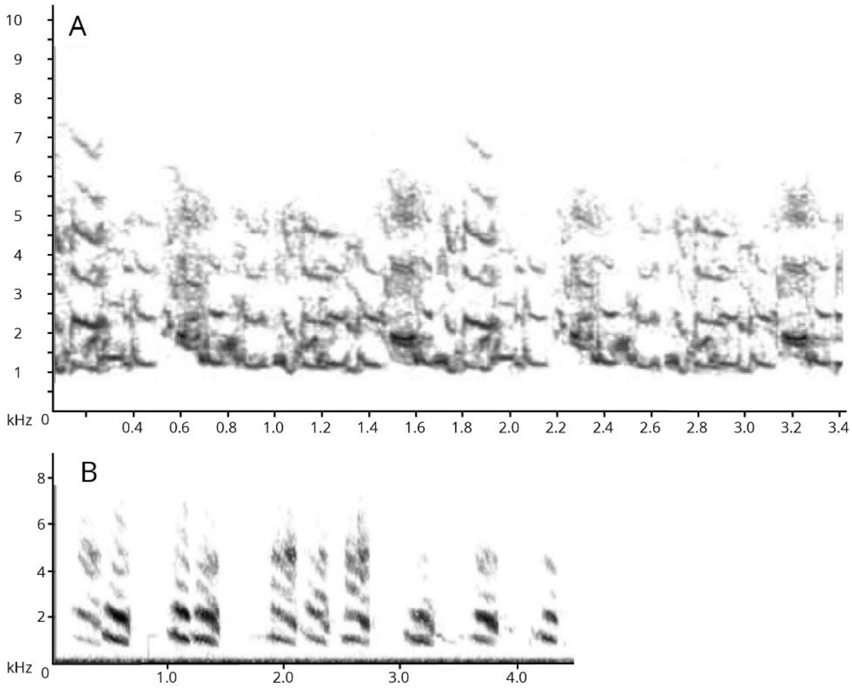

Figure 1 - Alarm calls by Australian magpies - *A: the referential "eagle alarm call; B: the generic alarm calls. As can be seen, the generic alarm call is much simpler and quite different in structure. The eagle alarm call has some complex structural elements and is delivered like a curtain of sound: a complex but consistent structure, delivered at high frequency and high decibels. (Spectrograms G.Kaplan)*

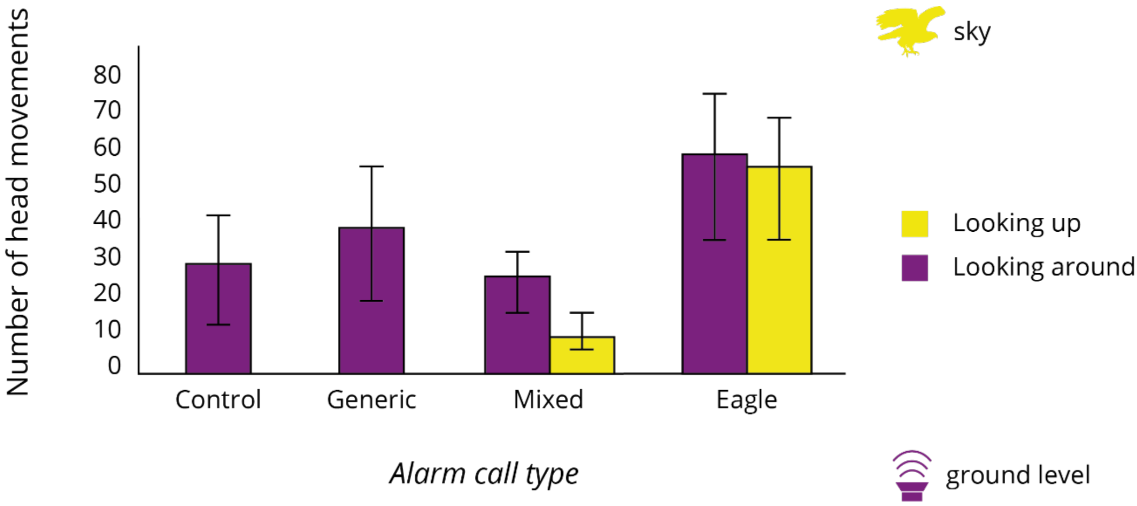

Figure 2 - Playback of alarm calls - *Note that the playback comes from a source placed on the ground when, in random order, playback switches from general alarm calls to a mixture of generic and mixed/eagle alarm calls and one playback contains exclusively eagle alarm calls (responses to eagle alarm calls in yellow;* see also [99]*).*

As *Figure 2* shows, when playback contained some 'eagle alarm calls' the birds looked up. The magpies of any group and territory responded to the alarm calls by consistently looking around but once the eagle alarm call was introduced (either interspersing the playback with generic and eagle alarm calls (mixed category), the birds looked around and, once the eagle alarm call was played, also looked up. The incidence of looking up increased (statistically significantly).

Note that 'looking up' behaviour, looking towards the sky, made no sense whatsoever since the *sound source* was on the *ground nearby* and would have been easy to find, unless the birds were in fact expecting to see a bird of prey in the sky and understood the calls as a warning to be aware of an imminent danger from the sky. This behaviour provided convincing evidence of referential signalling, warning others of birds of prey that would indeed most likely be seen in the sky [99].

Bird behaviour in encounters with researchers and their equipment

Over many generations, research has shown that most birds generally seem to have learned that most humans are dangerous, even more dangerous than apex predators and this elicits responses of hiding, fleeing or quiet (freezing) behaviour [108]. If anything, one could speculate that such fear might have increased over the last decade since the report by Ciuti and colleagues came out in 2012 [108]. A very recent paper has shown that this is indeed so [109].

The sources of creating fear of human-inhabited areas are manifold, are culture and area specific. This may involve poaching in one area, shooting birds for food or fun in another, simply removing roosting and nesting trees but also unleashing millions of cats on birds' trails, flooding the landscape with noise and light and many other variables [110]. In some areas, when we went 'outback' into relatively uninhabited inland semi-desert areas of Australia, birds fled when they saw a human shape or even just a car on the horizon, several kilometres away. We then learned that the red-tailed black cockatoos (*Calyptorhynchus banksia*) were regularly shot in that area. Flight was their only defence.

Hence, fieldwork can be made much more difficult by the potential dangers that humans have come to represent. It can take a year or more to habituate birds to one's presence. Jane Goodall needed 2 years before the chimpanzees were able to relax in her presence [111]. While the geographical areas in which I conducted most of my research was low in human populations, the key feature was that most landholders entertained friendly relationships with their magpie families and that certainly helped in the habituation process. However, it did take at least half a year before I felt that the birds were getting used to my presence and continued foraging, preening, vocalising or playing. Some even approached me. Nevertheless, I continued being watched for every move I made. To make things easier, I wore only khaki-coloured clothes, which had no patterns and turned up day after day in the same outfit, just equipped with a camera, a notebook and later also with a camcorder.

Equipment: camcorders and camera traps

The camcorder that I used to film magpie behaviour at first created some problems and, when turned on to recording mode, it almost caused a direct attack by one male during the breeding season. By accident, I noticed what the problem might have been when the camcorder, still on recording, was trained on me by an assistant. When the recording function of the camcorder was turned on, there was a red light flashing next to the lens, via a small vertical slit. This looked like an image of a dangerous flashing eye, like a cat's eye but in bright red. To test this, next time I filmed magpies at the nest, I placed a non-transparent sticker over that flashing slit and the male never tried to mob me again. This simple adjustment changed the behaviour of the breeding male immediately. The camera traps I had set up also showed the same problem: they had a small round red flashing light once activated, facing the objects to be captured on camera and that problem too was remedied by a non-transparent sticker.

Flashing lights have also been a problem in many studies using camera traps. Ironically, camera traps come in camouflaged colours of patterned jungle greens, the motor while recording is rather quiet but for many years the camouflage did not extend to the recording function. They too have flashing lights. In one study, 40% of all camera traps were destroyed by elephants, *Loxodonta africana* [112]. In another study, it was mentioned that flashing lights deterred pumas, *Puma concolor*, from attacking livestock [113]. There are guides for field researchers about types and features of camera traps [114] but I am not aware of the instructions always including specific advice on red or flashing lights facing outwards and towards the subjects to be recorded.

Camera traps are a highly useful tool in situations when one cannot be certain whether any of the target species (now often used for detection of rare and endangered species) are in the area at all. They are especially useful in vast forest terrains that are difficult to access and survey [114][115]. Yet a flashing light is enough to signify a threat or a warning of danger to the animals and this is so seemingly across a wide range of vertebrates. Again, the question arises why a strong natural (deterrent) signal for the subjects to be captured on film has been ignored by countless wildlife researchers. One would have thought that a small matter, such as avoiding the visibility of a simple light signal, could be solved technically very easily but in the models we have used, we had to modify this manually every time.

The point is that in observational fieldwork one needs to think of what the *animal* might see and do; how it might react physiologically, emotionally and cognitively to any human presence and to technology introduced into its environment. Further, one needs to ask how the animal is likely to interpret any newly introduced stimuli. Taking the animal's perspective when designing experiments in the field or collecting data would thus seem beneficial in all cases. Considering factors even as minor as flashing lights or the colour of such light, can avoid creating a bias, either elicited by fear or rising aggression in response to an environmentally alien stimulus.

Invasive techniques

Many techniques in the study of wildlife may be invasive to some extent. Just checking on a nest or removing eggs is invasive and the researchers usually are aware of it and are as considerate as possible. Perspective-taking of the subject under investigation is even more important in invasive research projects designed to trap birds and attach foreign objects to their bodies which are known to interfere with aerodynamics, feeding and reproduction [14].

While some researchers have told me personally and repeatedly, that the modern advanced backpacks are not at all harmful to birds, one must ask on what grounds such statements are made: there are only very few longitudinal studies that compare the outcomes of using this GPS technology to alternative methods over a longer period of time. I will come back to this point later (see '*Distorted results due to telemetry*' section). Suffice it to say here that the appeasing belief in the innocuous nature and the great advantages of these devices is a myth without scientific evidence to back it up and serves only those who feel that large data sets serve the mission to save a species, regardless of some collateral damage. The point of this paper is that the data cannot be trusted if they are gained under duress.

Unlike humans, birds do not show fear or pain but rather tend to mask such experiences as well as possible [116]. One particularly terrible technique, called subcutaneous 'anchoring' [117][118] refers to a device being anchored in the muscle of the bird and this is a painful procedure and possibly causes pain whenever the bird tries to fly or dive. One study suggested sedation using isoflurane inhalant anaesthetic to reduce pain and stress associated with attaching the GPS device. This was ascertained by measuring corticosterone (stress hormone) concentrations. In manually restrained Amazon parrots, *Amazona ventralis,* the levels were significantly higher than for birds anesthetized using isoflurane [119]. However, then the authors dismissed the traumatic event as a "*once in a lifetime experience*" that would ultimately "*not be worse than other stressful events in a bird's' life*" [119]. This study was published 22 years ago and, no doubt, a good deal has been learned since then about the impact of traumatic events on a bird's life: it is not just a "*once in a lifetime event*" but the beginning of a potentially traumatic and persistently painful chapter in its life [8].

Whatever the context, perspective taking, more likely to occur in observational research, may have to become the new yardstick for what is acceptable and not acceptable methodology in field research. 'Perspective taking' is considered a sign of theory of mind but such 'perspective taking' and consideration of the animals to be studied often seems to be wiped out in ecological research by the obvious convenience of using technology that promises to yield substantial data for conservation.

There is no doubt that advanced technology, be these camera traps or more recently even drones, has transformed ecological studies, as a recent paper has confirmed [120]. Drones are very noisy, they invade the airspace (once one of the few remaining untouched domains for birds) and they look like alien attackers, oversized insects, probably more like monsters never seen before and alien to the experience and capabilities of birds. Indeed, a recent paper recommended that drones are good as a deterrent of birds but should be avoided in wildlife studies [121].

The use of drones as methods of studying terrain and identifying nest sites and possible congregations of rare species is a rather recent technology introduced into ecological studies. This paper will not discuss drones any further other than to say that such use in fieldwork has moved research in a direction that has either unwittingly or callously expanded the 'ecology of fear' [110]. This is achieved by introducing new and additional stress factors for animals located usually in an already compromised environment or concerning animals that are already in decline. Drones, as I have tested on birds, either shriek in fear or, as only a few species dare (raptors or Australian magpies) will try and attack the invader.

The examples above demonstrate also another very important point in the use of such technology: its anonymity. The question arises as to how to assess fieldwork data based on almost complete anonymity of the researchers vis-a-vis the study species on one hand and the data gained from hours of personal observations taken by researchers in the field on the other.

Predicting behaviour is one of the strengths of animal behaviour studies because the researchers get to know their subjects generally very well and can test responses to known and new stimuli. when the researcher is and remains in visual distance to the birds or other animals to be studied. Here the two different methods (interventionist on one hand and observing on the other) are at the most opposite end of each other. One cannot but conclude that research methods involving the new devices for surveillance and those remaining non-invasive must capture very different behaviour and thus lead to sometimes very different results and conclusions.

Human anonymity punctured by episodes of invasiveness, no matter how sophisticated the technology might now be [120] creates a scientific abyss as far as data gathering is concerned. Fear and thus stress-inducing techniques may have consequences that may not help the intention of the research, such as nest abandonment and flight from the area [121].

Ironically, ecology was instrumental decades ago in exposing anthropogenic disturbances (such as recreational pursuits; developments such as construction and operation, and hunting as having serious implications for conservation [122] but more recent research endeavours using drones [123] and other devices seem to have lost an appetite for considering the often disastrous effects of such technologies on the very species that are meant to be saved from declining or from extinction.

By contrast, observational studies in the field attempt to be as unobtrusive as possible with the aim of reducing fear and suspicion of the researcher(s). This process of habituation can be rather time-consuming and cumbersome, as mentioned before, and may have its own issues, such as provisioning or the animals losing fear of humans, which in turn may help poachers. Effects of habituation, a term used to explain "*a decrement in response intensity to a repeated* *stimulus or set of stimuli*" [124] have been studied in detail and tests have been advocated to establish whether the behaviour exhibited indeed suggests an absence or reduction of stress [124].

When comparing observational with technology-driven field studies, the differences are obvious: in the latter the birds remain largely anonymous and so does the researcher, in the observational studies one of the inevitable consequences is the *total loss* of anonymity of the researcher. Researchers moving amidst their study subjects, or are at least visible to the birds, become a known factor in the lives of the animals being studied and vice versa [125].

From the few species studied so far for their attitudes to humans, it has become clear that at least some avian species have learned to distinguish between dangerous and friendly humans. New Zealand's North Island robins, *Petroica longipes* [126] and magpies, *Pica pica* [127], American crows, *Corvus brachyrhynchos,* for instance, remember particularly those faces that they perceive as threatening and dangerous [128][129]. Australian magpies have been shown to categorise people according to risk and threat levels [94]. During breeding time, the male defends the nest and the brooding female by engaging in mobbing behaviour, swooping on humans and some animals that may be seen as a risk to the nest. The males do so very selectively: those humans that are considered low risk, never get swooped, no matter how often they pass the nest during the day. They may even be walking a dog and yet no mobbing behaviour occurs. Strangers or people who have shown hostility in the past will be swooped regularly [94].

FIELDWORK – ANECDOTES, COGNITION AND METHODS

Fieldwork may not always produce publishable results, but it frames one's experiences with the species under investigation. It often raises questions that one would probably not have thought about nor would one have necessarily thought that the birds under investigation could even perform behaviour that one might well describe as cognitively complex, such as the pointing behaviour in magpies, as discussed above.

On the other hand, taking some well-established simple laboratory tests to the field, can be both laborious and frustrating and lead to no publishable results at all. A few examples will be given to make this point clear.

Means-ends test in the field

The means-ends test is one of the standard tests used in studies of cognition in birds [130] but to replicate this in fieldwork can be difficult, if not impossible. To test insectivorous magpies in the field, we used a black steel cage (1.0 x 2.0 x 0.8 m) placed on the ground and the food was clearly displayed on the inside of the cage in a cross-stringed fashion. The structure of the cage in the field elicited no startle responses and the birds readily passed the cage without any hesitation. The magpies had seen the mince meat, one of their favourite foods, but not one approached the cage directly or attempted to retrieve the food. The placement of the test cage was repeated in three different territories, always in a prominent position and within the area of their normal foraging paths. Not a single magpie showed the slightest interest in the cage or the food. They proceeded with their normal foraging activities, often walking straight past the cage.

However, after weeks of observation, a recently fledged juvenile in one territory showed great interest in the food but seemed unable to pull it within reach. The adult female parent walked by while the juvenile was trying to reach the food, approached the cage and, in the briefest moment, without actually stopping, in one fast and goal-directed movement, pulled the correct string, getting the food within reach of the juvenile. She then walked on without glancing back, seemingly without any further interest in the matter. Over several weeks, there were no repeats of this performance. Although this standard experiment has been used successfully in laboratories across the world [130][131][132], after three weeks of attempting to test the string-pulling task in this manner (without interference or training) bore no success, the attempt to conduct the means-end test as a field experiment was discontinued. This is an example of incidental observations leading to discontinuing an experiment.

However, this one interaction between juvenile and adult was puzzling and a question of interpretation. Experiments had shown that magpies can accurately distinguish between the nutritional value of different food items [133][134] and the meat should therefore have been of great interest. The brief incident also showed that, for the adult, the string-pulling task posed no difficulty at all. The adult chose the correct string for pulling the food item outside the cage. Juveniles walk with a parent at the time of foraging and by watching, begin to be able to identify what is edible or not and how to obtain the food, including extractive foraging [135]. Yet the interaction was unusual in the speed with which it occurred and the distinct lack of interest in following it.

The experiment was never reported, and the event remained indeed ‘anecdotal’. One conclusion that could be drawn from this experiment might have been that adult magpies have no problem solving the string-pulling problem. Another, that in a time of plenty (as it was), it was not desirable to engage in risky behaviour as the cage might have represented. Put more simply: artificial food sources held no temptation at a time of plenty other than for an inexperienced youngster.

Social breaches: behaviour suggesting rationality, (im)moral acts and considered decisions

As said before, engaging in this form of fieldwork, being in the environment and amidst one's bird families, one inevitably also encounters incidental behaviours that tend not to be reported because they either do not have any repeats (or are rare or rarely observed) or they cannot be replicated easily or not at all. In some cases, specific observations raise the question whether rare observations should not also be made public because a single observation can have seminal character and perhaps should not be dismissed entirely.

Example 1

A singular observation of group behaviour left an indelible mark on me as it suggested qualities that seemed well outside known bird behaviour. I have called this behaviour 'holding court'. This group behaviour is difficult to place into a meaningful cognitive framework unless one had more examples or frame this experience in a new theoretical context. To date, I have not found a way to explain this or devise a way of testing the behaviour. A group of Australian magpies, engaged in 'holding court' (court not as a regal but as a legal environment): magpies would be seen forming a semi-circle, standing on the ground. In front of the group, a single magpie stood facing the group arranged in a semi-circle. Then one individual would step in front, face the single magpie and deliver a sharp jab on its head. The so-punished magpie did not move away but continued to stand in its position until each magpie in the group had delivered the jab. This was a highly controlled sequence of behaviour - there was no obvious indication of aggression, apart from the pecking behaviour. Every bird stood completely still, performed its one and only pecking role and then stepped back into its former position. There are two similar reports of this behaviour that I know of, and both were privately communicated. This behaviour does raise perplexing questions. If this hapless bird standing in front of the group had broken some serious rules of social conduct and was being punished, why does the entire group participate in this and why in such a controlled manner? This raises questions of rationality, morality and group consensus, not issues that have been explored in birds although rational accounts have been considered [136]. There have been attempts in the past to argue for the presence of causal reasoning in rats but in my reading of these arguments raised by Dwyer and Burgess [136] and Blaisdell et al. [137] this went nowhere not even when invoking Morgan's dictum, formulated in 1894 [138], and still a yardstick today: "*a complex cognitive account was only accepted once simpler accounts were considered and rejected*". And yet, in the debate on rats' ability to reason there has been no answer.

Example 2

Example 2 mentioned here describes behavioural evidence of an extra-pair copulation across two magpie territories. Genetic tests had already revealed that Australian magpies, while they may pair-bond for years and sometimes even for life, are apparently by no means faithful to their life partners [139]. Since magpies are strictly territorial, a question arises how such infidelities might occur. In a field study on vocal behaviour in magpies, it became my habit to be out at sunrise (about 5 or 6 am with recording equipment and sound enhancing dish) to record any early morning vocal behaviour. On several of such occasions over several breeding seasons starting in the cold winter months, a single young male magpie was observed walking stealthily towards his family's territorial boundary, frequently looking back. If another magpie was spotted far away, the bird turned to pretend foraging while walking towards and eventually crossing the boundary meeting a female. The bird eventually returned some 20 minutes later, feign-foraging its way back from the edge to more central parts of the territory. This was not a singular observation.

The fact that magpies have extra-pair copulations, although at different rates in different regions [139][140] is a behaviour rarely seen and, to my knowledge, has been described here for the first time. Having watched the behaviour of the 'offending male' one wonders whether there is more to this behaviour. The first stages of moral development, described in dogs, is called 'resistance to temptation', and it is thought that the degree to which an animal 'violates a taboo' after punishment may be related to the same variables that control shame and guilt in children [141]. Rats, as Hank Davis argued, are at a 'preconventional' level of morality, i.e., they show obedience for its own sake and avoid breaking rules backed by punishment [142]. Obviously, magpies go a little further and some break the rules. Rule-breaking juvenile magpies get disciplined regularly by parents or aunts or at least warned. As long as the juvenile immediately changes into a submissive posture (lying on its back or at least bending its back), the youngster would get away with a warning and not get pecked (see *Figure 3*).

Parents tightly control their offspring and do so usually for at least 7 months post-fledging. Under their watchful eye, all edible foods are identified, and everything a magpie needs to know is imparted at this extended period post-fledging. In some cases, magpie offspring may even remain in their natal territory for another year (as helpers) and in some regions even for several years. The longer they are permitted to stay, the more likely the chance to survival and overall fitness as some researchers found [143].

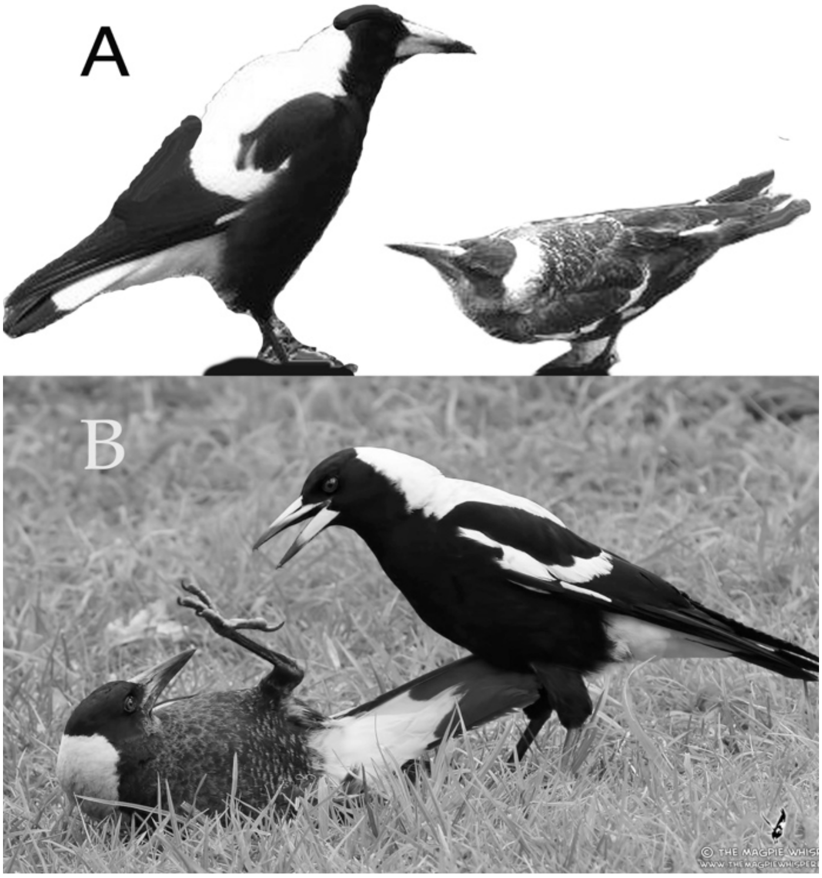

***Figure 3 - Magpie adult chastising juvenile –** A: young magpie (on right) 'apologising' for minor misdemeanour- crouching, bending its back, but looking up; a quick action to avoid receiving physical punishment. B: shows a typical posture of complete submissiveness: juvenile magpie flings itself on its back voluntarily, often accompanied by some woeful little cries and lifting one leg and foot in defensive action. Parent bird is still angry (short angry vocalisations) but will observe behaviour of juvenile and might allow the juvenile to get away with a pull on its foot, rather than a jab to the belly or to its head. (Photo credit: G. Kaplan). These appeasement postures are very similar to those found in dogs.*

My observations over the last 25 years have led me to the conclusion that this species has a wealth of social rules that govern daily life. Unacceptable behaviour is followed by swift expressions of disapproval and even punishment. As far as extra group paternity is concerned, social rules seem to forbid mating with neighbours. This also means that rule-breaking should have some consequences. For this adult male to carry out extra-pair mating, the male had to break two social rules: one to engage in copulation with an unpaired female from a neighbouring group, another to avoid parenting, a sneaker male, that will not raise his offspring. When in pairs, this task is always shared.

The conclusions formed here are interpretations of observed behaviour of two divergent examples in the field: one a failed traditional means-end test used in cognitive studies, and the other a fanciful example of behaviour that could not be arbitrarily repeated. Indeed, this is the first time that such deceptive behaviour (seeking a mating outside territorial borders) is reported in detail in a cognitively complex bird. There are plenty of examples in nature documentaries showing extra matings – from cuttlefish to a range of songbirds, meerkats as well as primates. Genetic studies are plentiful and, even if inconsistent in their conclusions [144], confirm the very widespread practice of extra-pair matings (also referred to as genetic polyandry) in birds [145] even in avian pairs we once thought of as monogamous.

What makes the observation of this rule-breaking male magpie special, are some specific behavioural elements: the bird kept looking over its shoulders, stayed close to the ground and pretended to be foraging on the way out of the territorial boarder and looked up ahead and engaged in the same pretend-foraging on the way back into its own territory. All of these acts demonstrate unmistakably that his actions were deliberate and pre-planned to conceal his *intention* and ensure the successful *deceit*.

Intentionality is both a sign of advanced cognition and, in this case, also a sign of knowing that the intended deed is (morally) wrong and forbidden. The mention of morality in animals is tenuous but not improbable [146][147]. Fitzpatrick (2017) conceded de Waal's observation (2006), for instance, that "*chimpanzees appear to engage in third-party policing of behaviour, which seems to indicate the existence and enforcement of norms of conduct within their communities*" [148][149]. The same might be said of Australian magpie family life but it is only possible to establish such an ethogram of the birds by having spent hours and seasons in the fields. The individual components of behaviour may be fleeting and occur only once or twice (no large data set) but add a crucial dimension to the overall social and cognitive profile of the species.

However, it is generally agreed that large-brained birds have fewer incidents of extra-pair matings because of close social bonds [150]. We know that in such list of large-brained species cockatoos and parrots dominate. Australian magpies were perhaps, and possibly erroneously, not included in that list, leaving one to wonder how often field observations do not make it into the statistics and thus distort the conclusions we draw.

RESEARCH GEARED TO PROTECTION, TRANSLOCATION OR REINTRODUCTIONS OF ENDANGERED SPECIES

As said in the introduction, conservation is largely the field of ecology and largely based on fieldwork and, as a field, has made major contributions to bird studies. It is also well recognised that ecology grapples with its own demons and mismatches, at times referred to as 'wicked problems' which possess specific challenges to reconcile a mismatch between failures or ambivalent success and a tension between 'best practice' and creativity [151]. But even 'best practice' may not always be informed by the latest scientific insights, may not always be ethical if it involves pain and suffering for the animal and does not always deal effectively with unexpected findings (surprises) if they do not fall into the canon of the expected outcomes [152]. 'Surprises' here suggest something very different from 'discovery'. Surprises are not the kind of findings that may fit into the conceptual framework of the researcher — 'discoveries', on the other hand, do. The difference between the two terms may simply lie in the bias that the researcher brings to the tasks and, that, of course, is a problem not specific to one discipline but pervasive across many disciplines. Some of the failures of reintroductions/translocations that were actually predictable happened because key behaviour and likely responses to stress were ignored. There are so many examples of failures and there is little point in reiterating them here because they happened in the past and lessons have been learned.

Failures of some conservation efforts, at least of some current conservation fieldwork, may lead to what psychologist Leon Festinger in the 1950s coined as an important concept of 'cognitive dissonance' [153] — the inability to reconcile two seemingly opposing views and sticking with the framework one has learned but uncomfortably so when ignoring other findings that do not fit into the framework. In 2016, the North American Society for Conservation Biology held a symposium with the title "*Realizing Failure's Opportunity*". It would have been valuable to establish whether any ethologists attended that symposium and how ecologists responded to ideas obviously counter to their current practice. In personal interactions, there have been ecologists who became extremely aggressive and angry and dismissed cognition and emotions as 'rubbish' and on the topic of conservation they asserted that academics dealing with cognitive ethology or compassionate conservation 'didn't know what they were talking about', while others, in personal contact, felt bad about causing pain to animals but accepted this, if it was for 'the greater good'.

However, it is argued here that cognition and emotions in birds are of great importance to their chance of adaptations and survival and, when ignored, may lead to disorientation, stress and avoidable failure [154][155]. The historical roots of any study concerned with conservation [156][157] are largely irrelevant in this paper but the data and what can be believed is not.

Hence, the treatment of birds in fieldwork and in captive breeding programs is of considerable interest in terms of research ethics and conservation. The latter has been reported in detail elsewhere [4]. However, here it is more a matter of whether the data, however large the data set might be, can be believed and advances our knowledge of a species.

The growing technology-driven type of fieldwork for conservational purposes, already mentioned above, has some problems that are more substantial than just anonymity/distance from the subjects under investigation. Indeed, this fieldwork is sometimes at risk of turning the very subjects to be protected (*i.e.*, endangered species) into victims because of their reliance on geolocators and telemetry in general. These devices are attached to the bird itself by glue or harnesses and can stay attached for as long as a year or even longer.

Use of such devices has become pronounced and fashionable, and its use is steadily on the rise but rarely challenged to the point of examining animal ethics standards. Some of these gadget-driven field practices provide large-scale data sets and researchers can be assured to obtain them while waiting for downloads from satellite-provided data, sitting at the computer in an office, often without any further direct contact with the birds whose bodies and life space they invaded.

Such field practices, as will be explained further below, might urgently need updating and brought into line with our current understanding of animal welfare in cases when obvious, even if unintended, cruelty against birds (due to methods employed) can be shown [158]. This is so because some ecological field work consists of trapping and often fitting individual birds with GPS devices or similar technology attached to wings, the back or a leg, or even with invasive subcutaneous instruments [8].

The trend of attaching devices directly to the body of birds has been particularly evident over the last decade. The ease of use of such remote devices have made this technology very attractive. and their use has become so standard that these methods are often no longer elaborated on or defended in papers. Universities and journals have usually not questioned the technology as an ethical problem either, even though some of these devices are detrimental to the bird's health and survival, let alone raising questions about the validity of data. No questions are asked and no follow-up on survival of the individuals wearing these devices are usually available [14]. Researchers must be made aware that at least some of such devices are the most questionable and the most harmful way of collecting data [14][158].

In a recent review looking specifically at papers using modern geo backpacks in avian studies, more than 34,000 papers were identified using tracking devices, with an increase of its use on birds by 4.4% annually [14]. Hence this is not a marginal issue. The question is which data one can believe and this may well depend on how they are collected. Technology that may cause stress, possibly even chronic, and is responsible for well-documented damage of weight loss, reduced reproductive success and even death [8] is likely to produce data that are biased because of these negative health impacts.

Methodology thus really matters and may become a central concern in terms of the veracity of data that arise from such practice as will be discussed next.

Some pitfalls in the usability of data obtained via telemetry

There are a number of consequences that follow the installation of remote electronic devices directly on birds. Many mammalian species are also fitted with such devices but the focus here is on avian species.

One of the consequences, diametrically opposed to standard ethological field research, as briefly alluded to before, is relative anonymity of the birds. Once the device is attached, the researchers may not necessarily watch the tagged birds, may not see them interact at all, and presumably won't even get close to learning something about the dynamics of a pair or social groups, also precluding discoveries of surprising new foraging techniques, problem-solving or other cognitive behaviour useful for survival. Equally, a researcher would be unable to identify non-adaptive behaviour and, importantly, would not get to witness any short or long-term effects caused by such a device.

Second, the allure and attraction of such devices are that data are being generated and beamed back to the researcher's computer at regular interval. Producing large data sets is often highly encouraged because they suggest validity or representativeness of results. If there is a critique of this technology, it is often geared towards any problems with the equipment itself, not with the living organisms. Whether these concern GPS radiotelemetry error and bias in mountainous terrain [159], underestimating the frequency, strength and cost of antipredator responses with data from GPS collars [160], or simply the problems of inferring animal densities from such trackers [160][161]. Such debates are generally enjoyed and reveal the gadget-tinkering side of fieldwork.

But these practices hide heart-breaking stories. For instance, Dougill and colleagues reported on the consequences of antenna design in telemetry studies used on endangered Hawaiian honeycreepers, Palila (*Loxioides bailleui*) [162]. They had been radio-tagged with transmitters equipped with long, limp, solder-tipped antennas that keep moving over the back and close to the top of the head with every movement of the bird.

Consequences of carrying antennas were described in detail and one appreciates the honesty of the researchers [162]. The birds were found suspended in trees by their transmitter antenna on eight occasions and at least one bird died. This may not sound too dramatic. However, bearing in mind that reintroductions into the wild of endangered species always happen in relatively small numbers and that the birds take a long time to raise in captivity and prepare for release, such outcomes are lamentable. The authors recommended avoiding transmitters equipped with an antenna that can lead to entanglement and the birds literally hanging themselves.

This was not a singular event. The Puerto Rican parrot (*Amazona vittata*), one of the most critically endangered birds worldwide [163] was subjected to the very same equipment with a floppy antenna. The valuable individual birds had been hand-raised in suitable large cages, largely by local volunteers in the environment into which they would be released and when they had gone through all the proper pre-release stages (*i.e.*, also identifying edible food, etc.) the volunteers were then given this equipment by experts. More than likely, this last act before release would see the birds off not into freedom but into misery, pain, fear and even death.

One may argue that these are singular events and the ones described above happened a long time ago while technology has since improved markedly. This may be so, but evidence of serious harm to birds keeps accumulating, albeit for slightly different technical reasons. An even more anonymous form of research was conducted in the Bolivian Andes using endangered

red-fronted macaws, *Ara rubrogenys* [164], a project ironically conducted by a Centre for Nature Conservation. The birds were caught in nylon traps, then immediately fitted with satellite transmitters and let go. The weight of transmitters of 22.5g conformed with ethics regulations of a maximum weight of 5% or less of body weight (these were between 3.4% and 4.5% of the body mass and thus legal). Translated: for an average 80kg human male this percentage represents a weight between 2.72kg and 3.6kg. Permanently affixed to the body, this weight and bulk would even be difficult for humans. And this is not even considering flight, turbulence, drag and all the restrictive elements to flight that such a backpack may bring, discussed elsewhere [8]. Very clearly the welfare rules should change and be changed urgently.

As was shown so clearly even in a flightless bird, the endangered New Zealand rail (a tahake, *Porphyrio mantelli*) daily energy expenditure increased by 8.5% simply by carrying the radio tag. Because the researchers tested the effects, they were able to make appropriate changes to their program [158].

In another study, also an endangered species, the blue-throated macaw (*Ara glaucogularis*) in Barba Azul Nature Reserve (Beni, Bolivia), three individuals were released, fitted with Geotrak collars (also satellite telemetry) [165]. The researchers received dispersal data for two birds, until battery depletion in November and December 2019. It does not say whether the collars were ever removed or automatically fell off. One bird with a collar was spotted 2 years later, a torturous burden to bear for the bird - yet the paper celebrated the project as a victory because it helped them uncover a distant nest site [165]. The other two collar-bearing birds were never found and, as in so many other cases, one can surmise, unless otherwise stated, that they died as a consequence of the fitted apparatus.

Distorted results due to telemetry

A very useful study of golden eagles, *Aquila chrysaetos*, was conducted by McIntyre [166]. This study is very important within a discussion of what makes trustworthy data because this piece of field research compared two methods of bird retrieval markers and thus data collection post-release of 300 golden eagles. It concerned the dispersal patterns of these birds from inner Alaska to wintering ranges southwards.

The important part of his methodology was that the author used two different techniques for the same release project in a ten-year period and then compared the results of the two different identification methods. One was achieved via traditional leg banding, the other (48 eagles from the same group and origin) were given radio tags, that is, had backpacks with harnesses affixed to the back of their bodies.

The eagles that were recovered and had been fitted with traditional banding (see *Figure 5C*), lived long lives. If they met their death, it was due to being shot by hunters or to electrocution.

By contrast, the ones fitted with backpacks (see *Figure 4B*) suffered a 30% death rate and those deaths, after autopsies had been conducted, were identified as having been due to starvation. There are further hints that telemetry was the cause of their deaths: firstly, for backpack-wearing eagles, the flight distance covered from Alaska to their wintering quarters south fell substantially short (by hundreds of kilometres) of the group that had been traditionally banded [166]. Getting to the right wintering quarters is, of course, important for food supplies. The question is why did so many eagles die on the way?

Figure 4 *- A: Healthy wedge-tailed eagle (Photo credit G. Kaplan); B: adult wedge tailed eagle fitted with a backpack (secured by straps underneath the wings). It is easy to see how flight and flight speed can be impaired by this attachment (for details see Kaplan* 2022 [8])

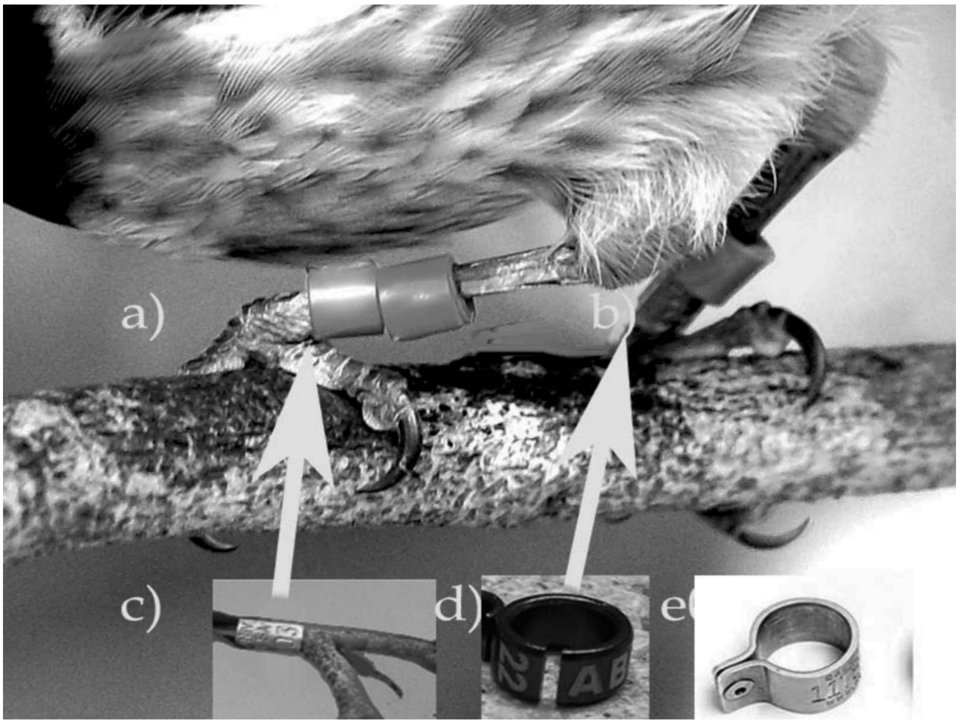

Figure 5 - Banding methods *- a, b: Songbird fitted with plastic rings of different colour, typically used in research projects to keep individuals and locations apart; c: traditional banding- well-fitted metal band with identifying numbers stamped into metal; d, e: different banding styles. The arrows refer to possible spots for chafing and inflammation due to movement and contact with foot. Constrictive injuries can occur if banding is too tightly fitted or inflammation leads to swelling.*

Aerial predators like golden eagles depend entirely on their aerial manoeuvrability and speed. The golden eagle is the fastest and most nimble raptor in North America, with top speeds reaching over 200km/h. There is plenty of evidence that telemetric devices affixed to the back create turbulence and resistance and thus slow down flight. Catching prey or not is often a matter of seconds, even milli-seconds, thus precise timing is essential. And, of course, the more often hunting attempts are unsuccessful, the weaker the raptor will become and the lower the chances of a successful kill. We know that eagles deal well with atmospheric turbulence during soaring flight by folding in their wings [167] but in the turbulences created by backpacks, no wing folding is going to remove or counteract the source of the turbulence. Further, the traditionally banded golden eagles stayed close to the road, while the radio-tagged birds stayed away for at least 5 km from the roads. Roads, with their occasional road-kills, can become an important source of food but the proximity to humans would have been avoided by the transmitter-fitted birds, if the birds were not confident of being able to take flight quickly.

The serious concerns that have been raised throughout this section concern the data produced. As McIntyre demonstrated so well, methodology affects and significantly changes results. Different banding or tracking tools produced very different outcomes [166]. Importantly, the distortions happened right across all measures-flight distance, proximity to roads and death rates. If one had been presented only with data from the radio-tracked individuals, the data would have been thoroughly misleading.

Ironically, many studies may use telemetry to investigate where the birds go and they may do so to use the data to argue for policy changes. They may want to identify migration stops and wintering grounds so that such locations may be declared sanctuaries. Since many field data are now collected with the explicit aim of ensuring the survival and protection of declining number of endangered birds, methodologies are not of small concern. To come back to the eagle study: what if, as in these golden eagle studies, the areas in which the tagged eagles landed and stayed (as wintering stops) were not the optimal areas to which the eagles would normally have gone? They went there only because they could go no further? There is no guarantee that the recorded terrain had good, let alone optimal conditions for their survival. Hence it is of great significance to address these possible data distortions in methodology sections and be clear on the least harmful ways of obtaining valid results prior to engaging in a research project.

Some scientists have now asked whether the data sets derived from telemetry may not lead to

a) poor outcomes for the birds being studied and

b) partly or entirely falsify the data, rendering it possibly useless or substantially flawed.

On both counts, there are justified reasons for doubt of the value of results. Even those birds that stayed alive despite their ordeal, may have been forced to choose very different courses of action than had they been healthy and pain-free [162]. When in pain or fearful, very different and often poor decisions may be made as researchers well know [158] and as the golden eagle study by McIntyre so well exemplified [166].

The review by Geen and colleagues, mentioned before [14], drew attention to these confounding problems for two main reasons: to support more rigorous science and to improve or even just introduce rules for avian welfare in fieldwork [14]. Here, the emphasis was on data collection which does not minimise the message that more compassionate and benign research methods need to be considered or, the technology so changed or improved (and time-limited) that it can be shown to reduce or do no harm.

At the other end of the debate are cases of some singular events, seen just once or twice in the field, which the observing researcher considered extraordinary and revealing in terms of either problem-solving or general cognitive abilities. Such events and moments are certainly not well-described as 'anecdotal' because they are significant observations. In other words, some significant observations tend not to get published while others, despite large data sets, may be highly misleading. In either case, some adjustments in thinking about animals and in ethical and journal publishing rules could probably improve the situation.

CONCLUDING REMARKS

Those who still believe that a bit of telemetry or other invasive procedures carried out in the field constitute brief encounters that do no harm, be this to the individual bird or to the data set, are incorrect. Humans have created fear with "*landscape-scale impacts from lions to mice*" [168]. They are recognisably the apex predators and invaders [169]. Invasive and aggressive interventions by humans can lead to the collapse of entire niche structures and species co-existence [170]. With dangerous humans nearby, predators have even been shown to increase their prey-capturing rate [171].

Researchers have pleaded for years to look more closely at methods in field research, arguing that sound science requires animal subjects to be physically, physiologically, and behaviourally unharmed [164] and that more compassionate wildlife research [172] should move from invasive to non-invasive methods [172][173].

The days of relatively non-invasive ethological field research methods are dangerously close to going extinct and, at this time of species decline, this development is going in a direction opposite to that needed. We need intimate knowledge of bird behaviour as much as we need to understand their macro-movements in their natural environment without prejudice and distorting factors. We need also more compassion and perspective-taking: what may be easy for researchers to do (pluck individuals from their daily lives and subject them to painful or long-term damaging memories), is not in the spirit of the explicit goals of wildlife and conservation research. Just because we can do something, does not mean we are entitled morally to do it [172][173][174].

The survival of species does not just relate to habitat and other macro-problems such as humans, but is reflected in individual behaviour, on the support by conspecifics and their communities, as well as attributable to external influences that we may not have considered. The choices birds make ultimately depend on the sum-total of experiences, the management of emotions and cognition [175].

The point is that the instigators of field research that may have brought about any such harm, even if only just going to nest sites and taking some eggs, then walk away [176] do not see what behaviour follows. The data then collected, however, reflect the post-manipulation phase of behaviour and it may not be at all what an individual, pair or group might have done without such intervention.

In summary, there is plenty of scientific evidence now that we, as a species and as researchers, have had a detrimental effect on birds and on wild animals in general. Further, the mega-data obtained from technologically advanced equipment may not deliver the same results a healthy, fearless and free bird would yield. Indeed, the problem of the 'ecology of fear'[108][109][110] a well-known concept, has been magnified by the exponential growth, even explosion, of human populations in just 100 years (a more than seven-fold increase). Recent papers have clearly shown that animals' fear of humans now far exceeds the fear they have of large carnivores [169], perhaps a shocking finding but one that should not surprise, given how much damage we have done to the environment and to wildlife. Ignoring this dimension in field research, especially in one's methods and approach to wildlife, is a luxury we can ill afford in the Anthropocene. One barely needs to be reminded that the living world is a dynamic interaction between organisms and that humans have played and play a very significant, and an increasingly overwhelming negative role in this mass extinction of life forms.

The welfare aspects aside, covered in detail elsewhere [8], the emphasis in this paper has been on the quality and trustworthiness of data generated often under unknown and presumed stressful conditions of the subjects. It has also been argued that cognition research may, on occasion, have overinterpreted the results. Bernstein had formulated a powerful dictum for good research, condemned rare behaviour as anecdotes and said that "*the plural of anecdote is not data*" [177]. For fieldwork, this can be a requirement that cannot be met because, ironically, going by this rule could wipe out any observations in the natural environment not part of an experiment. And that is a ridiculous restriction for fieldwork. Most of Jane Goodall's observations and insights into chimpanzee behaviour would have had to be eliminated. In cognitive behaviour observed in the wild, there are many occasions when one observation of one particular behaviour, or suite of behaviour, is all one will ever see in one's research life and possibly in the bird's or even species' life.

Some special observations can and should make one data point and each new one may eventually create an ethogram of an individual, a group or even of a species. While this can be a laborious process, rare behaviour does not necessarily equate 'anecdotal', and use of gadgets as shortcuts, however technologically attractive and accurate in what they measure, are not always the best way to do and produce good science. Being burdened with backpacks may do the very opposite of what we need: we need good data, meaning trustworthy data not behaviour produced under duress and extreme stress. Rare behaviour observed and noted in fieldwork ought to be seen as a discovery and remain so if no follow-up experiments can be logically devised to confirm the event.

Recently, an interesting article argued that perhaps we are not as rational as we wish we were and not all decisions and behaviours when we study other species are always rational, objective or permanent. Yong et al. doubted that we were incorruptibly 'rational' but argued that we are the most 'rationalising' species [178]. However, even if one cannot solve the problem of what motivated an animal or a bird in some of its actions and behaviours, it seems that by quiet and non-assertive respectful human behaviour vis à vis the subjects of study and believing, even without irrefutable evidence, that they might be explicable reasons for their behaviour, good behavioural data can be secured that might otherwise not be discovered.

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