Table 1. Calculating a constriction's proximity to a resonance's velocity minimum or maximum from the constriction's proportional distance from the glottis to the lips.

Place of constriction	Segment	Proportion of oral cavity length	Proximity to minimum or maximum		
			Calculation	Odd/even	Lower/higher
Labial	b	1	1*λ1/4=1/4 1*3λ2/4=3/4 1*5λ3/4=1/4	Odd Odd Odd	F1 lower F2 lower F3 lower
Alveolar	d	7/8	7/8*λ1/4=7/32≈1/4 7/8*3λ2/4=21/32≈3/4 7/8*5λ3/4=35/32≈4/4	Odd Odd Even	F1 lower F2 lower F3 higher
Palatal	i	3/4	3/4*λ1/4=3/16≈1/4 3/4*3λ2/4=9/16≈2/4 3/4*5λ3/4=15/16≈4/4	Odd Even Even	F1 lower F2 higher F3 higher
Velar	g, u	2/3	2/3*λ1/4=2/12≈1/4 2/3*3λ2/4=6/12≈2/4 2/3*5λ3/4=10/12≈3/4	Odd Even Odd	F1 lower F2 higher F3 lower
Pharyngeal	a	1/4	1/4*λ1/4=1/16≈0/4 1/4*3λ2/4=3/16≈1/4 1/4*5λ3/4=5/16≈1/4	Even Odd Odd	F1 higher F2 lower F3 lower

again be predicted once the acoustic effects of lip rounding are added, as the simultaneous labial constriction, together with the protrusion of the lips, lowers F2 along with all other formants.

Summary

Speech sounds' articulations produce sound sources by transforming aerodynamic energy into acoustic form, and those sound sources in turn cause air inside the oral cavity to resonate, at frequencies determined by the length of the resonating cavities and where they are constricted.

– John Kingston

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ADAPTATION

An adaptation is a characteristic in an organism that evolved because it helped the organism or its relatives to survive and reproduce. Examples include the vertebrate eye, claws, mammary glands, the immune system, and the brain structures that underlie the human capacity for language. More completely, an adaptation is 1) a reliably developing set of characteristics 2) whose genetic basis became established and organized in the species (or population) over evolutionary time because 3) the adaptation interacted with recurring features of the body or environment 4) in a way that, across generations, typically caused this genetic basis to increase its gene frequency.

If a characteristic lacks any of these features, it is not an adaptation. An adaptation is not, therefore, simply anything in an individual with a "good" or "functional" outcome, or that has useful effects by intuitive standards. Rice cultivation, useful as it is, is not a biological adaptation because it lacks a specific genetic basis. Similarly, the English language is not an adaptation, however useful it might be. In contrast, if a mutation occurred that modified a neural structure so that the vocal chords could more reliably produce distinct phonemes, and this gene spread throughout the species because its bearers prospered due to the advantages resulting from a lifetime of more efficient communication, then the modified neural structure would qualify as an adaptation.

Researchers judge whether something is an adaptation by assessing how likely or unlikely it is that its functional organization was produced by random mutation and spread by genetic drift. For example, the eye has hundreds of elements that are arranged with great precision to produce useful visual inputs. It is astronomically unlikely that they would have arrived at such high levels of mutual coordination and organization for that function unless the process of natural selection had differentially retained them and spread them throughout the species. Consequently, the eye and the visual system are widely considered to be obvious examples of adaptations. For the same reason, evolutionary scientists consider it overwhelmingly likely that many neurocognitive mechanisms underlying language are adaptations for communication (a proposition that Noam Chomsky has disputed; see Lyle Jenkins's essay, "Explaining Language," in this volume). Language competence reliably develops, is believed to have a species-typical genetic basis, and exhibits immensely complex internal coordination that is functionally organized to produce efficient communication, which vastly enhances the achievement of instrumental goals, plausibly including those linked to fitness.

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Within the evolutionary sciences, the concept of adaptation plays an indispensable role not only in explaining and understanding how the properties of organisms came to be what they are, but also in predicting and discovering previously unknown characteristics in the brains and bodies of species.Evolutionary psychologists, for example, analyze the adaptive problems our ancestors were subjected to, predict the properties of previously unknown cognitive mechanisms that are expected to have evolved to solve these adaptive problems, and then conduct experimental studies to test for the existence of psychological adaptations with the predicted design (see EVOLUTIONARY PSYCHOLOGY). An understanding that organisms embody sets of adaptations rather than just being accidental agglomerations of random properties allows organisms to be properly studied as functional systems. If language is accepted as being the product of adaptations, then there is a scientific justification for studying the underlying components as part of a functional system.

The concept of adaptation became more contentious when human behavior and the human psychological architecture began to be studied from an adaptationist perspective. Critics have argued that not every characteristic is an adaptation – an error adaptationists also criticize. More substantively, critics have argued that it is impossible to know what the past was like well enough to recognize whether something is an adaptation. Adaptationists counter that we know many thousands of things about the past with precision and certainty, such as the three-dimensional nature of space and the properties of chemicals, the existence of predators, genetic relatives, eyes, infants, food and fertile matings, and the acoustical properties of the atmosphere, and that these can be used to gain an engineer's insight into why organisms (including humans) are designed as they are.

– Julian Lim, John Tooby and Leda Cosmides

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AD HOC CATEGORIES

An ad hoc category is a novel category constructed spontaneously to achieve a goal relevant in the current situation (e.g., constructing *tourist activities to perform in Beijing* while planning a vacation). These categories are novel because they typically have not been entertained previously. They are constructed spontaneously because they do not reside as knowledge structures in long-term memory waiting to be retrieved. They help achieve a relevant goal by organizing the current situation in a way that supports effective goal pursuit.

Ad hoc categories contrast with thousands of well-established categories associated with familiar words (e.g., *cat, eat, happy*). Extensive knowledge about these latter categories resides in memory and may often become active even when irrelevant to current goals. When ad hoc categories are used frequently, however, they, too, become highly familiar and well established in memory. The first time that someone packs a suitcase, the category *things to pack in a suitcase* is ad hoc. Following many trips, however, it becomes entrenched in memory.

Ad hoc categories constitute a subset of role categories, where roles provide arguments for verbs, relations, and **SCHEMATA**. Some role categories are so familiar that they become lexicalized (e.g., *seller, buyer, merchandise,* and *payment* name the agent, recipient, theme, and instrument roles of *buy*). When the conceptualization of a role is novel, however, an ad hoc category results (e.g., *potential sellers of gypsy jazz guitars*). Pursuing goals requires the constant specification and instantiation of roles necessary for achieving them. When a well-established category for a role doesn't exist, an ad hoc category is constructed to represent it.

Both conceptual and linguistic mechanisms appear central to forming ad hoc categories. Conceptually, people combine existing concepts for objects, events, settings, mental states, properties, and so on to form novel conceptual structures. Linguistically, people combine words in novel ways to index these concepts. Sometimes, novel concepts result from perceiving something novel and then describing it (e.g., seeing a traditional opera set in a modern context and describing this newly encountered genre as "modernized operas"). On other occasions, people combine words for conceptual elements before ever encountering an actual category instance (e.g., describing mezzo sopranos who have power, tone, and flexibility before experiencing one). The conceptual and linguistic mechanisms that formulate ad hoc categories are highly productive, given that components of these categories can be replaced systematically with alternative values from *semantic fields* (e.g., *tourist activities to perform in X,* where *X* could be *Rome, Florence, Venice,* etc.). Syntactic structures are also central for integrating the conceptual/linguistic components in these categories (e.g., the syntax and accompanying closed class words in *tourist activities to perform in Rome*).

Lawrence Barsalou (1983) introduced the construct of ad hoc categories in experiments showing that these categories are not well established in memory and do not become apparent without context. Once constructed, however, they function as coherent categories, exhibiting internal structures as indexed by typicality gradients. Barsalou (1985) showed that these gradients are organized around ideal values that support goal achievement and also around frequency of instantiation. He also showed (1987) that these internal structures are generally as stable and robust as those in familiar taxonomic categories.

Barsalou (1991) offered a theoretical framework for ad hoc categories (see also Barsalou 2003). Within this framework, ad hoc categories provide an interface between roles in knowledge structures (e.g., schemata) and the environment. When a role must be instantiated in order to pursue a goal but knowledge of possible instantiations does not exist, people construct

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