THE ACOUSTIC ORIGIN OF THE SMILE*

by

John J. Ohala

Phonology Laboratory
Department of Linguistics
University of California
Berkeley, CA 94720

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ABSTRACT

In many species, appeasement or submissive vocalizations have a high fundamental frequency in order that the sender may sound like an infant and thus elicit a parental helping response from its would-be antagonist [Morton, Am. Naturalist 111, (1977)]. High vocal tract resonances may also enhance the infantile character of the vocalization by seeming to originate from a shorter vocal tract. Higher resonances can be achieved by a trumpet-like flaring of the tract and/or by retracting the corners of the mouth. This latter gesture, I hypothesize, is the origin of the smile. Ritualization of the visual component of this acoustically-motivated gesture accounts for the smile often being performed soundlessly by man and higher primates. The up-shifting of the resonances due to mouth corner retraction and/or flaring was simulated using pulsed plasticine models of vocal tracts. Significantly, the ethological literature also documents a widely found cross-specific aggressive display that involves constriction and protrusion of the lips, which by lowering the resonances of the vocalization would enhance the impression that the sender was very large.

Ethologists seek to explain animal behavior and, by extrapolation, human behavior. Perhaps their greatest challenge is explaining stereotyped behavior in which there is an apparent mismatch between the form and the function of the behavior. For example, in contrast to limb movement during locomotion, where form and function agree, there is the curious habit of bulls (and other ungulates) of pawing the ground with the forelimbs prior to charging.

Another stereotyped behavior which many species display and in which form and function seem to be separated is the smile, i.e., retraction of the mouth corners. All species showing this gesture, e.g., dogs (and other canids), primates, including humans, seem to use it in similar ways. It is displayed by subordinates towards those higher on the social hierarchy or towards potential antagonists--apparently to signal appeasement, deference, submission, and the like. It is also displayed by dominant individuals approaching a subordinate or an equal without aggressive intent, as, for example, when soliciting copulation,--in other words, to put one's companions at ease. In both situations, one can say that the smile serves to make the receiver (viewer) react in a kindly, amiable, tolerant way toward the sender (smiler).[1] Why, then, in its most intense form, the open-mouthed smile, should the teeth be displayed? As is evident from Figure 1, in most instances, display of the teeth usually, and quite understandably, signals aggression or intention to attack.

Ethologists have posited evolutionary scenarios where the mouth corner retraction was originally a gesture preparatory to biting or a gesture whose primary purpose was the removal of something noxious from the mouth.[2] Such scenarios are ingenious and have much to recommend them[3] but they require that rather large functional changes overtook this gesture from its origins to the present.

I propose instead that the shape of the mouth in the smile may have originally functioned--and in some species still functions--to modify the acoustic quality of an accompanying vocalization.

Morton (1977) has presented convincing evidence for the use of what may be called a "frequency code" by a variety of mammals and birds in their close-contact vocalizations during agonistic encounters. Aggressive individuals tend to utter low-pitched and/or aperiodic vocalizations, i.e., "growls". Submissive individuals use high-pitched, tonelike vocalizations, i.e., "whines" or "yelps". The reason for this, Morton theorized, is as follows: The animal that hopes to win the competition can intimidate its opponent by appearing to be as large as possible and accomplishes this in part by familiar visual means, e.g., erecting the hair, ears, tail, etc. It can also do this by emitting a low-pitched vocalization since the rate and smoothness of vibration of the vocal cords will be inversely proportional to vocal cord mass which itself will be positively correlated with overall body size.[4] On the other hand, a animal wishing to avoid the fight will attempt to inhibit the

aggression directed at it. It has a good chance of doing this if it appears to be as small as possible, i.e., small enough to constitute no threat to the other or, possibly, to appear to be an infant of the species. Adults of many species will not attack an infant and may even give care and protection to an infant in distress. A high-pitched tonelike vocalization would enhance the infantile aspect because that is the kind of cry the smaller vocal cords of an infant would naturally produce.

(I am, of course, using the usual shorthand expressions of ethology here: I do not mean, literally, that a submissive animal actually intends to mimic an infant but rather that natural selection would have favored animals that exhibited such behavior when threatened because it would earlier have favored adults who would respond sympathetically to infants in distress.)

Thus, the pitch of these vocalizations serves indirectly to convey an impression of the size of the sender as do so many visual aggressive and submissive signals.

I propose that the open-mouthed smile originally functioned in a similar way. Opening the mouth wide (producing a trumpet-like flaring) and retracting the corners of the mouth raises the resonances of an accompanying vocalization in such a way as to make it resemble the cry that would naturally be produced by the shorter vocal tract of a smaller individual. Mouth corner retraction would be particularly effective for this purpose in animals with snouts.

It is easy to demonstrate this effect with pulsed plasticine models of vocal tracts. In fact, this rather primitive approach is necessary since the mathematical accounts of the conversion between vocal tract shape and sound cannot easily take into account radiation surfaces which do not lie in a single plane normal to the long axis of the tract.[5] Figure 2 shows the spectra of three simple cylindrical vocal tracts, all of which have cross-dimensional areas of 3 cm^2. At the top is a 14 cm long uniform tube (approximately the length of a chimpanzee vocal tract) and at the bottom is a 10 cm long uniform tube. Naturally, the shorter tube has higher resonances.[6] The tube in the middle is also 14 cm long but has simulated mouth corner retraction of 4 cm. It shows the resonances raised in the direction of those that would be characteristic of a shorter tract (actually, one about 12 cm long). Flaring of the tract termination would have a similar effect, as is well known.[7]

Ritualization of this corner retraction--that is, where one gesture preparatory to a second, subsequent one comes to take on the meaning of or to signal the intention to perform the second gesture--can explain why the smile is often given soundlessly or even with the mouth shut, at least by humans and higher primates such as the chimpanzee. Nevertheless, the ethological literature suggests that among the lower primates the open-mouthed smile is almost invariably displayed during a high-pitched vocalization, part of a submissive or appeasement signal.[8]

Additional support for my hypothesis comes from the fact that a facial expression commonly displayed by aggressive individuals of many species, e.g., the dog, involves just the opposite of the open-mouthed smile: the mouth opening is somewhat constricted and the mouth corners are brought forward (see Figures 3 and 4). Why, during an aggressive display, should the teeth, the primary offensive weapon, be partially hidden? Again, the answer may be that, as in the case of the smile, this mouth shape originally served (and in some cases may still serve) to modify the resonances of an accompanying growl: such puckering of the lips makes the growl's resonances lower and thus make it sound like it came from a much larger individual, thus helping to intimidate an opponent.

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FOOTNOTES

1 Cf. Andrew 1963a, b; van Hooff 1967, 1972; Eibl-Eibesfeldt 1971; Izard 1971.

2. Cf. Andrew 1963a, b; Bolwig 1964; Eibl-Eibesfeldt 1971; Izard 1971.

3. Andrew hypothesizes that mouth corner retraction shown during a submissive display is but one part of a generalized protective response whose primary and original purpose was to guard vital parts of the body from injury in the face of some sudden threat to life or limb. Thus, (a) the mouth corners are retracted and the head shaken in order to dislodge something noxious from the mouth, (b) the ears are flattened to keep them from being torn, (c) the eyes are closed to keep foreign objects out, (d) the glottis is closed to keep objects out of the lungs (whence the strong vocalization that accompanies such displays), etc. This is an elegant scenario and succeeds in knitting together in a principled way a number of the separate elements of a typical submissive display as produced, for example, by many primates. Nevertheless, this account does not explain why a gesture to dislodge a foreign object from the mouth should be given in response to a threat from another animal. Natural selection, one would think, would quickly eliminate individuals who gave such a non-functional response in such a situation in favor of those who dealt with a threat in a more practical way, say, by immediately fleeing or by trying to turn off the aggression directed at them. The use of the "frequency code" which indirectely conveys to the receiver an impression of the size of the sender, which Morton suggests motivates patterns of fundamental frequency of agonistic vocalizations, and which I claim motivates patterns of the spectral quality of these vocalizations, does constitute a practical response and one which, therefore, would be favored by natural selection.

4 Cf. Gautier and Gautier 1977; Meuser and Nieschlag 1977; Ryan 1980.

5 Cf. Fant 1960; Flanagan 1965:32ff.

6 Cf. Fant 1960; Pickett 1980.

7 Cf. Fant 1960.

8 Cf. Andrew 1963a; van Hooff 1967, 1972.

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Figure 1. Two mouth shapes in which teeth are shown. Left: the "snarl"; right: the open-mouthed smile.

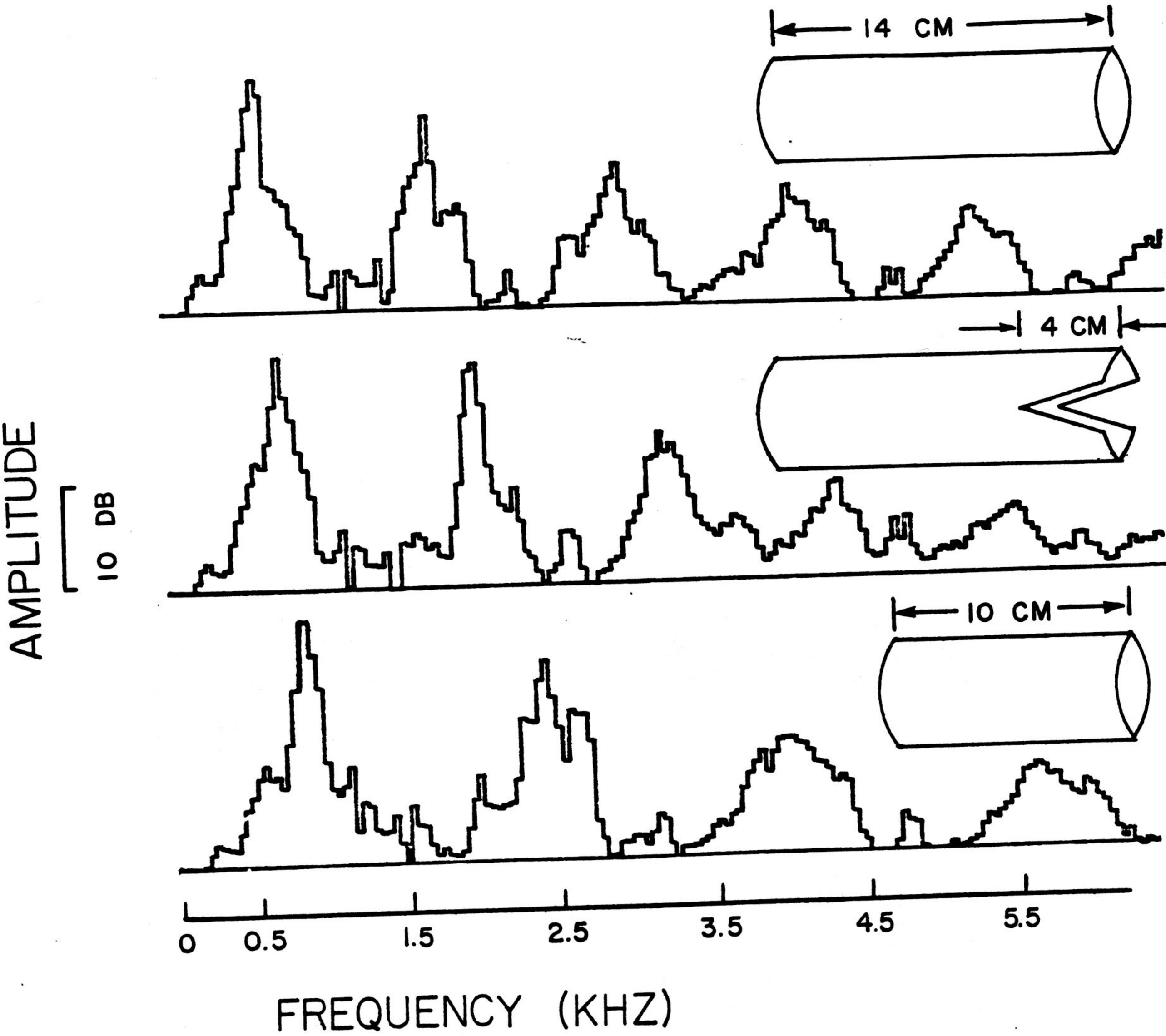
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Figure 3. Two facial expressions of dogs and other canids. Left: expression of submission; right: expression of aggression. Mouth corners are retracted in the former, brought forward in the latter. (Redrawn from Schenkel, 1947.)

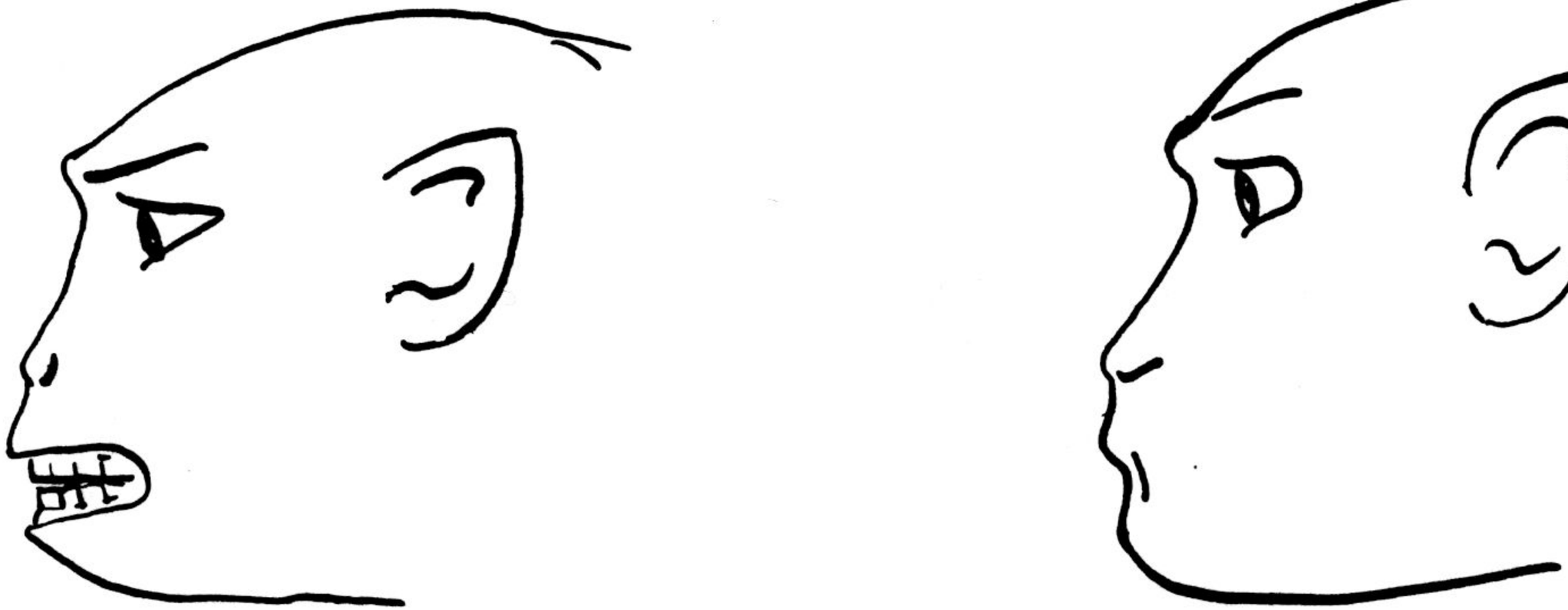

Figure 4. Two facial expressions of monkeys. Left: expression of submission; right: expression of aggression. Mouth corners retracted in the former, brought forward in the latter. (Redrawn from .van Hooff, 1962.)