The art of chicken sexing[*]

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Abstract

Expert chick sexers are able to quickly and reliably determine the sex of day-old chicks on the basis of very subtle perceptual cues. They claim that in many cases they have no idea how they make their decisions. They just look at the rear end of a chick, and 'see' that it is either male or female. This is somewhat reminiscent of those expert chess players, often cited in the psychological literature, who can just 'see' what the next move should be; similar claims have been made for expert wine tasters and experts at medical diagnosis. All of these skills are hard-earned and not accessible to introspection.

But is there really anything unusual about the chicken sexer, the chess grand master, the wine buff or the medical expert? I argue that there is not. In fact, we are all constantly making categorizations of this sort: we are highly accurate at categorizing natural kinds, substances, artefacts, and so on. We do so quickly and subconsciously, and the process is completely inaccessible to introspection. The question is, why is it so difficult to acquire skills such as chicken sexing, when we automatically acquire the ability to categorize other objects. In this paper, I argue that we have mechanisms for learning the cues necessary for categorization, but that these mechanisms require selective attention to be given to the relevant features. We automatically acquire the ability to categorize certain objects because we have inbuilt attention directors causing us to attend to diagnostic cues. In cases such as chicken sexing, where we do not automatically develop categorization abilities, our inbuilt attention directors do not cause us to attend to diagnostic cues, and out attention therefore has to be drawn to these cues in another way, such as through training.

I

> *…great reading even for those not interested in chick sexing: the simple philosophy expounded in the book applies to success in all walks of life.*
> —Marlene Bernal (review of R. D. Martin's *The Specialist Chick Sexer*)

It's a little-known fact that the world's best chicken sexers come almost exclusively from Japan. Poultry owners once had to wait until chicks were five to six weeks old before differentiating male from female (the sex became visible when adult feathers started appearing, on the basis of which cockerels and pullets could easily be

[*] I would like to thank Deirdre Wilson for her valuable comments on this paper, and for first suggesting chicken sexing as a potential avenue for investigation.

distinguished). But for commercial egg producers it's important to identify the females as soon as possible, to avoid unnecessary feeding of unproductive male chicks. Enter the Zen-Nippon Chick Sexing School, which began two-year courses training people to accurately discriminate the sex of day-old chicks on the basis of very subtle cues.

If you ask the expert chicken sexers themselves, they'll tell you that in many cases they have no idea how they make their decisions. They just look at the rear end of a chick, and 'see' that it is either male or female. This is somewhat reminiscent of those expert chess players, often cited in the psychological literature, who can just 'see' what the next move should be; expert wine tasters, who have the uncanny ability to identify wines and vintages; and medical experts who can diagnose diseases on the basis of subtle information.[1] All of these skills are hard-earned and not accessible to introspection.

In some cases, we can learn to discriminate objects on the basis of casual exposure to instances. No doubt we learn to identify dogs, cats, our friends and relations, chairs and water in this way. In other cases, no amount of exposure seems to do the trick. Humans have been farming poultry for millennia, and have needed to determine the sex of chicks as early as possible,[2] but it was only in the 1920s that a perceptual basis for such a discrimination was discovered, and then passed on through explicit training (examples of rare or confusing configurations are shown and discussed, and diagnostic cues are explicitly pointed out).

So on the one hand there are situations where we automatically develop the ability to discriminate complex objects. On the other, there are situations where we are unable to develop such abilities, regardless of how much exposure we have. There are also cases between these two extremes: that is, cases where we do develop some ability to recognize objects after exposure to instances, but we generally lack speed and/or accuracy.

Consider the case of soldiers who must learn to distinguish friend from foe in battle. Clearly, such discriminations need to be fast and accurate, and must often be based on a degraded stimulus (a tank glimpsed briefly through trees; a fast-moving aircraft seen in the distance). The task is made more difficult by the fact that a large number of sometimes very similar stimuli need to be discriminated. Subjects do develop some ability to discriminate different tanks and aircraft just from exposure to instances, but these skills can be significantly improved through explicit training.

The need for rapid aircraft identification first became vital during the second world war. As Allan (1958) discusses, formal training was first given in Britain in

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[1] For a review of the psychological literature on such expert abilities, see Ericsson & Lehmann (1996).

[2] Female poultry are preferred for a number of reasons. Not only are male birds of no use to egg producers, they also produce lower quality meat in most species, and can be very disruptive.

1940, prompted by the threat of imminent invasion. Expert 'spotters'—aircraft enthusiasts who had a high level of skill in aircraft differentiation—did exist, but there were too few of them. Training centres were therefore set up, but the problem was that the experts had no idea how they had acquired their skills in the first place, or how to transmit those skills to others. Training regimens therefore had to be developed somewhat by trial-and-error.

The difficulty that untrained subjects have with tasks such as aircraft identification suggests that the special-purpose mechanisms which evolved for similar tasks (face recognition, animal kind classification, and so on) are not of much help in these cases. To improve speed and accuracy, current training methods involve soldiers being given specific instruction to attend to certain highly diagnostic cues.[3] Notice that this is different from the chicken sexing case, where untrained subjects have no discriminatory ability, since there are no obvious differences between male and female chicks.[4]

Another interesting case is bird-watching. This presents similar challenges to tank/aircraft identification, though for different reasons. Bird-watchers need to make quick and accurate identifications on the basis of often impoverished information. Many birds look alike, at least to the untrained eye (many are small and brown, for example). Birds are often timid, and therefore difficult to see. They also move about a lot, so when they are in sight, a quick identification is desirable. And bird-watching is very popular, so lots of people try to develop bird identification skills.

While some ability to recognise different birds does develop from casual exposure, as with tank/aircraft identification explicit instruction is required in order to develop the ability to identify a large number of species quickly, often on the basis of brief and/or distant sightings. Such instruction is widely available in the form of bird books, which point out the features that are diagnostic of particular species.

One feature of expert chicken sexing that has attracted the interest of philosophers (e.g. Brandom 1998) and psychologists (e.g. Harnad 1996) is that the chicken sexers report that in many cases they do not know on what basis they make their discriminations: '*To be close to 100 per cent accurate at 800 to 1200 chickens per hour for a long day, intuition comes in to play in many of your decisions, even if you are not consciously aware of it. As one of my former colleagues said to*

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[3] For more detailed discussion of these matters in relation to identification of aircraft see Allan 1958, Goettl 1996, and Ashworth & Dror 2000; for tanks see Biederman & Shiffrar 1987.

[4] In fact, Biederman & Shiffrar (1987) report that untrained subjects perform slightly better than chance at chicken sexing, probably because they interpreted a prominent bead as an indication that the chick was male. Although this is not an accurate diagnostic, there is a weak statistical correlation.

me…'There was nothing there but I knew it was a cockerel'. This was intuition at work.'[5] This is interesting to philosophers because it appears to be a case of knowledge in the absence of (rational) justification. It is interesting to psychologists because it is a capacity which, although learned, appears not to be accessible to introspection. A similar feature has been reported with aircraft identification, as mentioned above.

Experienced bird-watchers develop similar skills. After a great deal of practice, many bird-watchers can identify a bird by the 'way it looks', even when the bird is glimpsed too briefly, or is too far away, to allow individual features to be identified. They even have a name for this brute property, which they call the bird's 'jizz'. This skill takes some time and effort to develop, and is similar to chicken sexing in that birdwatchers perceive the jizz as a gestalt, but cannot say what the features are that make up the whole. Although identifications made on the basis of jizz are reliable, they are generally regarded by bird-watchers as requiring some objective verification.[6]

There is nothing particularly unusual about these abilities from a psychological point of view. Granted, it takes people a lot of time and effort to learn to identify birds by jizz or reliably sex chicks, they are highly accurate, can generally reach a decision quickly (in the case of chicken sexers, at the rate of over 1000 chicks per hour) and do so subconsciously. In fact, though, we are all constantly making categorizations of this sort: we are highly accurate at categorizing many natural kinds, substances, artefacts, and so on. We do so quickly and subconsciously, and the process is completely inaccessible to introspection (on what basis do you decide to classify something as a chair or as a tiger, for example?).

If chicken sexers, bird-watchers and plane spotters have developed detection abilities in their particular fields of the same kind that all humans employ to detect many animal kinds, faces, artefacts, and so on, then the various features of these skills that have been reported are exactly what would be expected. When we identify everyday objects and kinds, the nature of the process employed, and the various features that we make use of, are completely inaccessible to introspection. Our detection abilities are also fast and accurate, and usually a briefly presented or

[5] Quotation from R. D. Martin, 'Discipline – intuition – focus: All by products of accurate chick sexing', <http://www.bernalpublishing.com/aboutthebook/discipline.shtml>. Page accessed 26 March 2002.

[6] One cautionary tale concerns a wader that was spotted in the distance by some bird-watchers, and which had an unusual jizz that none of them recognised. Word spread, and soon a large number of people had gathered to catch sight of the bird, which stubbornly remained too far away to allow a positive identification. Eventually, the bird landed close to the hide, and showed itself to be a very common species that was missing its tail. (Thanks to Gary Allport of BirdLife International for this anecdote, as well as a very interesting conversation on 'jizz'.)

partially occluded object can still be identified. These are precisely the cluster of properties that have been reported for expert detectors in the various domains we have looked at.

The interesting question is then why it is so difficult to acquire these expert skills, and through what process they are acquired. In this regard, it is instructive to consider the processes involved in everyday object categorization.

II

While I, no doubt, have learnt something extra about chick sexing, I was also reminded that man's abilities are limited only by his thinking.
—R. D. Martin in his epilogue to *The Specialist Chick Sexer*

In this paper, I would like to focus on one rather novel explanation for our object categorization capabilities, put forward by Berretty et al. 1999 within Gerd Gigerenzer's 'fast and frugal heuristics' framework. This framework postulates simple rules that allow us to make accurate decisions under time pressure. Berretty et al. contrast two different kinds of categorization, using the following example. First, we are invited to consider the hiker who comes across a bird while walking in the alps. In trying to identify the bird, the hiker takes out their bird book and uses a number of features of the bird (cues) to correctly identify it. Second, we are asked to consider the rabbit, who has a far more limited aim when it sees a bird: identify it as predator or non-predator, as quickly as possible.

The basic point is that since its survival is at stake, the rabbit does not have the luxury of adopting a strategy of the kind used by the hiker—considering a relatively large number of cues, some possibly redundant, to come to an accurate identification. In particular, the rabbit needs to come to a decision on whether the bird is a predator as quickly as possible, and will therefore want to use the smallest possible number of cues. It will also want to stop the identification process as soon as a decision can be reached, rather than making use of all available cues. Humans also need to make similar quick judgements in many circumstances.

Berretty et al. suggest a categorization procedure which they term 'categorization by elimination'. Cues are accessed sequentially in a pre-determined order, and each cue eliminates candidates from the set of possible categories for an object (initially, this is the set of all categories). When only one category remains, the procedure stops, and the object is assigned to this category. In the case where all cues are exhausted, and more than one possible category remains, a random assignment is made.

Cue order has a large impact on how effective the categorization procedure is, and it is therefore vital for organisms to be able to consider cues in the most effective order. Berretty et al. propose that cues may be ordered by determining their effectiveness when used alone. More effective cues are then ranked higher than less effective cues. This implies that the same cue order is used for all objects in a particular domain.

There are several ways in which cues and cue orders can be acquired. Gigerenzer & Goldstein (1999: 92) suggest three different ways: genetic coding, cultural transmission, and direct observation. These possibilities will be considered in more detail in the next section.

Let us now consider how we might apply this framework to the kinds of expert classification we have been considering.

III

If I went for more than four days without chick sexing work I started to have 'withdrawal symptoms'. Several of my students have expressed the same feeling when they have not sexed chickens for a week or so.
— R. D. Martin, author of *The Specialist Chick Sexer*

There might appear to be a problem with applying this kind of 'fast and frugal heuristics' approach to the kinds of phenomena we have been looking at. In the cases we have mentioned, expert categorization seemed to be a gestalt phenomenon, rather than being based on individual features.

There are two distinct possibilities. It may be that expert categorization is a truly gestalt phenomenon which cannot be broken down into the recognition of particular features. Alternatively, it may be that expert categorization does take place as a result of the recognition of specific features, but that since the process is not accessible to introspection, we are not aware that categorization is feature-based.

The evidence seems to point to the latter possibility. First, it would be surprising if we had (or could develop) a truly gestalt categorization ability in respect of complex objects under poor viewing conditions. It is likely that we detect lines of various orientations, edges, points, small numerosities (by subitizing), and so on directly (i.e. by gestalt). In many of these cases, this is because we have specific neurons or neurophysiological structures dedicated to such detection. It is not wildly implausible to suppose that we might also be able to detect some animal kinds in certain situations on the basis of a single feature, general shape. This might also qualify as a gestalt process. But it seems unlikely that any gestalt process could be involved in categorization of fast-moving aircraft seen in the distance, briefly glimpsed birds, or complex configurations of chick genitalia.

More compelling than appeals to intuitive plausibility, however, is the strong evidence that recognition/categorization in other domains is achieved on the basis of features, even though the process appears to introspection to be a gestalt one. Consider visual word recognition (Rayner et al. 2002). Reading is a difficult skill to acquire, and one that humans do not have an innate predisposition for. For accomplished readers, however, the process is fast, accurate, and subconscious—that is, we are not aware while reading of the actual process involved in converting the visual stimuli into meanings. In fact, most people have the impression that they recognise whole words at a glance, rather than having to sound them out.

It is this impression that forms the basis for the 'whole-word' (or 'whole language' in its more recent incarnation) approach to the teaching of reading. On this approach, children learn by rote how to recognise at a glance a basic vocabulary of words. They then gradually acquire new words through seeing them used in the context of a story. This is in contrast to phonics, the other main approach to reading instruction, which explicitly teaches the connections between letters and phonemes (including exceptions to the standard rules).

Experiments suggest strongly, however, that this basic premise of the whole-word approach is false. In a series of experiments, Van Orden (1987) and Van Orden et al. (1988) began by asking subjects a question, such as 'Is it a flower?'. The subject was then presented visually with a word (e.g. 'rose') and had to indicate whether the word fit the category. Sometimes, subjects were offered a homophone (either a word or a non-word), such as 'rows'. Subjects often mistakenly identified such words as fitting the category, providing evidence that readers routinely convert strings of letters to phonological representations, which they then use to access semantic information for the lexical item.

Reviews of the literature comparing the effectiveness of phonics with that of whole-word instruction (such as those reported in Rayner et al. 2002) indicate that while most children will learn the connection between letters and phonemes without explicit instruction, through exposure to text, the explicit teaching of these principles is far more effective.

In the case of word recognition, the individual letters or letter combinations can be seen as cues. Although people are not aware that they make use of these cues (except possibly when sounding out a novel word), words are regularly recognised on the basis of their spelling, rather than being recognised as a gestalt (for example, by pattern-matching of the whole word). People lack awareness of this process because it is not accessible to introspection.

In fact, the parallels between reading and some of the skills we considered earlier (such as friend-or-foe discrimination and bird-watching) are striking. In reading, as with these other skills, some ability may develop without explicit instruction as to which cues to make use of. This ability is significantly enhanced, however, through explicit instruction which draws attention to diagnostic cues. With reading, as with these other skills, the process becomes subconscious once proficiency is attained. Moreover, reading is a process that is amenable to systematic psychological investigation (for example, the cues—or letters—are discrete and may be varied systematically).

The moral seems to be that even automatic categorization processes that appear to introspection to be based on gestalt properties are in fact based on discrete cues. So whether we are trying to identify a bird with a bird book using a conscious process we are fully aware of, or we are quickly and automatically identifying an animal as a dog using an unconscious process we have no access to, we are doing so on the basis of individual cues.

So how does one actually become an expert chicken sexer (or plane spotter, or bird-watcher, or whatever)? As Berretty et al. (1999) have shown, the order in which cues are employed is key to the speed and efficiency of the process. This suggests two possibilities open to the would-be expert: acquire new cues, or acquire a new ordering for your existing cues. But this is not enough by itself. The explicit learning of new cues (for example, being told that the marsh tit can be distinguished from the almost-identical willow tit by the absence of a distinct wing patch) may improve a person's expertise and perhaps their speed at identification, but this does not in itself make the process subconscious. The person still has conscious access to the cues that they are using. This suggests that there is more to becoming an expert than the explicit learning of cues.

As mentioned in the previous section, Gigerenzer & Goldstein (1999: 92) suggest three different ways for acquiring new cues: genetic coding, cultural transmission, and direct observation. Let us consider each of these possibilities in turn.

Evolution could give rise to the genetic coding of cues (psychologically or neurophysiologically, for example), or a predisposition to learn cues. Such an account has been proposed for the visual cues used in distance perception. This suggests that not only might we be innately disposed to use specific cues, we may also be endowed with mechanisms that allow us to acquire further cues.

Clearly, cultural transmission can also play a role in the acquisition of cues. This could be through apprenticeship, education, or other forms of knowledge transfer (such as bird books or plane-spotting guides). We can learn facts about which cues are diagnostic in a particular domain, just as we can learn facts of many other kinds.

Lastly, we could also learn cues by direct observation. Given exposure to enough instances, we could presumably learn merely by observing, in a fully conscious way, that marsh tits and willow tits can be distinguished on the basis of whether they have a distinct wing patch, for example. Those pioneering Japanese chicken sexers presumably acquired their skills in this way. Sushi chefs also famously learn their abilities purely from observation (see de Waal 2001).

Cues acquired through cultural transmission or direct (i.e. conscious) observation are presumably accessible to consciousness. If we are taught the 'wing patch' cue for distinguishing marsh tits from willow tits, or we read this in a book, or learn it from direct observation, then when we use it to distinguish the two kinds of bird, we are consciously aware of the cue we are using. This suggests that the cues used by experts when they make fast, unconscious categorizations must be those that are acquired via subconscious (and presumably innate) mechanisms.

If this is correct, then it would seem to imply that learning by cultural transmission or by direct observation is not necessary for acquiring the fast, subconscious categorization abilities of experts. But in fact these kinds of learning do appear to be necessary to acquire these skills, or at least to facilitate them to a significant degree: people do not spontaneously become expert chicken sexers, or spontaneously acquire the ability to categorize birds by their jizz. Some training or at least a great deal of direct observation appears to be necessary.

An understanding of the way in which our innate mechanisms of cue acquisition work is crucial here. The evidence that we have such mechanisms comes from various lines of research. The first is 'causal cognition' (Sperber et al. 1995), the capacity that humans and other animals have for detecting causal relations and making causal inferences. It has been shown in many animals that contiguous events, when they co-occur many times, are assumed to be causally related (i.e. if the first event occurs again in the future, it is assumed that the second will also occur). This is known as 'weak causal knowledge' since it is restricted to effects that immediately follow their causes and is unaided by any expectations about the kinds of events that are likely to be causally related. The need for many repetitions reduces the number of accidental correlations that are learned.

A second line of research relevant to mechanisms of cue acquisition is that on implicit learning (Lewicki et al. 1992; Cleeremans et al. 2000). This is where learning takes place in the absence of conscious awareness on the part of the learner that it has done so or of conscious access to what has been learned. In particular, there is considerable evidence which suggests that the human cognitive system can nonconsciously detect and process information about covariations between features or events in the environment. It has been proposed that such implicit learning goes beyond mere associative learning to include learning of rule-governed regularities. Interestingly, experiments conducted by Jiang & Chun (2001) suggest that implicit learning takes place only when relevant, predictive information is selectively attended.

Implicit learning of cues, then, may require both repeated exposures and selective attention. This could explain why cultural transmission and/or direct (conscious) observation are required for experts to acquire their fast, subconscious categorization abilities. Cultural transmission and direct observation fulfil both these criteria: they lead to repeated exposure to relevant stimuli, and they also serve to direct attention to relevant, predictive cues which would not otherwise be attended to. This allows our unconscious learning processes to acquire diagnostic cues.

We started by looking at a range of cases of categorization. We noted that in certain cases we automatically develop the ability to discriminate complex objects (faces, animal kinds, and so on). The reason that we automatically develop such abilities is that the relevant diagnostic cues, or a predisposition to acquire them, is built in. This predisposition could take the form of attention directors that allow automatic mechanisms to acquire the cues.

In other cases, we automatically develop some ability to discriminate objects, but this ability can be further enhanced with training or detailed observation. This is the case, for example, in tank and aircraft recognition, bird-watching, and so on. In such cases, our built-in cues, or those cues we are predisposed to acquire, do aid in discrimination. Other more highly diagnostic cues are available, but these are neither built in, nor do we have a predisposition to acquire them. This could be because our attention is not naturally drawn to these cues. Training which draws attention to these cues will serve to direct our attention to them, and will allow automatic mechanisms to acquire these cues. Detailed observation can also result in our learning the diagnostic cues, which will also serve to direct attention to them.

Finally, we looked at cases where we do not automatically develop any ability to discriminate objects. This is the situation with chicken sexing. In such cases neither our built-in cues, nor our predispositions to acquire cues, provide any aid in discriminating the objects in question. We require training, or a great deal of detailed observation, in order for us to notice the relevant features, and thereby allow our unconscious mechanisms to acquire the diagnostic cues.

This explains why, even though the cue acquisition processes are automatic and subconscious, it takes a great deal of time, effort, and often explicit training for people to develop expert categorization abilities in many domains.

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