

Communicating about Communicating: When Innate Is Not Enough

MEREDITH J. WEST

*Department of Psychology
Indiana University
Bloomington, Indiana*

ANDREW P. KING

*Department of Psychology
Indiana University
Bloomington, Indiana*

MICHELE A. DUFF

*Department of Psychology
University of North Carolina
Chapel Hill, North Carolina*

The cowbird is a brood parasite, providing no parental care to its offspring. The species has often been cited as a model of the usefulness of the construct of innate behavior, as an explanation of how young cowbirds develop species-typical behavior. Here we evaluate the adequacy of this perspective. We show that although it is difficult to explain ontogenetic beginnings without recourse to the concept of innate behaviors, ontogenetic outcomes are less easily accommodated. Constraints on the explanatory power of innateness as an ontogenetic concept are demonstrated with data from the development of singing in cowbirds and the development of babbling in human infants.

Won't this whole instinct matter bear revision?

Won't any theory bear revision?

To err is human, not to, animal.

Or so we pay the compliment to instinct . . .

Frost, 1963

That animals err, and that they err owing to instinct, is the secret to the

Reprint requests should be sent to Meredith J. West, Department of Psychology, Indiana University, Bloomington, IN 47405

Received for publication 10 May 1988

Revised for publication 30 November 1988

Accepted at Wiley 13 July 1990

Developmental Psychobiology 23(7):585-598 (1990)

© 1990 by John Wiley & Sons, Inc.

CCC 0012-1630/90/070585-14\$04.00

cowbird's success. Female cowbirds lay their eggs in the nests of over 200 different species and subspecies; the young are unwittingly but obligingly raised by the foster parents along with their own brood (Friedmann, 1929; Friedmann, Kiff, & Rothstein, 1977). The foster parents' error in allocating care to an alien species reflects the less complimentary side of instinct alluded to by Frost. Nestling cowbirds show no special adaptations to elicit care, they rely on the fixed adaptations of others to thrive.

The behavior of cowbirds also underscores Frost's call for revision of theories concerning behaviors classified as instinctive or innate or inherited. In this article, we examine cowbirds' vocal capacities with respect to the general issue of innateness. We focus on vocal communication, and male song in particular, because avian songs in all oscine birds appear to be especially sensitive to species-typical stimulation and because comparisons have been drawn between avian song and human language (Marler, 1970; Petrinovich, 1972).

First, we describe the experimental methods used to analyze cowbird communication. Next, we describe some of the behaviors of cowbirds that suggest that the species comes about as close as is possible to representing an avian model of an innate system of communication, that is, a system that appears to produce species-typical behavior in the absence of experience with conspecifics. Then we follow with evidence revealing that such an innate program is insufficient to explain the ontogeny of vocal competence. Thus we propose that the utility of the concept of innateness is in identifying initial capacities whose ontogenetic course often cannot be accurately predicted without knowledge of the nature of the animal's environment. As further evidence of the nature of innate behaviors, we end by examining new findings with respect to human infants' vocal behaviors. These data suggest that the beginning stages of language development may not be well served by too strong a focus on innate behavior.

Experimental Metrics of Vocal Development

Mature male cowbirds sing from two to seven song types, that is, stereotyped vocal patterns similar enough to be considered as acoustic photographs from rendition to rendition. Females do not sing, but they play a key role in the evolutionary survival of song types because male song is used as a means of selecting mates (West, King, & Eastzer, 1981). In the nine to ten months preceding the acquisition of stereotyped or crystalized song, young cowbirds (and other songbirds) produce an abundance of sounds; some utterances are sung softly, some are produced in a fragmented or unpredictable sequences or sung backwards relative to final adult syntax.

A central feature of most studies of avian vocal ontogeny is a comparison at the end of the males' first year between the songs of normally reared males and the songs of experimentally reared individuals. Experimental rearing involves some condition of sensory deprivation or distortion, ranging from deafening to selective tutoring of hand-reared males. In most studies, auditory deprivation is achieved by housing naive males alone. The songs produced by isolates are then often considered as a baseline condition for evaluating the effect of postnatal experience, with the songs sometimes labeled as the "innate" or "genetic" songs

of a species, that is, songs coming as close as is phenotypically possible to revealing the putative genetic blueprint (Marler, 1982; Petrinovich, 1972; Thorpe, 1961).

Despite the prevalence of the aforementioned procedure, it is one fraught with long-recognized problems. Solitary living is not a developmentally neutral environment (Kuo, 1967; West & King, 1987, 1988a). No such environment exists outside the cryogenic crypts of science fiction. In order to study the contributions of specific forms of acoustic stimulation, procedures of controlled rearing are required that preserve essential components of the social environment while manipulating access to auditory stimulation. With such a procedure, measures of song production are not confounded by the effects of social isolation. Moreover, measures of outcome beyond song structure such as courtship success are possible because social housing often prevents the behavioral pathologies characteristic of birds confined in solitary enclosures.

In the studies to be reported of cowbirds, all individuals were socially housed, although the identity of the social companions differed depending on the experimental question. Sometimes males were housed with nonsinging females and sometimes males were housed with members of other species such as canaries (*Serinus canaria*) or starlings (*Sturnus vulgaris*).

After rearing conditions, the second most important issue in research on vocal development concerns evaluation of the structural and functional properties of the songs. Consensus exists about the need to consult the natural recipients of songs to resolve utterances into natural units, but the search for appropriate probes continues. In cowbirds, the process of parsing male song is made easier by the captive female cowbird's responsiveness to playback of song. Females, whether naive or experienced with respect to males or their songs, respond with reflexive copulatory postures to the playback of songs of their species but not to the songs of other species (King & West, 1977). Moreover, females show intraspecific selectivity, permitting qualitative and quantitative estimates of differences in the potency of different songs of the same male or of superficially similar song types sung by different males (West et al., 1981).

Playback to females has shown that certain parts of the song have a telegraphic quality, bearing much more of the communicative weight than other parts (West, King, Eastzer, & Staddon, 1979; King & West, 1983a). These elements are not the ones most distinctive to the human ear (or to the human eye examining sound spectrograms), emphasizing the need for a "bird's-ear" perspective on the functional nature of the acoustic signals of males housed in different environments.

A final methodological issue concerns the function of song. How do different rearing regimes affect song use? To answer this question, we observed captive colonies of males and females residing in large aviaries or male-female pairs living together in smaller enclosures. We used these settings to watch song in action. How, for example, does song affect mate choice? The data collected in this context indicates that, at least in captivity, female assessment of the acoustic quality of male song is a necessary condition for mate choice (Searcy & Andersson, 1986; West et al., 1981; West, King, & Harrocks, 1983).

Observations in a seminatural arena have also been beneficial in two other ways. First, we have been able to show that songs judged to be effective on the basis of the playback bioassay are ones typically produced only by dominant males, as measured by success in intrasexual competition and in intersexual mate

selection (West et al., 1981; West et al., 1983). Playback responses thus appear to tap biologically meaningful attributes of song production. A second benefit of the captive colonies is that it has permitted us to look at the fate of males whose song development was experimentally biased by controlled rearing in the laboratory. By introducing such males to a colony, we could look at the natural outcome of song development, the males' attempts to use songs to court females.

Ontogenetic Beginnings: When Innate Appears Enough

Three sets of findings suggest that male and female cowbirds possess impressive communicative capacities. First, when the variable and fragmented sounds of six-month-old captive cowbirds (given limited tutoring with male song) were tested in the previously described playback procedure, the females reliably responded more to the immature songs of the young cowbird males than to the songs of other species. Thus the message that the singer is a cowbird can be transmitted with the most rudimentary of vocalizations (West & King, 1988c).

Second, playback tests indicated that the adult songs of males raised from the egg with no contact with other males were extremely effective releasers of copulatory postures, even more attractive than the songs of normally reared males! Thus, the sounds males produce with no access to adult models appear supernormal in their species-typical characteristics (King & West, 1977).

Naive males can also recognize highly effective signals. Acoustically naive males, tutored with 12 songs ranging widely in effectiveness (as independently judged by the female bioassay), sang the more potent tutor songs most often: Over 75% of all their singing could be matched to the six most potent songs. The males not only recognized the more attractive songs; they learned to imitate them accurately when only six months of age. Thus, the motoric capability to copy a song to the major criteria for stereotyped song (good articulation and stability of structure) is present early in development when the song material is provided.

The final set of relevant findings concerns female recipients. When females are reared in isolation from males (but housed with other females or nonconspecifics), they respond to song playback in a manner that is indistinguishable from that of experienced females. They prefer cowbird song to that of other species; they discriminate between the songs of native and non-native populations, preferring the former (King & West, 1983b); and they display high degrees of intrasexual concordance as to which songs are most to least effective (West & King, 1986).

In summary, the ontogenetic resourcefulness of the species seems clear: With no exposure to male song and recourse only to self-produced stimulation, naive males sing effective songs and naive females recognize effective songs. But these capacities, at least in the case of the male, do not automatically insure adult competence. Appearances can be deceptive, especially when working with organisms outside of their natural habitat and when focusing only on selected attributes of so complex a behavior as communication. If living in acoustic isolation seems to produce such good singers, why do wild cowbirds live in flocks (King & West, 1988)? And if cowbirds can produce effective songs at six months of age, why do wild birds continue to change their songs for several months thereafter?

To find out, we looked beyond measures of song structure or function to song use in social environments. We looked at birds not only during the time of courtship

but many months prior to it, during the time when song structures are developed and crystalized. The latter form of analysis has not been employed often. The use of solitary housing has the indirect effect of isolating experimenters from subjects during this time period. As a result, it helps to maintain the scientific fiction that the experience of isolation is understood.

Ontogenetic Outcomes: When Innate is Not Enough

Our studies of song function and of song development demonstrate that naive male cowbirds may be able to rely on self-stimulation to fashion the appearance of a species-typical repertoire, but in reality the repertoire is ultimately ineffective and counterproductive. Naive males manifest several crucial deficiencies. First, they lack the social skills to know when and to whom to sing, a deficit leaving them vulnerable to physical attack from experienced males. The opportunity to sing comes only after extensive interactions with other males. During such interactions, dominance relations that affect singing are established. In particular, males must learn that singing too potent a song can have serious consequences. In our studies of captive colonies, dominant males attacked socially naive birds who sang to females. The new males had to learn to sing their highly potent songs only when far from males and close to females (West et al., 1981).

These data cast the experience of controlled rearing in a new light. By housing males apart from males, either with females or with members of other species, we had conferred dominance on them. Auditory deprivation may have taken something away—the opportunity to imitate—but it had added something as well—the opportunity to sing to a nonthreatening audience. What had seemed to be deprivation may actually have been enrichment, and what had seemed a story with a happy ending (the development of potent songs) was actually a story with a potentially deadly finale. Now that the contextual tables were turned, the finding of superior song potency of deprived males took on a different meaning. Pleasing females and appeasing males rested on different ontogenetic experiences in this species, experiences we had separated by virtue of the housing arrangements.

The lives of birds in the laboratory took on a more ivory-towerish appearance after we watched naive males attempt to negotiate life in a colony. Further observations of social interactions between young males and adult females revealed that a male's audience teaches more than etiquette. It is not just a matter of learning when to sing what song; the actual song material retained in or deleted from the juvenile male's repertoire is also influenced by social experience (King & West, 1988). Most important, the data show that vocal alteration is not always triggered by an innate maturational schedule. It is a male's audience, not his age, that precipitates the next stage of vocal development.

Briefly stated, social experience with females motivates males to change the songs they have developed, even ones that might be quite potent. To study the effects of social experience, we compared the repertoires of naive males housed with nonconspecifics to those of males housed with females. We found that acoustically naive males housed with nonconspecifics developed repertoires composed of "generic" cowbird songs, songs containing elements common to different geographic regions and typically not mixed in the repertoire of one individual (King & West, 1983c; West & King, 1985; King & West, 1988). Like infants babbling in

a multilingual tongue, the males housed with other species produced vocalizations that were species-recognizable but not species-typical. Some songs lacked the phonetic markers that serve to identify the male's local population, and some songs contained vocal markers typically absent in the local population under study, markers that females use to discriminate between different populations (King & West, 1983b; West et al., 1983). Time did not correct these differences; the males' final crystalized repertoires were only acoustically clearer versions of their mixed signals.

Thus auditory deprivation biases the course of vocal development in neophenotypic directions. How does vocal development proceed when appropriate social, but not acoustic, stimulation is provided? We were able to segregate the effects of social and acoustic stimulation in the male's environment by studying the nature of vocal development in naive males housed with female cowbirds, which cannot sing. The studies show that although females cannot serve as fellow performers or models, they can serve as social critics and co-composers (King & West, 1983c; West & King, 1985; King & West, 1989).

Several lines of evidence demonstrated that females can supply the incentive to modify song. In a longitudinal study of acoustically naive males, we found that males housed with females from different geographic locations began to produce distinctively different vocal precursors from as early as five months of age. Even when their vocalizations consisted primarily of fragmentary and highly variable sounds, acoustic analyses revealed significantly different developmental patterns in males housed with females from different geographic regions. Thus, males "babbed" different when housed with silent females possessing different perceptual preferences (King & West, 1988).

How can females communicate about song without singing? "It must be magic," muttered a skeptical colleague (a familiar phrase in psycholinguistic circles as well). Magic is, however, an apt analogy. Magic is decipherable, once you know where and when to look. In the case of cowbirds, the sounds of males had so dominated our perception that it took years to see through their vocal performances to the visual performances of females, performances powerful enough to provoke males into the vocal improvisations needed to transform their self-taught repertoires into song types suited to their immediate surroundings.

To learn how males and females communicated about song, we videotaped captive pairs in early spring, when song changes still occur but when the sexes would, in the wild, be returning to breeding grounds and interacting with prospective mates (West & King, 1988b). We asked how females behaved when males sang. What females did over 90% of the time (to our anthropomorphic eyes) was absolutely nothing—if the observer did not know a male had just sung, watching the female would provide no clue that a song had occurred.

But it was precisely that quality of nonresponsiveness that appeared to enhance the salience of the behavior of females when they did respond (West & King, 1988b). A female responded to certain songs with special body and wing movements, movements perceived by the male as evidenced by his physical approach to the female and by his vocal repetitions of the song type that had elicited the movements. The most conspicuous form of movement by females was a display termed a "wing stroke," a rapid lateral movement of one or both wings away from the body while the male's song is in progress. But these observations could not

reveal the functional properties of wing stroking. We set out to test the functional significance of wing strokes. We carried out a playback experiment, exposing male-deprived females to songs that had elicited wing strokes as well as to songs from the same recording sessions that occurred before and after the wing stroke (West & King, 1988b). The results revealed that wing-stroke songs were highly effective releasers of copulatory postures—wing-stroke songs were always highly potent songs, as were the repeated renditions produced after the wing stroke.

The results provide the first evidence to date that social interactions based on non-imitative learning can influence vocal ontogeny. The males modified their vocal repertoires in response to visual signals from females. They did not do what the females did but acted in response to watching the female's behavior. The role of vision has not been considered a vital part of song learning, although it has always been clear that males witness a diversity of visual outcomes when they sing. But now that a potential role has been uncovered, new questions must be asked about the adequacy of auditory templates and imitation to account for vocal ontogeny.

The generative effect of the presence of females on song development is theoretically crucial to understanding the limitations of innate views of vocal development because it takes the analysis of song development beyond the boundaries of innate auditory templates and introduces learning abilities that cannot be reduced to imitation, the only form of song modification postulated for songbirds (Kroodsmma & Baylis, 1982). It also highlights the importance of exogenetic inheritance: Males are as likely to interact with females as they are to develop adult plumage. Ecological forms of heredity differ from genetic forms in many ways, but a critical difference is that the former relies on activity of the legatee whereas the latter implies only passive transmission.

Before turning to the broader issue of the comparative relevance of song development to innateness and language acquisition, one frequently asked question must be addressed. Perhaps in cowbirds the innate properties of importance reside in the perceptual capacities of females. Has the species undergone an ontogenetic division of labor, with males becoming the learners and females the guides?

Studies of geographic variation suggest that this is not the case. We have found little evidence of malleability in females from sites in the eastern United States, but such malleability has been demonstrated in females of the same subspecies residing in the ancestral populations of the species in the Midwest. When females from Oklahoma were housed with males from a different geographic region, the females' playback preferences changed (King, West, & Eastzer, 1986). In the east, we face a methodological paradox: Males (from many geographic areas) are so sensitive to feedback from females that they change their vocal behavior beginning in late fall. It has therefore not been possible to use social housing as a means of modifying female preferences. The females modify the males, converting them from sources of influence to subjects of influence (King & West, 1987). A consequence of these synergistic effects may be that the males' behavior serves to maintain (*sensu* Gottlieb, 1976) the females' initial preferences: She may be reexperiencing or relearning her local preferences by virtue of her ability to stimulate males to reproduce preferred songs. In any case, we can reject the argument that all the "innateness" is in the female and all the "experience" in the male on empirical grounds.

Cowbirds and Innate Behavior: Comparative Perspectives

What is the possible relevance of these studies to the consequences of assuming that human language is innate or that any behavior is innate? We hesitate to broach the issue at all because the psychobiological literature is replete with examples in which the compliment was paid to instinct for the origins of a behavior, only to find out later that an apology was in order. Experiential contributions are easy to overlook because they are often so finely woven into the epigenetic manifold as to be invisible (Gottlieb, 1980). Nevertheless, we believe the data presented here can be discussed with respect to three issues in the study of language acquisition: the nature and function of vocal precursors in birds and humans; the contribution of multimodal sensory stimulation; and the status of "song" and "language" as workable scientific constructs.

The Function of Vocal Repertoires

If adult birds have repertoires, then young birds have "prepertoires," that is, vocal behaviors that precede and prepare the singer to become a proficient singer. Are prepertoires functional, that is, do they have communicative properties? For most songbirds, we do not know. The untested assumption is that vocal precursors are not functional except perhaps as advertisement of the bird's youthful status, but the studies of cowbirds suggest the need to look more closely at early vocalizations. As stated earlier, precursors elicit copulatory responses from adult females and precursors provide sufficient stimulation that females react to them with responses ranging from inattention to wing stroking. More to the point, the content of males' prepertoires differed from 100 days of age (at the onset of songlike utterances) if the males had different social companions.

Thus, social and vocal experience may begin to operate early in development. Its effects are undeniably hard to detect, requiring sensitive bioassays and structural analyses. An investigator could easily miss signals in all the noise. One problem we see with too hasty a reliance on assumptions of innateness is that it may not motivate researchers to look for variation shaped by experience early in development. Why invest time and energy examining vocal rudiments that ultimately may disappear?

Recent research on babbling suggests new incentives to such an enterprise. Infant babbling has often been compared to subsong and plastic song in songbirds, because it consists of the production of individual speech elements or only the most rudimentary of combinations of consonants and vowels. Babbling occurs in normal infants as well as in infants with sensory or mental impairments. Reports based on diaries of transcribed infant vocalizations noted the absence of conspicuous differences in the nature of babbling in infants with sensory impairments and thus fostered the belief that babbling was not influenced by specific forms of experience (Jakobson, 1941; Lenneberg, 1967). The belief persisted until more sophisticated means of categorizing infant sounds were introduced (Oller, Wieman, Doyle, & Ross, 1976; Eilers & Oller, 1988). In particular, the identification of "canonical" babbling (syllables possessing at least one supraglottal consonant-like element and one vowel-like element, often with fully resonant properties on the vowel, and characterized by stereotyped timing and articulation) led to a new perspective on the relationship of babbling to speech.

A focus on the content and age of onset of canonical babbling revealed differences between deaf and hearing infants and between some mentally retarded and hearing infants (Oller & Eilers, 1988; Oller & Seibert, 1988). Differences between hearing and deaf infants had been thought to be minimal prior to these studies because the two groups shared "precanonical" sounds and because, in a case of one set of twins of whom one was deaf, no differences were found in the quantity of infant sounds (Kent, Osberger, Netsell, & Hustedde, 1987). But deaf infants showed significant delays in the onset of canonical babbling as well as in the acoustic features of the sounds. The delays can be a matter of many months, even in deaf infants receiving therapy. Thus the inability to hear has measurable effects, suggesting babbling to be a less biologically robust phenomenon than previously assumed (Lenneberg, Rebeľsky, & Nichols, 1965).

The differences in the canonical babbling of normal and mentally retarded infants also suggest the vulnerability of babbling to postnatal experience. Oller and Seibert (1988) found that some retarded children had lower ratios of canonical babbling within their repertoires. There was considerable variability in the sample of children, reflecting in part the different conditions underlying their retardation, but the data provide additional reasons for considering the effects of prelinguistic experience on prespeech vocalizations. Many retarded children engage less in imitative behavior and thus may be deprived of opportunities for vocal stimulation. Taken together, the studies indicate the benefits of increased attention to the nature of infant vocal production. Many of the early studies of deaf infants suffered either from small sample size or from global measures of the quantity of quality of speech (Oller & Eilers, 1988). It is noteworthy, given these methodological deficits, that the view of babbling as immune to experiential deficits persisted. One can only speculate that the reports of no experiential effects matched the prevailing theoretical view of babbling as a maturational phenomenon independent of individual experience, a view that would not encourage a search for definitive evidence.

Another source of information that appeared to fit this view came from analyses of children unable to produce sounds during the normal period of babbling. Lenneberg (1967) studied the first such case: a 14-month-old child tracheostomized for six months. One day after the cannula was removed, he reported appropriate babbling. Locke & Pearson (1988) studied a child similarly deprived of the opportunity to speak for 20 months. Once given the opportunity to vocalize, the child produced sounds deemed "primitive" and "restricted" in terms of content. Because of the paucity of data, we do not as yet know the full impact of self-produced vocal activity in affecting speech production. But as Locke discusses in this volume, more recent evidence suggests that precursors to formal speech sounds appear to be affected by prelinguistic vocal activity; what the child hears, when and how the child vocalizes, and what opportunities exist to engage in relevant cognitive activity such as imitation in the second six months of an infant's life may be of more consequence than previously thought.

These data also prompt questions about the functions of babbling. Few would dispute that babbling can serve as vocal exercise. That children can learn to speak without such exercise is not denied, but most children are not denied this source of stimulation. The possibility of multiple pathways is hardly a new developmental phenomenon and it should not detract us from looking carefully at quite dependable sources of vocal stimulation. The functions of babbling may be more extensive.

Canonical babbling appears to consist of the phonological building blocks of "true" words, as evidenced by their acoustic nature. A study of the "playpen monologues" of one-year-olds has found relationships between first words and babbling forms, suggesting individual continuity between these two stages (Elbers & Ton, 1985). Assumptions of lack of continuity between infant sounds and formal speech thus seem unfounded.

A corollary question, as yet unanswered, is whether such sounds provoke differential feedback from caregivers. Investigations of infants' perceptions of speech sounds suggests that differential experience listening to sounds leads to decreases in the infant's capacity to perceive sounds not in their native tongue by approximately 10 months of age (Werker, 1989). This is the point at which normal infants begin to produce canonical babbling. It may be that as infants begin to become more discriminating listeners and more articulate speakers, they may also begin to be able to use feedback from conversational partners about the functions of sounds. As in the study of birdsong, studies of speech production and perception are rarely carried out simultaneously in the same species by the same investigators. Such studies are clearly needed to test further assumptions about relationships between comprehension and production.

The cowbird studies also reinforce the need to consider not only what infants hear but what they see. In many cultures, what infants see as they begin to utter recognizable words is conspicuous signs of parental delight. So too, vocal games become sources of mutual stimulation. Several investigations have linked participation in turn-taking interactions to advanced linguistic production (e.g., Bloom, Russell, & Wassenberg, 1987). While we need to pursue this level of analysis as a means of understanding how social learning might affect language acquisition, we must not neglect more basic roles for visual stimulation. Blind infants produce a lower proportion of sounds that begin with the visible initial consonants, for example, labial versus dental/palatal sounds (Mulford, 1988). Blind infants are denied access not only to speech referents but also to the facial mechanics of speech production. This latter form of deprivation is less obvious but may be no less crucial as it limits the degrees of freedom in the child's developing lexicon.

Such data also indicate the need to consider the multimodal nature of experiences relevant to the development of communicative skills, another parallel to studies of songbirds. The contributions of species-typical stimulation may often be more difficult to see because we dissect them with reference to the physical anatomy of the organism. We speak of the effects of visual or auditory or tactile experience as if the senses traveled forever on unconnected pathways. Although some cross-modal systems such as visual and haptic stimulation have been explored in detail, the basic classification of kinds of sensory information available is referenced to sense organs, not sensory experiences.

Resurrection of J. J. Gibson's concept of a "performatory" system of perceptual activity might facilitate analysis at a more integrative level. He offered the term "performatory" to emphasize that "action-based stimulation is *obtained*, not *imposed*" (1966, p. 31) and to argue that classification of stimulation should be based on the function of behavior, not on its location in the nervous system. Along these lines, it is worth noting that the categorization of babbling with reference to speech behavior as opposed to acoustic description was the basis for definition of canonical babbling (Oller, 1986). A functional approach prevailed and led to the aforementioned findings of experiential effects.

A final comparative issue involves the general constructs of birdsong and language. The tendency to talk about them as nouns flows subtly into an innate framework. Making them things instead of activities makes them seem more comparable to bodily organs and hence internal possessions. But birds do not have songs as they have tail feathers. Infants do not acquire language as they acquire teeth. The actual unit of analysis is a complex of verbs including vocalizing, comprehending, discriminating, attending, imitating, memorizing, and improvising, to name only the most obvious. Once the energy of verbs is added to the equation, it becomes more difficult to see the concept of innateness as equally applicable to all the activities that constitute even the beginnings of communication.

Conclusions

What then is the value of the concept of innate behavior? There is no doubt that animals are as constitutionally designed to communicate in particular ways as they are constitutionally designed to walk or fly or move in only certain ways. At this level of analysis, the concept of innateness is not problematic. It sums up in one word the actions of natural selection over innumerable generations to breed into the bone and into the brain capacities that favor survival in the average expectable environment of a species. However at the level of explaining the ontogeny of individuals in the range of environments actually constituting a species' habitat, the concept cannot be relied on to convey the multiple sources of stimulation that transform capacity into competence.

Said another way, being told a behavior is innate seems comparable to being given the name of a commercial cake mix when requesting information on how to bake a cake. We still must analyze the cake mix to answer the original question, not only to isolate ingredients but to learn about the order in which they are to be used and their chemical, thermal, or mechanical states as the recipe progresses. To study ontogeny, we too must unpack the rhetoric comprising the concept of innateness in order to identify mechanisms.

And thus, we have tried to refrain from using the word "innate" because it is a weasel word, a word "used in order to evade or retreat from a direct or forthright statement or position" (*Webster's Ninth New Collegiate Dictionary*). A behavior is often labeled as innate when we find no evidence that "the environment" or "experience" affected developmental outcome. But what is meant by "environment" or "experience"? Can we base a science of development on an inflated verbal currency backed only by the heavy hand of habit? The word "environment" can refer to the cosmos or the microcosm of the genome. Can we really expect the science of development to rely on one word to capture all environmental effects? In the same way the word "experience" sometimes denotes a brief but dramatic event and sometimes a gradual change as a result of direct practice or participation. The term "interaction," often recruited as a peacemaker between nature and nurture, is also suspect as a scientific construct because interactions take myriad forms. Thus, the label "innate" should carry a warning, "Buyer beware."

In closing, we offer a final thought. The studies reported here on cowbirds and human infants indicate that ontogenetic stages previously thought to be insensitive

to experiential variation are not. The stages studied occur just prior to the onset of the formal behaviors at issue, birdsong and speech. If young birds and infants make use of environmental input prior to the appearance of "true" songs or words, why would they refrain from using such abilities later on? And yet theories of language acquisition during the second year of life that assume an innateness position would seem to have to make explicit such a postulate. If babbling can be shaped by contingent experiences, why should later achievements not also be susceptible to influence? Recent evidence from Moerk (1986) suggests that some syntactical achievements can in fact be predicted from a knowledge of the language forms used by parents. We urge continued caution before assuming that the environment fails to have an impact at these later stages.

We also suggest that scientific constructs appropriate for one stage of development not be overextended to explaining the next stage. Children outgrow this strategy and so should we. Perhaps the most important lesson of the studies of cowbirds and babies is recognizing how often our instincts about how development ought to work can be wrong. Such mistakes fuel the nature of discovery. It is not only entirely human to err, it is also utterly scientific.

Note

The work reported here was funded by grants from the National Science Foundation and the National Institute of Neurological and Communicative Disorders and Stroke and by the National Institutes of Health Biomedical Support Grant 2S07 RR07072 to the University of North Carolina. A similar version of this article was presented in April 1987 at the meeting of the Society for Research in Child Development in Baltimore, MD. We thank D. Owings and C. Snowdon for thoughtful reviews.

References

- Bloom, K., Russell, A., & Wassenberg, K. (1987). Turn taking affects the quality of infant vocalizations. *Journal of Child Language*, 14, 211-227.
- Eilers, R. E., & Oller, D. K. (1988). Precursors to speech: What is innate and what is acquired? In R. Vasta (Ed.), *Annals of child development* (Vol. 5, pp. 1-32). New York: JAI Press.
- Elbers, L., & Ton, J. (1985). Play pen monologues: The interplay of words and babbles in the first word position. *Journal of Child Language*, 12, 551-565.
- Frost, R. (1963). *Selected poems of Robert Frost* (pp. 181-183). San Francisco: Rinehart.
- Friedmann, H. (1929). *The cowbirds*. Springfield, IL: Thomas.
- Friedmann, H. Kiff, L. F., & Rothstein, S. I. (1977). A further contribution to the knowledge of host relations in parasitic cowbirds. *Smithsonian Contributions to Zoology*, No. 235.
- Gibson, J. J. (1966). *The senses considered as perceptual systems*. Boston: Houghton Mifflin.
- Gottlieb, G. (1976). Roles of early experience in the development of behavior and the nervous system. In G. Gottlieb (Ed.), *Studies in the development of behavior and the nervous system* (Vol. 3, pp. 25-54). New York: Academic Press.
- Gottlieb, G. (1980). Development of species identification in ducklings: VII. Highly specific early experience fosters species-specific perception in wood ducklings. *Journal of Comparative and Physiological Psychology*, 94, 1019-1027.
- Jakobson, R. (1941). *Kindersprache, Aphasie, und allgemeine Lautgesetze*. Uppsala: Almqvist and Wiksell.
- Kent, R. D., Osberger, M. J. Netsell, R. & Hustedde, C. G. (1987). *Journal of Speech and Hearing Disorders*, 52, 64-75.

- King, A. P., & West, M. J. (1977). Species identification in the North American cowbird: Appropriate responses to abnormal song. *Science*, *195*, 1002-1004.
- King, A. P., & West, M. J. (1983a). Dissecting cowbird song potency: Assessing a song's geographic identity and relative appeal. *Zeitschrift für Tierpsychologie*, *63*, 37-50.
- King, A. P., & West, M. J. (1983b). Female perception of cowbird song: A closed developmental program. *Developmental Psychobiology*, *16*, 335-342.
- King, A. P., & West, M. J. (1983c). Epigenesis of cowbird song: A joint endeavor of males and females. *Nature*, *305*, 704-706.
- King, A. P., & West, M. J. (1987). Different outcomes of synergy between song production and song perception in the same subspecies (*Molothrus ater ater*). *Developmental Psychobiology*, *20*, 177-187.
- King, A. P., & West, M. J. (1988). Searching for the functional origins of cowbird song in eastern brown-headed cowbirds, *Molothrus ater ater*. *Animal Behaviour*, *36*, 1575-1588.
- King, A. P., & West, M. J. (1989). The presence of female cowbirds (*Molothrus ater ater*) affects vocal imitation and improvisation in males. *Journal of Comparative Psychology*, *103*, 39-44.
- King, A. P., West, M. J., & Eastzer, D.H. (1986). Female cowbird song perception: Evidence for different developmental systems within the same subspecies. *Ethology*, *72*, 89-98.
- Kroodsma, D. E., & Baylis, J. R. (1982). Appendix: A world survey of evidence for vocal learning in birds. In D. E. Kroodsma & E. H. Miller (Eds.), *Acoustic communication in birds* (Vol. 2, pp. 311-337). New York: Academic Press.
- Kuo, Z. Y. (1967). *The dynamics of behavior development*. New York: Random House.
- Lenneberg, E. H. (1967). *Biological foundations of language*. New York: Wiley.
- Lenneberg, E. H., Reblsky, F. G. & Nichols, I. A. (1965). The vocalizations of infants born to deaf and hearing parents. *Human Development*, *8*, 23-27.
- Locke, J. L., & Pearson, J. M. (1988). Linguistic significance of babbling: Evidence from a tracheostomized infant. Unpublished manuscript.
- Marler, P. (1970). Birdsong and speech development: Could there be parallels? *American Scientist*, *58*, 669-673.
- Marler, P. (1982). Some ethological implications for neuroethology: The ontogeny of birdsong. In J. P. Ewert, R. R. Capranica, & D. J. Ingle (Eds.), *Advances in vertebrate neuroethology* (pp. 21-52). New York: Plenum.
- Moerk, E. L. (1986). Environmental factors in early language acquisition. In G. J. Whitehurst (Ed.), *Annals of child development* (Vol. 3, pp. 191-235). New York: JAI Press.
- Mulford, R. (1988). First words of the blind child. In M. D. Smith & J. L. Locke (Eds.), *The emergent lexicon* (pp. 293-340). New York: Academic Press.
- Oller, D. K. (1986). Metaphonology and infant vocalizations. In F. Lindblom & R. Zetterstrom (Eds.), *Precursors of early speech* (pp. 1-15). New York: Stockton.
- Oller, D. K., & Eilers, R. (1988). The role of audition in infant babbling. *Child Development*, *59*, 441-449.
- Oller, D. K., & Seibert, J. M. (1988). Babbling in prelinguistic retarded infants. *American Journal of Mental Retardation*, *92*, 369-375.
- Oller, D. K., Weiman, L. A., Doyle, W. J., & Ross, C. (1976). Infant babbling and speech. *Journal of Child Language*, *3*, 1-11.
- Petrinovich, L. (1972). Psychobiological mechanisms in language development. In G. Newton & A. H. Riesen (Eds.), *Advances in Psychobiology* (Vol. 1, pp. 259-285). New York: Wiley-Interscience.
- Searcy, W. A., and Andersson, M. (1986). Sexual selection and the evolution of song. *Annual Review of Ecology and Systematics*, *17*, 507-533.
- Thorpe, W. A. (1961). *Bird-song: The biology of vocal expression in birds*. London: Cambridge University Press.
- Webster's Ninth New Collegiate Dictionary*. (1984). Springfield, MA: Merriam-Webster.
- Werker, J. F. (1989). Becoming a native listener. *American Scientist*, *77*, 54-59.
- West, M. J., & King, A. P. (1985). Social guidance of vocal learning by female cowbirds: Validating its functional significance. *Zeitschrift für Tierpsychologie*, *70*, 225-235.
- West, M. J., & King, A. P. (1986). Song repertoire development in male cowbirds: Its relationship to female discrimination of song potency. *Journal of Comparative Psychology*, *100*, 296-303.
- West, M. J., & King, A. P. (1987). Settling nature and nurture into an ontogenetic niche. *Developmental Psychobiology*, *20*, 549-562.

- West, M. J., & King, A. P. (1988a). Coming to terms with the everyday language of comparative psychology. In D. Leger (Ed.), *Nebraska Symposium on Motivation* (Vol. 35, pp. 51–89). Lincoln: University of Nebraska Press.
- West, M. J., & King, A. P. (1988b). Female visual displays affects the development of male song in the cowbird. *Nature*, 334, 244–246.
- West, M. J., & King, A. P. (1988c). Vocalizations of juvenile cowbirds (*Molothrus ater ater*) evoke copulatory responses from females. *Developmental Psychobiology*, 21, 543–552.
- West, M. J., King, A. P., & Eastzer, D. H. (1981). Validating the female bioassay of cowbird song: Relating differences in song potency to mating success. *Animal Behaviour*, 29, 490–501.
- West, M. J., King, A. P., Eastzer, D. H., & Staddon, J. E. R. (1979). A bioassay of isolate cowbird song. *Journal of Comparative and Physiological Psychology*, 93, 124–133.
- West, M. J., King, A. P., & Harrocks, T. H. (1983). Cultural transmission of cowbird song (*Molothrus ater*): Measuring its development and outcome. *Journal of Comparative Psychology*, 97, 327–337.