
Musical Nature: Vocalisations of the Australian Magpie (*Gymnorhina tibicen tyrannica*)*

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There is currently contentious debate over the presence and extent of music-making in the wider animal kingdom.¹ The question of the exclusivity of musical activity to *Homo sapiens* (humans) has long prompted fierce philosophical debates. Music and the process of music making touches the core of what is commonly considered to be our humanity. The ability to appreciate musical aesthetics, be moved to complex emotions and to structure a form of leisure that requires excessive time and effort with no explicit survival benefit has long been regarded as a trait of 'higher' human intelligence. Yet is music solely the domain of humanity or do other species also participate in complex behaviour which could be described as music making?

Animal music-making is problematic for the evolutionary biology paradigm. Evolutionary biology centres around the idea of survival of the fittest. Every positive adaptation must provide survival benefit. Music making requires excessive energy, can advertise an individuals' presence to potential predators and apparently has no direct survival benefit. Yet this trait seems to be a homoplasy, that is, a trait that has evolved multiple times, most notably in *Homo sapiens* (humans), *Cetaceans* (dolphins and whales), *Hylobates* (gibbons), *Anura* (frogs and toads), *Chiroptera* (bats) and a multitude of *Passeriformes* (perching birds).

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¹ See Nils L. Wallin, Bjrn Merker and Steven Brown, eds, *The Origins of Music* (Cambridge, MA.: MIT Press, 2000); Donald E. Kroodsma and Edward H. Miller, eds, *Ecology and Evolution of Acoustic Communication in Birds* (Ithaca, NY: Comstock Publishing, 1996); Clive K. Catchpole, *Bird Song: Biological Themes and Variation* (Cambridge: CUP, 1995); C.H. Greenwalt, *Bird Song: Acoustics and Physiology* (Washington: Smithsonian Institute Press, 1968).

This article is based on an exploration of a single facet of the complex world of animal vocal communication, the musicality of birdsong. This field-based study will examine the unique behavioural traits associated with solo vocalisations or sub-songs in the Australian Magpie (*Gymnorhina tibicen tyrannica*). Utilising a combination of observational research, audio-recordings and playback I hope to elicit a greater understanding of the Magpie sub-song, and discuss its location in the sphere of music.

The Australian Magpie (*Gymnorhina tibicen*) is an endemic Australian passerine.² It is a largely sedentary bird, which occupies permanent year-round territories. Magpies live in large co-operative groups ranging in size from two birds up to twenty birds.³ The sub-species *Gymnorhina tibicen tyrannica* is found on the southeastern coast of Australia, primarily in the state of Victoria. Most tribes consist of one breeding pair and several helper birds, who give up the right to breed in return for highly productive territory.

The Australian Magpie is sexually dimorphic, with males ranging up to 44 cm in length.⁴ It is possible to distinguish between adult males and females, as females have a grey back, whilst adult males have a white back. Juvenile birds are harder to classify as both sexes have mottled grey feathers until they reach approximately three years of age.⁵

The Australian Magpie is an ideal candidate for biomusicological research due to its wide repertoire of vocalisations including complex antiphonal duetting, solo warbles and sub-songs. The primary focus of study is the solo song or warble vocalisation with a minor analysis of other prevalent vocalisation practices. The aim of this research is to examine the functionality and demographic frequency and distribution of Magpie warbles, to determine whether Australian Magpie warbles can be considered a form of functional music making.

Field research was undertaken on Australian Magpies (*Gymnorhina tibicen tyrannica*) found in suburban Melbourne and country Victoria. Utilising playback techniques, observations were made with regard to the physical and vocal responses elicited by a series of traditional warbles. Observational data and recordings of the everyday vocalisation practices of *G. t. tyrannica* were also collected.⁶

To ensure a broad spectrum of Australian Magpie behaviour with an opportunity for statistical analysis, playback and observation was undertaken on 120 birds found in a variety of social groupings including tribes and pair bonded birds and in rural and urban environments. The experiment also examined male and female birds at varying stages of development. Only wild Magpies were used for these experiments.

In order to collect a wide and varied sample of vocalisations, six locations were chosen

² Richard Schodde and I.J. Mason, *The Directory of Australian Birds: Passerine* (Melbourne: CSIRO Publishing 1999).

³ A. Robinson, 'The Annual Reproductive Cycle of the Magpie, *Gymnorhina dorsalis* Campbell, in South Western Australia,' *Emu* 56 (1956): 233–36.

⁴ Ken Simpson and Nicholas Day, *Field Guide to Birds of Australia 'Simpson and Day'* (Giraween, NSW: Penguin, 1992).

⁵ Kate Durrant, *The Genetic and Social Mating System of the White Backed population of the Australian Magpie (*Gymnorhina tibicen tyrannica*)*, PhD thesis, Australian School of Environmental Studies, Faculty of Environmental Studies, Griffith University, 2004.

⁶ All recordings for this research were collected on a Marantz PMD660 Portable solid-state recorder. All graphical analyses of vocalisations were created utilising the *Raven* 1.2 software analysis program. All recordings and field observations were made between July and October 2006 (Winter and Spring).

across Victoria for observation and recording. These locations were equally divided between metropolitan and rural sites and each location provided a unique ecological setting. In each location, either three or four Magpie tribes were observed.

The first region, based around the inner city suburb of Port Melbourne, displayed birds living in a high-density urban environment. The second urban sampling region was in Royal Park, Parkville, where there appeared to be communal occupation of a fertile hunting ground by several co-operatively melded groups. The final urban sampling location was on the grounds of La Trobe University, a suburban university campus, which backs on to light bushland.

Country recordings were spread across Victoria, to allow for geographic variation. The majority of recordings were obtained on and around Lake Natimuk, in northwest Victoria. Magpies were also observed on Phillip Island and in the Little Desert National Park. The Little Desert birds represent the most extreme end of wild/rural Magpies due to their remote location, removed from significant human and intraspecific interaction.

The study showed that the vocalisations of the Australian Magpie can be divided into three main categories. The first of these contains general communicatory signals (possibly phonocoding). These vocalisations are generally more guttural in sound and last for between two and five seconds.

The second category of vocalisation practices is the ensemble vocalisations typified by the dawn and dusk choruses. These types of vocalisations are generally performed by all Magpies in the area. They are more melodious in sound and are generally performed either as a unison chorus or in call and response fashion. Ensemble vocalisations are performed at fairly high amplitudes to assist in long distance transmission. These choral songs generally last for between one and five minutes. At dawn, however, they can last upward of an hour.

The third group of vocalisations found in the repertoire of Australian Magpies is the solo song or warble. These vocalisations are also highly melodious, with the line involving countless melismatic phrases and ornamentations. Songs are generally performed alone, or on rare occasions as a duet, and are sung at fairly low amplitude to reduce transmission range. Though solo songs and warbles can last for upwards of an hour, they generally are around ten minutes in length.

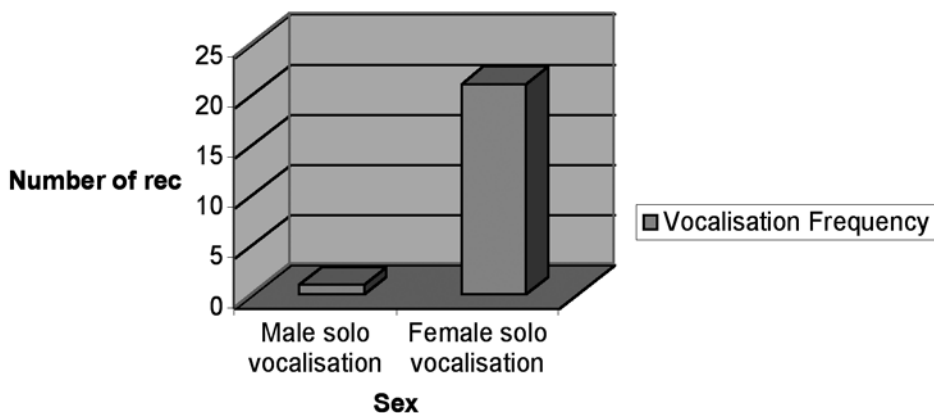
Historically, sexuality has played an extremely important role in the study of birdsong. Since the earliest studies into bird song, sexual selection has presented an attractive reason for elaborate vocalisations by various bird species. In the northern hemisphere temperate zones, where the majority of research has been undertaken, birdsong is largely restricted to male birds during a brief breeding season when they establish a temporary territory in order to attract a female companion before migrating. Yet studies of tropical birds often break the vocal stereotypes established by northern hemisphere temperate species. Morton, in his treatise into the vocal behaviour of neotropical birds, found that 'song is not highly correlated with pairing and reproduction,' and that 'singing and territorial defence are not entirely or even largely, male behaviours.'⁷ He claims that year round territoriality causes sexual roles to converge, thus allowing females to adopt male singing behaviour. Morton also signals that

⁷ E.S. Morton, 'A Comparison of Vocal Behaviour among Tropical and Temperate Passerine Birds,' *Ecology and Evolution of Acoustic Communication in Birds*, ed. D.E. Kroodsma and E.H. Miller (Ithaca, NY: Comstock Publishing, 1996) 258–59.

the generally socially monogamous breeding system of tropical passerines removes the need for male birds to attract mates through elaborate vocal displays. *Gymnorhina tibicen tyrannica* appears to fit the model of a communal tropical passerine, living in the southern hemisphere temperate region.

The field research demonstrated that the first determining factor in the frequency of singing is sex. Observations demonstrated a stunning disparity between the frequency of singing in males and females. Of the recorded material collected only two of the twenty-three adult recordings were performed by male birds; of these two, only one conformed to general solo singing behavioural norms. The second male recording appeared to be a long distance territorial conversation, as a fight ensued less than one minute into the vocalisation. Statistically male birds performed less than 5% of solo vocalisations, with females participating in more than 95% of solo vocalisation performances, as shown in Figure 1.

Figure 1. Difference in vocalisation frequency between male and female Magpies



The sex of juvenile singers was unable to be included in this figure as visually it is impossible to determine the sex of juvenile birds less than three years of age.

Though age did not appear to impact on the frequency of vocalisations, it did have a noticeable effect on the behavioural norms exhibited by vocalising Magpies. Adult Magpies sing from arboreal perches of varying heights (possibly to increase transmission or to allow for the observation of the area for predators or other Magpies), but will rarely if ever sing from on the ground. Adult female Magpies multitask whilst vocalising by actively grooming and cleaning their beak and wings between vocal phrases. Adult female Magpies are also highly sensitive to invasion of their personal vocal space by other Magpies and will immediately cease singing if their space is invaded. They are impartial, however, to the presence of other species of birds: on several occasions adult Magpies were observed singing with a Yellow Wattlebird (*Anthochaera paradoxa*) sitting on the same branch. Females will participate in vocalisation activity whilst other members of the tribal group continue to forage, out of hearing but within visual contact range.

Juveniles on the other hand can often be observed vocalising on the ground whilst foraging. They also appear indifferent to other Magpies occupying their vocal space. Often juveniles will perform solo warbles as a vocal duet whilst actively exhibiting the behaviours and vocal

techniques associated with solo vocalisations. There is an interesting transference between homophony and polyphony and blending of vocal improvisation in juvenile vocalisations.

Tribe demographic also appears to have an effect on the frequency of solo vocalisations. Tribes consisting of three or more birds appear to participate in vocalisation activity much more frequently than tribes of only two Magpies. Birds in a tribe of one male and five females were observed to participate in solo vocalisations ten times in a two hour period, a frequency of one warbling event every twelve minutes. In tribal groups of only two birds, the frequency of song is much less. Warbling frequency for tribes composed of two adult birds was between once and twice an hour.

It is also important to note the relative position of vocalisers in tribal society. Magpie tribes are generally composed of a dominant or breeding pair and several communal members/helpers. There is observational evidence that the majority of warbles are performed by helper/non-breeding female Magpies, with the dominant or breeding female being more actively involved in foraging and territorial defence.

The response of Magpies to playback of solo warbles was varied. Playback did not elicit any form of explicit behaviour displays such as aggression or sexual attraction. The most common response of subject Magpies to playback of solo vocalisations, either from their own tribe or from foreign tribes was characterised by confusion and curiosity. This curiosity was exhibited by a characteristic head tilt towards the speaker and an immediate cessation of movement which gradually returns as the Magpie appears to determine that the vocalisation poses no immediate risk. Generally at this point the subject Magpie returns to foraging. On two occasions the dominant male of the tribe made aggressive postures after other Magpies determined that there was little to no risk from the recording. However these aggressive postures appeared to be more theatrical than real, as the Magpie always drew short of attacking the speaker.

One unexpected response to playback occurred when members of a tribe were played a recording made a week earlier of their own song. Whilst half the tribe went off and systematically searched for the bird invading their territory, two female Magpies flew into the tree nearest to the speaker and began duetting with the recording.

So what is the importance of sex in Australian Magpie vocalisations? As stated above, my observations showed that the female Magpie is the predominant vocaliser in Australian Magpie society. The dominance of female birds in vocal activities and song behaviour in Australian Magpies diverges significantly from many of the base models for song behaviour in Passerines. An analysis of male and female vocalisations reveals several important sexual variance factors. Firstly male solo song is notably shorter than female song, in addition to being less prevalent. Secondly the acoustic density is notably thicker in male solo song. Figures 2 and 3 show the different waveforms of male and female song.

An obvious difference in timbre also exists between male and female solo warbles. Additionally, the male Magpie appears to be performing a well known tune from memory as compared to many instances of female warbling when the performer appears to be meditating on a theme, slowly extracting improvisations based upon the original theme. Though the ability to perform complex vocalisations is present in both male and female Magpies, the frequency, structure and function of solo warbles is quite divergent between sexes.

The developmental history of song learning is also important in deriving the role of vocalisations and can be traced in various species of birds allowing the broad classification

Figure 2. Waveform analysis of male vocalisation

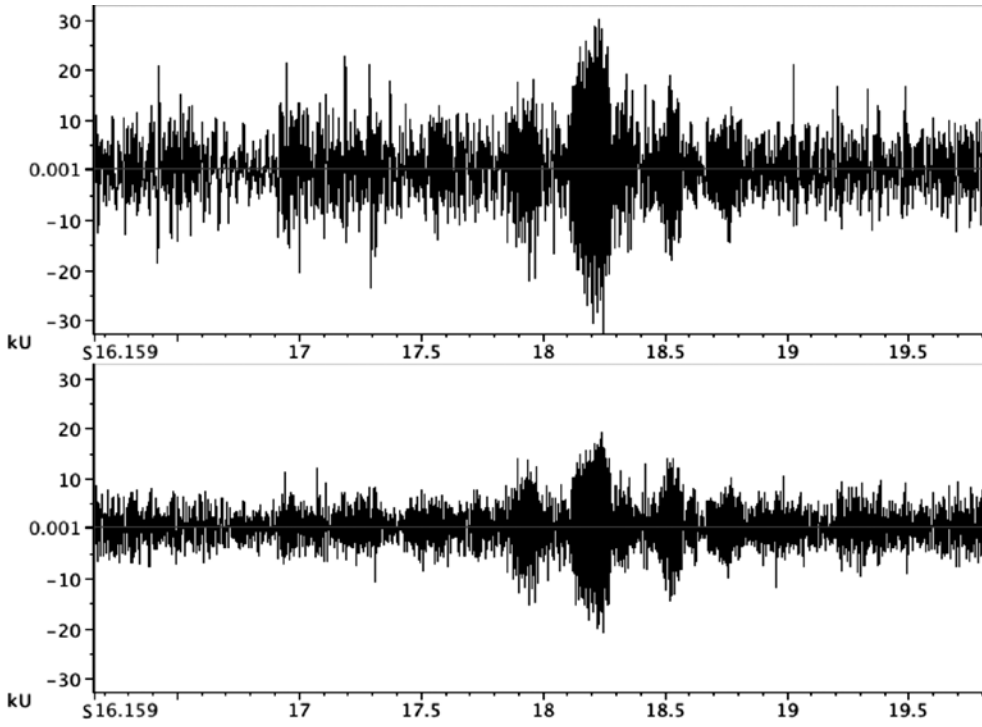
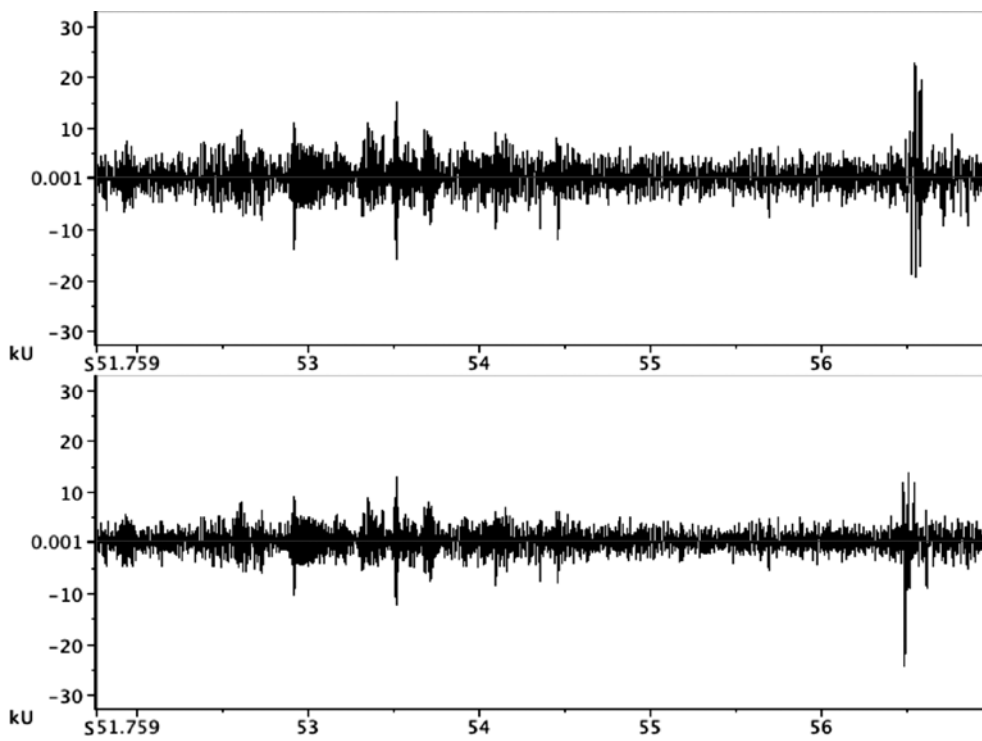


Figure 3. Waveform analysis of typical female warble



of song learning styles into three distinct categories. Song learning in avian species has been demonstrated to be a delicate balance between innate or genetic characteristics and learned behaviour controlled by many varied factors.

In many species, the most thoroughly researched being the Common Chaffinch (*Fringilla coelebs*),⁸ sexual hormones control song learning. Hormone controlled learning, which is the most prevalent form of song learning, allows the infant bird to imprint songs heard during a brief developmental period (usual its first year of life) without active imitation. Once the birds' levels of testosterone reach a sexually mature stage, the birds begin to practice the songs they imprinted at an earlier stage of life. From this point on they are unable to learn new songs.

The second form of vocal learning is that of imitation of an adult tutor, whilst a bird is in a juvenile stage. This process can occur over a much broader time span as observed in the Australian Zebra Finch (*Taeniopygia guttata*),⁹ which in the absence of a tutor during its peak development time can learn new songs at a later stage of development.

The final major song-learning category is that of open-ended learning. Open-ended learning allows individuals to acquire new vocal material throughout their life. Open-ended learning is a rarer form of learning than the other two categories. This category provides important co-operative territorial defence benefits. The Australian Magpie fits into the final category, with song sharing playing an important role in territorial maintenance and social dynamics and cohesion over the lifetime of the bird.¹⁰

Mimicking is also an important factor in vocal learning. Many open-ended songbirds are also skilled mimics. Though the Australian Magpie is not considered a true mimic, unlike other Australian birds including the famous lyrebird (*Menura novaehollandiae*),¹¹ which has been observed mimicking chainsaws, there have been several recorded instances, especially in hand-reared Magpies, of mimicking vocal behaviour.

As part of their 1988 research into song sharing in Australian Magpies, Brown, Farabaugh and Veltman observed the vocalisations of a hand-reared female Magpie who had spent the first three years of her life in the Zoology faculty at Massey University interacting solely with humans. They noted that her repertoire was composed of a large array of human whistles, performed both in imitation, and in improvisation. The researchers observed that she varied her "whistle" repertoires' pitch and rhythmic contours and would often improvise upon her repertoire for upward of an hour, constantly experimenting with and introducing new musical content.¹²

Song development in Australian Magpies is largely controlled by physiology. Full vocal displays are impossible until the syrinx is fully developed. The syringeal muscles mature

⁸ Clive Catchpole and Peter Slater, *Bird Song: Biological Theme and Variation* (Cambridge: CUP, 1995): 45-71.

⁹ Peter J.B. Slater, L.A. Eales and N.S. Clayton, 'Song Learning in Zebra Finches: Progress and Prospects,' *Advances in the Study of Behavior* 18 (1988): 1-34.

¹⁰ Susan M. Farabaugh, Eleanor D. Brown and Clare J. Veltman, 'Song Sharing in a Group-living Songbird: The Australian Magpie. Part II. Vocal Sharing between Territorial Neighbours, within and between Geographic Regions and between Sexes,' *Behaviour* 104.2 (1988): 105-25.

¹¹ William Homan Thorpe, *Bird Song* (Cambridge: CUP, 1961) 14.

¹² Eleanor D. Brown, Susan M. Farabaugh, Clare J. Veltman, 'Song Sharing in a Group-living Songbird: The Australian Magpie, *Gymnorhina tibicen*. Part I. Vocal Sharing within and among Social Groups,' *Behaviour* 104.1 (1988): 1-27 at 20.

dimorphically, with female birds achieving fully muscular maturity long before their male peers. Baby Magpies are able to produce low frequency vocalisations from a few days after hatching and rapidly strengthen their syrinx muscles. By around three weeks of age infant Magpies begin independently practicing the songs they hear.

Extended observations of a baby Magpie which had fallen from its nest after a significant storm event were made as part of this study. The extent of downy feathers, in addition to the short tail feathers, indicated that the baby Magpie was still a nestling probably around three to four weeks of age. The period from four weeks to six weeks in a baby Magpie's life is highly significant as it generally represents the fledgling period when baby Magpies rapidly learn to fly. It also represents a period of rapid behavioural maturation due to the demands of leaving the nest.¹³ This infant bird was observed for several days from one day after its rescue, during which time the researcher was able to build a complete picture of its vocalisation characteristics and development.

In addition to recordings of the solo vocalisations of the baby Magpie as exhibited around meal times, two playback experiments were undertaken to observe how a baby Magpie reacted to the vocal behaviour of other Magpies. The basic form of vocalisation in an infant Magpie consists of a single short, sharp call repeated at regular isometric intervals. Generally, these calls accompany a food begging posture, but they were also observed with relation to the entry of new people and animals into the room and upon waking up in the morning. The rhythmic frequency and pitch of vocalisations was observed to alter when the infant Magpie became excited or impatient.

It is pertinent also to notice the rapid development of vocal ability between 23 September 2006 (shown in Figure 4), and the date of the readings shown in Figure 5, taken on the 25 September 2006. In Figure 4, the infants' vocalisations are simple and vocally truncated, display a small pitch range and are dynamically restrained. In Figure 5, based on a recording taken a mere three days later, the infant Magpie's vocalisations display a much wider pitch range, and are more rhythmically varied and driven. The amplitude of the vocalisations has also significantly increased. Most interestingly the infant Magpie has begun melodic ornamentation of its basic vocalisations.

When the infant Magpie was exposed to playback of its own vocalisations, it responded by singing in call and response style with the recording. The infant did not appear to recognise the recording as itself, and responded as if the recording were another infant Magpie. It responded to each separate squawk either with a distinctive imitation call, or with a slightly altered call at a different pitch frequency. The rhythmic pattern of answer altered throughout, with some vocalisations eliciting a delayed answer whilst others were responded to immediately. Though the recording exacted a heightened sense of alertness in the infant Magpie's behaviour, it was not the catalyst for any explicit behavioural displays (such as begging). Though it is impossible to summarise the function of this behaviour, it would appear that vocalisations between infants act either as a form of communication or that infants practice vocalisations together in the nest, through call and response methodology. Further observation of nestling Magpies would be required to determine the validity of these hypotheses.

¹³ Gisela Kaplan, *Australian Magpie: Biology and Behaviour of an Unusual Songbird* (Melbourne: CSIRO, 2004) 56–57, 70–72.

Figure 4. Wave form analysis and spectrograph of the vocalisations of a three-week-old infant Magpie.

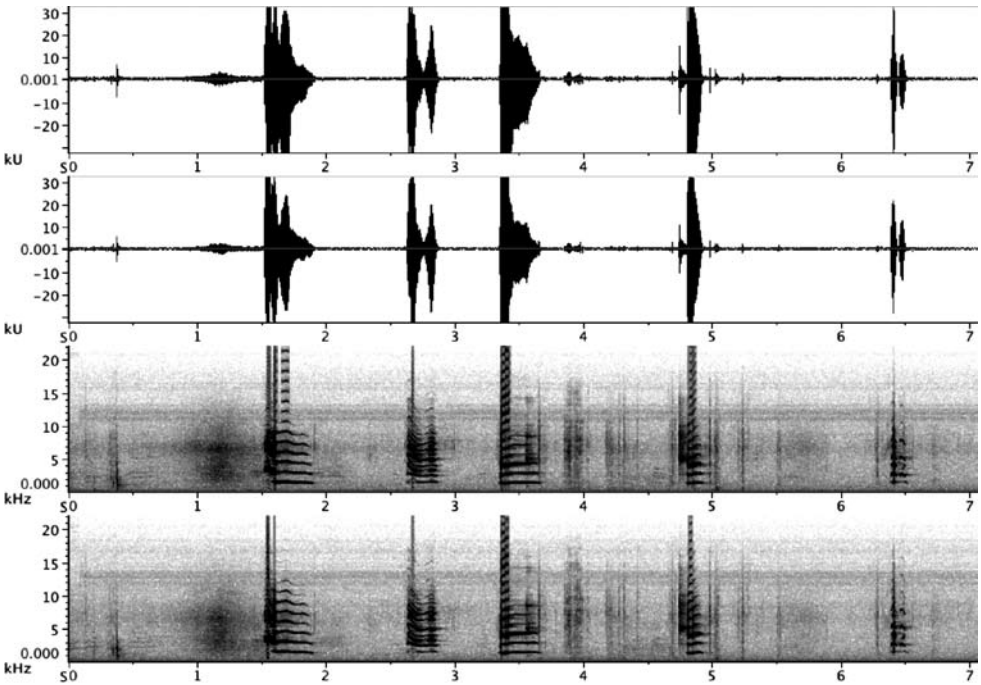
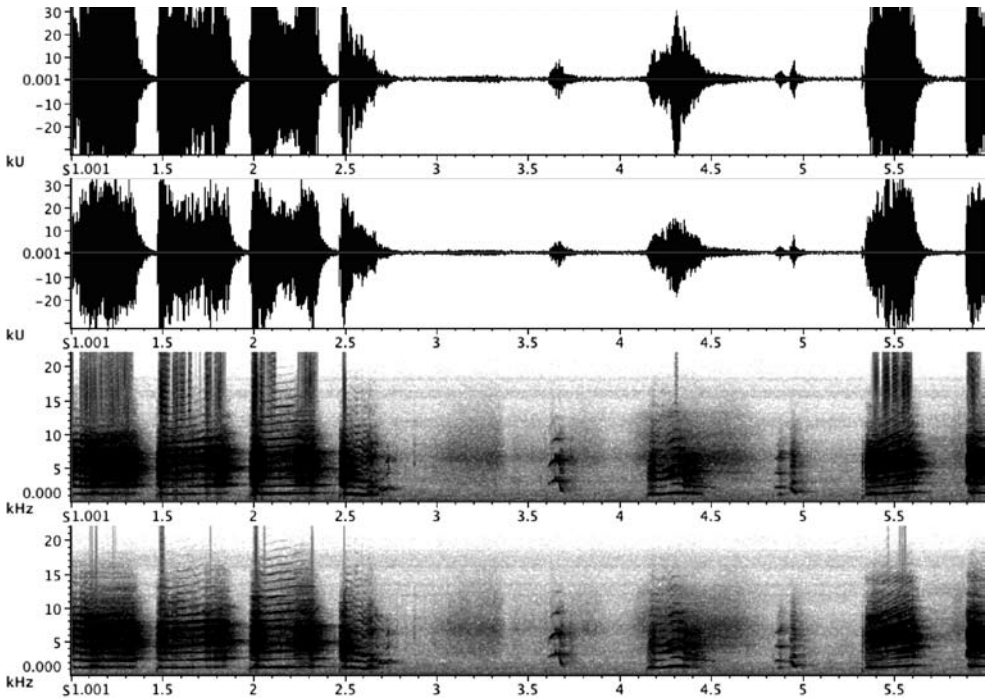


Figure 5. Waveform analysis and spectrograph of the second recording of the infant Magpie (taken three days after Figure 4). Note the significant development of the vocal line, increased amplitude and initial stages of melodic ornamentation and experimentation.



The second playback to the infant Magpie was of adult Magpies from the Lake Natimuk site performing the 'dawn chorus.' Unlike the first playback experiment, adult song did elicit an explicit behavioural reaction. Though the infant also chirruped along with this recording, it did so whilst adopting a severe begging position, which it re-enforced both visually and vocally.

Infant Magpie participation in the dawn chorus is not a rare occurrence, and may in fact be one of the main educational arenas. Infant Magpies learn via life long vocal assimilation allowing them to construct such complex vocal repertoires. However, the most interesting factor in infant Magpie vocal development is their ability to improvise and invent new melodic material. The melodic ornamentation demonstrated by the infant magpie in Natimuk and the improvisation upon human whistles observed in Brown, *et al.*, among hand reared Magpies indicate that these birds do not merely imitate the sounds they hear either from intraspecific teaching or the world around them but actively interact with these sounds. Improvisation and melodic innovation indicates that these Magpies are aesthetically engaged with their acoustic material. By being engaged with the sounds they produce, Magpies are not only making beautiful (or not so beautiful depending on the age of the bird) noises but are actively engaging in what could easily be defined as music making.

Location is also a crucial component of vocal behaviour. Location constraints affect the social transmission of songs and the frequency of singing activity. The relative availability or saturation of niches also affects the behavioural patterns associated with vocalisations.

Social transmission or song sharing plays a very important role in territorial maintenance and tribal dynamics especially in communal and cooperatively breeding species such as the Australian Magpie. In cooperatively breeding birds, 'helper' birds within the tribe assist in the parental care of fledgling birds with which they do not possess a genetic connection. Though studies have shown that the communal raising of young is limited in Australian Magpies, other communal activities such as communal territorial defense and communal caroling do play an active role in tribal dynamics. All members of a Magpie tribe participate to a greater or lesser extent in caroling. The importance of social singing in Magpie tribes is threefold: it builds group cohesion, assists in recognition of other members of the tribal unit and neighbouring tribes, and advertises the territory and the strength of the tribe that controls the territory. This process is especially well demonstrated in the dawn song.

The dawn chorus has an established functionality of territorial maintenance.¹⁴ Yet the aesthetics and structure of the dawn chorus make it an interesting study in large-scale vocal behaviour in co-operatively living songbirds and the intra and inter-tribal transmission of vocalisations. The dawn chorus is universally present in Magpie tribes, both rural and urban.

Examples discussed here were obtained from tribes living on and around Lake Natimuk. There were over fifty Magpies living around the shores of Lake Natimuk, in seven identified tribal groups. The sheer density of players present for the dawn chorus at Lake Natimuk creates a much richer and more complex dawn chorus than found in many urban regions, where there is little to no overlap of territorial boundaries.

The dawn chorus begins approximately half an hour before sunrise with a single Magpie singing alone. These preliminary solo melodic vocalisations (phase 1) owe much in character

¹⁴ Kaplan, *Australian Magpie* 108–9.

to adult sub-songs, but are much shorter in length (less than one minute). Gradually more birds add short melodic warbles to the silence of the morning. For around half an hour these unconnected short melodic warbles continue at an exponentially increasing rate reaching a critical mass around dawn.

At dawn, the structural dynamic of the dawn chorus shifts from phase one to phase two, from solo song to a complex call and response structure in which melodic material is actively passed between multiple tribal groups. In what could be construed as solo/tutti fugue, a single Magpie extols a melodic phrase from a prominent position (usually the top branch of a tree or a tree antennae), which is concluded by a choral cadence sung by the other Magpies in the tribe of the solo Magpie. This choral cadence signals the end of the melodic material with several closed chordal clusters. At this point the original solo melodic line is taken up in a slightly adapted form by one of the neighbouring tribes, repeating the process described above. One melodic idea was observed to pass through as many as four tribes before passing out of human audibility.

Figure 6. Schematic diagram of phase 2 of the dawn chorus: M = Melody, C = Cadence, S = Silence and V = Variation.

| | | | | | | | | |
|--------------------|------------|-----------|--------------|-------------|--------------|--------------|--------------|--------------|
| Tribe One | M1 Solo | C1 All | S | M2 Solo | C2 All | S | M3 Solo | C3 All |
| Tribe Two | | | M1V1 Solo | C1V1 All | S | M2V1 Solo | C2V1 all | S |
| Tribe Three | | | | | M1V2 Solo | C1V2 All | S | M2V2 Solo |
| Tribe Four | | | | | | | M1V3 Solo | C1V3 All |

The dawn song continues for between one and two hours after sunrise. However it rapidly decreases in transmission density from around half an hour after dawn, when many birds abandon singing posts in favour of hunting.

This process of vocal transmission has an important role in regional vocalisation dialects. Brown, Farabaugh and Veltman undertook an in-depth study of the intertribal transmission of melodic material.¹⁵ The researchers analysed the interchange of material between neighbouring tribes as well as with tribal groups. They also looked at the ability of Magpies to learn new vocal material at various stages in their lives as they move between social settings (from fledgling tribe, non-territorial juvenile flock to permanent adult territorial tribe). Though the birds discussed in this study were from a different sub-species (*Gymnorhina t. tibicen*) residing in New Zealand, the findings are pertinent for an understanding of *Gymnorhina t. tyrannica* in the absence of like data relating specifically to *G. tyrannica*.

They found that the sharing of warble or solo melodic material was common both within tribal groups and between neighbouring groups. They found however that this was an extremely complex process with only certain songs being shared. They also found that the frequency of song sharing varied significantly from tribe to tribe. They determined that no

¹⁵ Brown, Farabaugh and Veltman, 'Song Sharing. Part I.'

individual song was shared by more than five birds. Most interestingly they discovered that there was no song sharing between male/female couples, indicating that singing together plays no role in sexual selection and/or mating rituals (as discussed above). Thus the vocalisations of an individual Magpie are sculpted not only through imitation of parental models but evolve throughout life as a result of the group cohesion vocalisations of the tribal group it joins in adult life and by the vocalisations of neighbouring tribes.

Frequency of song transmission and singing behaviour was also affected by environmental constraint. Weather was observed to effect singing behaviour, with Magpies not participating in active vocalisation at times of excessive wind (gale force) and/or rain. This correlates with Armstrong's assertion that 'vocalisations (in all species) are later on windy or rainy days independent of light intensity' and that 'the effect of wind is to reduce the output of song.'¹⁶ Whether this aversion to singing in the rain and wind indicates a dislike for vocalizing in bad weather or is simply due to an unwillingness to expend excess energy on a vocalisation with reduced transmission range cannot be confirmed. It is interesting to note, however that song density increases in the period just before and after light to medium rain events.

Longer-term weather patterns also have been seen to affect the frequency of solo vocalisation activity. The affects of long-term weather patterns was especially evident in the solo singing frequency of Magpies living on and around the shores of Lake Natimuk. Located in the Wimmera region of northwestern Victoria, Lake Natimuk and the surrounding regions have been severely affected by a long running drought (currently in its seventh year). Drought has desiccated the land around Lake Natimuk, and has turned Lake Natimuk from a large fresh water lake (over three kilometres in diameter) into a large successional grassland area. As Magpies often hold territories for in excess of ten years (the average Magpie lives between 25 and 30 years)¹⁷, the evaporation of the major water source for the region would be strongly felt, with little to no selective adaptation to deal with the added pressures of aridity. Though Magpies are omnivorous, drought conditions would undoubtedly create unfavourable hunting conditions and therefore increase the time and effort allocation required for food collection. This was noticeable in the more than fifty Magpies that inhabited the Lake Natimuk region. Though singing of the dawn chorus continued (the territorial advertisement and tribal cohesion values making it too important to abandon), it appeared to be truncated in comparison to other dawn choruses in non-drought affected areas.

Many birds also only participated until the light was strong enough to permit efficient hunting, abandoning singing only minutes after sunrise. However it was during the rest of the day that the increased propensity to hunting behaviour at the expense of other activities less crucial to short term survival became apparent. General daytime solo singing and warbles with the exception of the dawn and dusk choruses were notably absent across the region.

Interestingly, when compared with the tribe of Magpies observed living in the centre of the Little Desert National Park (a permanently arid area), in which the female birds actively participate in elongated warbling behaviour, it appears that the absence of daytime solo singing is a reaction to ill adaptation to environmental conditions not to the arid conditions in general.

¹⁶ Edward A. Armstrong, *A Study of Bird Song* (London: OUP, 1963) 209–11.

¹⁷ Kaplan, *Australian Magpie* 63.

This observation would indicate that unlike the dawn and dusk choruses, solo warbles are a behavioural luxury not directly linked to species survival.

Area and/or niche saturation also plays a role both in the relative frequency of solo vocalisations, as well as the associated behavioural norms displayed. Another example of the abandonment of vocalisations due to excessive stress was observed in two tribes co-habiting in Port Melbourne. In this case, however, the stress was not a result of environmental factors but due to a territorial dispute. The tribes, each consisting of a male and female bird, were not so happily sharing the territory of a single football field. Over an extended observation period these four birds did not participate in any form of daytime solo song. The majority of activity engaged in by these four Magpies involved foraging for food, interrupted at regular intervals by short fights (usually between the two male Magpies). In this case the aggressive maintenance of territorial boundaries appears to have taken precedence over solo vocalisations.

Generally the behaviours associated with solo vocalisation consist of quiet vocal contemplation from a solitary arboreal perch. The close proximity of other Magpies will often result in the abrupt cessation of singing. Singing from ground level is restricted to adolescent birds. In locations where due to the relative richness of foraging large numbers of Magpies converge, however, these rules can often bend. The grasslands at Royal Park, Parkville, provided such a location, and deviations in behavioural etiquette are easily observed. The first and most obvious symptom of location saturation is the decreased proximity sensitivity of the singer to other Magpies. On several occasions the researcher observed a female Magpie singing and preening herself whilst Magpies occupied other branches in the tree. The sensitivity to intrusion is not completely absent as observed when a male Magpie alighted on the same branch as a warbling female, the situation ending in a prolonged fight. Singing whilst on the ground is also more prevalent in large groups of Magpies living and hunting in close proximity. Tribes living adjacent to the grassland, on separate territorial land, do not display the vocal behavioural traits of the grassland tribe(s).

Location-based restraints therefore play a significant role in the vocalisation behaviour of Australian Magpies. Location affects lifelong vocal learning, frequency of vocal performance, vocal behavioural norms, as well as many other diverse characteristics. There is also a tangible difference between the function of dawn and dusk song and regular solo warbles. Whilst it appears that dawn and dusk song are essential components of daily Magpie life, most likely due to their impact on territorial advertising and tribal cohesion, warbles appear not to be an essential component of Magpie survival. That solo vocalisations appear to be omitted from the behaviour of Magpie tribes under adverse conditions indicates that warbles are most possibly a leisure activity. With the behavioural assignment of leisure comes the intrinsic information that solo vocalisations are a behaviour that is possible in all Magpies but are performed at the discretion of the individual bird.

The solo vocalisations of the Australian Magpie are numerous in diversity and depth. It is however the extra-vocalisation characteristics that makes the solo warbles of the Magpie unique. It appears that Australian Magpies decide whether or not to perform solo vocalisations with specific referencing to the survival pressures placed upon them. It is also obvious that social life plays an important role in vocal development, lifelong learning and vocal behaviour. The importance of dawn song in social cohesion and the interchange of melodic material between neighbouring tribes indicates the significance of vocalisations.

It also appears that sex also plays a significant role in solo vocalisations in Australian Magpies. The prevalence of solo song behaviour in female members of the Magpie species are highly significant due to their absolute divergence from the recorded sexual norms of birdsong and may have significant paleo-evolutionary implications. The rapid development of vocal ability and the importance of improvisation indicates that Magpies take an aesthetic interest in the sounds they produce. The evidence presented with regard to vocal inventions upon wolf-whistles in a hand-reared Magpie suggests that Magpies are able to invent vocalisations without imitation of a tutor bird or sound recording.¹⁸

The conclusions that can be drawn from this study are both broad and narrow. Due to the relative domain specificity of the study in addition to the limited time period over which sample Magpies were observed, this study asserts the possibility of music making in Australian Magpies. The most important finding, however, is that Australian Magpies are involved actively in the acoustic sounds they produce. They produce solo vocalisations when they are not constrained by social and environmental factors. Magpies improvise upon, invent and imitate new melodic material throughout their lives.

¹⁸ Brown, Farabaugh and Veltman, 'Song Sharing. Part I' 20.