



## Why did language develop?

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### 5 KEYWORDS

6 Gesture;  
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**Summary** Language developed for communication, to facilitate learning the use of tools and weapons, to plan hunting and defence, to develop a “theory of mind” and the tools of thought, and to attract and keep a mate. The adaptations required took place over many millions of years. The first important one was left-sided specialisation of the neural apparatus controlling involuntary emotional vocalisations that began more than 200 million years ago. The next was the development in primates of “mirror neurones” in the pre-motor cortex some 45 million years ago. These enabled the imitation and voluntary control of previously involuntary manual gestures and vocalisations. The third important adaptation was the descent of the larynx, 100,000 years ago, which greatly increased the phonological range of vocalisations that could be made. Thus, language did not develop all at once as suggested by Chomsky, but evolved gradually building upon adaptations originally meeting quite different needs. © 2003 Published by Elsevier Ireland Ltd.

18 To ask why language developed might seem a  
19 very odd question; most people would say that  
20 the answer is blindingly obvious. Clearly, humans  
21 evolved language in order to be able to communi-  
22 cate with each other. Thinking about it long after  
23 the event, that seems trivially obvious to us. But  
24 we have to ask why more efficient means of com-  
25 munication than already existed in the form of  
26 facial expressions, gestures and vocalisations, was  
27 so selectively advantageous to humans. Actually  
28 language seems to have evolved relatively recently,  
29 perhaps only 50,000 years ago. So, despite its ob-  
30 viousness to us, development of language commu-  
31 nication was not that overwhelmingly essential. In  
32 this paper I want to show that language and then  
33 literacy only evolved gradually, long after many  
34 other things were in place. Contrary to Chomsky’s  
35 suggestion [2], recent opinion is that language was  
36 not the result of a sudden mutation endowing us  
37 with a new “neurologically encapsulated linguis-  
38 tic processor;” instead, it evolved gradually from

anatomical and physiological adaptations that took  
place long before. The main reason, I believe, this  
is important is that it means that we can hope  
to understand impairments in the development of  
language and literacy, in terms of the basic biolog-  
ical processes that underlie them. Ontology does  
to some extent mimic phylogeny, and understand-  
ing how basic motor, auditory and visual processes  
led to the development of language and literacy  
can help us to elucidate how they go wrong in  
conditions such as developmental dysphasia and  
dyslexia.

To understand how language evolved, we need to  
consider not only the selection pressures that oper-  
ated to advantage it, but also the genetic variations  
that occurred by mutation that made it possible.  
First, therefore, I will provide a very brief overview  
of ideas on why there were advantages to improving  
communication by the development of language,  
and then an equally brief review of the evolution  
of Homo Sapiens. Then, I will describe the evolu-  
tionary adaptations that were essential for the de-  
velopment of language before detailing how these  
may have mediated it.

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63 There are three strains of theory about what  
64 kind of selective advantage linguistic communica-  
65 tion provided for hominids [1]. The first suggestion  
66 is that it enabled the shared use of tools, i.e. the  
67 development of technology. In this scenario, the  
68 development of language was required to explain  
69 how tools should be used and to discuss the best  
70 ways of employing them. If these tools happened  
71 to be weapons, then they could be used for hunting  
72 either animals for food or indeed, enemy Nean-  
73 derthals. Sad to say, it seems that our ancestors  
74 simply annihilated their main competitors.

75 It has been pointed out that chattering away  
76 would not lead to a very successful hunt; but, of  
77 course, the conversations would have taken place  
78 in order to plan the hunt. The requirement for such  
79 planning gives rise to the second main suggestion  
80 about the pressure to develop language, namely  
81 that language enables you to discuss what is likely  
82 to happen by predicting and representing it in ab-  
83 stract terms, i.e. language gives you the tools to  
84 think about it.

85 This representation need not be confined to plan-  
86 ning a hunt, but could also be used as the basis  
87 of thinking about all manner of things. Perhaps the  
88 most important of these would be helping to deter-  
89 mine what others are thinking, developing a "the-  
90 ory of mind." Cynics believe this to be the basis  
91 of "Machiavellian intelligence," working out what  
92 people are likely to be thinking, thus being in a bet-  
93 ter position to deceive them and gain advantage.  
94 But, I prefer to emphasise how developing a the-  
95 ory of mind would naturally lead to the invention  
96 of the tools of thought: categorisation, quantifica-  
97 tion, abstraction, causality and logic.

98 The third kind of pressure that might have  
99 favoured the development of language was the re-  
100 quirement to find a mate. This sexual pressure is  
101 certainly the main driving force behind bird song.  
102 In fact, the left-sided brain structures that control  
103 song production by the syrinx actually increase in  
104 size during the breeding season; they grow new  
105 neurones under the influence of testosterone, and  
106 then during the winter, lose these neurones and  
107 regress. In addition, because of the long childhood  
108 of humans, females have the need to retain their  
109 mate for several years to help bring up the chil-  
110 dren. This is, therefore, the only account that can  
111 explain why females are in general slightly better  
112 at communication than males.

113 These three suggestions are not mutually exclu-  
114 sive; probably all three are partly correct. But they  
115 are almost impossible to confirm or refute. Hence,  
116 they are to a certain extent like Kipling's Just So  
117 Stories: how the rhinoceros got his skin might have  
118 been because the Parsee put itchy raisins into it

119 when he'd taken it off to swim; but that is very un-  
120 likely. Our stories about the selective advantage of  
121 communication by speech sound much more plau-  
122 sible, but since unprovable they might be just as  
123 totally off beam.

124 We must now consider the fossil record indicat-  
125 ing how Humans evolved, incomplete as it is. Mam-  
126 mals first appeared on the earth about 200 million  
127 years ago; primates around 65 million; the first An-  
128 thropoids about 45 million and Chimpanzees some  
129 12 million years ago. The first Hominoid, Ankarap-  
130 ithecus, split from the Chimp line about 9 million  
131 years ago, Australopithecus appeared around 3 mil-  
132 lion years ago, *H. erectus* at 2 million, Neanderthals  
133 250,000 and Homo Sapiens 200,000 years ago.

134 However, the important features of this history  
135 from the point of view of language development  
136 were that the left side of the brain became spe-  
137 cialised for the production of sounds many millions  
138 of years ago. Then bi-pedalism developed in the  
139 first phase of hominoid evolution, and this freed the  
140 arms for more efficient food gathering, tool use and  
141 gesturing. Descent of the larynx then made the voic-  
142 ing of phonemes possible to increase their number,  
143 and finally, almost in modern time, the develop-  
144 ment of consistent right-handedness seems to have  
145 been important for the invention of writing.

146 The origins of left-sided cerebral specialisation  
147 can actually be discerned from almost the very be-  
148 ginning of life in that the laevo-isomers of biolog-  
149 ical molecules are always favoured. The strongest  
150 asymmetries favouring the left are certainly found  
151 in birds, but they are not seen so strongly again until  
152 we reach Homo Sapiens. It is surely no accident that  
153 the two groups that make the most use of acoustic  
154 communication site the control system on the left.

155 However, walking on two legs only commenced  
156 with Homo erectus, just 2 million years ago, un-  
157 less you count Kangaroos that evolved in Australia  
158 separately from the mammals. The third important  
159 adaptation that enabled the development of true  
160 speech was the descent of the larynx, but this only  
161 occurred about 200,000 years ago. Even though  
162 other evidence suggests that true speech did not  
163 evolve until much later, perhaps only 35,000 years  
164 ago, descent of the larynx and the wider variety  
165 of sounds that this enabled must have been suf-  
166 ficiently advantageous to outweigh the danger of  
167 inhaling food.

168 The order in which these adaptations appeared  
169 is important because it sketches out the basis of  
170 how the capacity for speech may have developed  
171 innately. For a long time there have been argu-  
172 ments about whether language is innate or learnt.  
173 In 7000 b.c., the Egyptian pharaoh Tsammtemichus  
174 was said to have had a child brought up in isolation

175 in a cage to find out whether he would speak with-  
 176 out any teaching. His first word was the Phrygian  
 177 word for bread; which he had clearly learnt from his  
 178 guards, so the experiment suggested that language  
 179 was learnt. In Agra, in the 17th Century, a.d., Mogul  
 180 Akbar Khan ensured strict silence in his brutal ver-  
 181 sion of the experiment by employing dumb nurses  
 182 to rear 12 children in isolation. He found to his sur-  
 183 prise that none of the children learned to speak at  
 184 all, again implying that language had to be learnt  
 185 by example. In the 1960s, Genie was found in Los  
 186 Angeles completely unable to talk because she had  
 187 been protected by her over religious parents from  
 188 almost all sensory input that might have contami-  
 189 nated her with evil, by being locked up in a dark  
 190 cupboard. These and a host of other evidence have  
 191 shown clearly that language has to be learnt. The  
 192 English learn English from their parents; the French  
 193 learn French.

194 On the other hand, Johann, who had been aban-  
 195 doned as a baby in Burundi, was brought up by chim-  
 196 panzees and when found at the age of 5 was using  
 197 chimpanzee vocalisations and gestures to commu-  
 198 nicate. This shows that our evolutionary past equips  
 199 us to learn languages but does not provide language  
 200 itself. Nor does it specify the language we learn.  
 201 In Stephen Pinker's words, our genome gives us an  
 202 "instinct" to communicate, but we have to learn  
 203 the means to express it.

204 What we now have to do is to sketch out the ways  
 205 in which this came about [3]. Our starting point will  
 206 be the vocalisations that almost all mammals pro-  
 207 duce. As in birds, these are controlled by a network  
 208 of neurones that shows a propensity to favour the  
 209 left-hand side. Why it is the left side that is chosen  
 210 we do not know, and even why one side is favoured  
 211 is not entirely clear. Most features of animals are  
 212 bilaterally symmetrical and perfectly satisfactorily  
 213 controlled from both sides of a bilaterally symmet-  
 214 rical brain because there are good cross communi-  
 215 cations between the two sides.

216 Nevertheless, in about 95% of humans (includ-  
 217 ing 70% of left-handers), parts of the left cerebral  
 218 hemisphere are specialised for mediating the per-  
 219 ception and production of speech. Probably one side  
 220 is chosen because if the two hemispheres both try  
 221 to control the same structure, they tend to com-  
 222 pete with each other; hence, the majority of the  
 223 cross connections between the hemispheres have  
 224 been found to be inhibitory in order to prevent the  
 225 two sides trying to do the same thing. Placing the  
 226 control of vocalisations predominately in the same  
 227 hemisphere thus simplifies the control problem. An-  
 228 other contributory factor may be that the length  
 229 of axons joining sensory and motor language areas  
 230 within one hemisphere would be slightly shorter

231 than requiring connections between the two hemi-  
 232 spheres, thus cutting down on delays in a system  
 233 that requires millisecond accuracy.

234 In lower mammals, including monkeys, vocalisa-  
 235 tions are controlled by a medially placed system of  
 236 neurones that involves the cingulate cortex, basal  
 237 ganglia and hypothalamus. The composition of this  
 238 system suggests strongly that it is primarily con-  
 239 cerned with the expression of emotions, and it is  
 240 now clear that in primates other than man all vo-  
 241 calisations are automatic, driven by the emotions.  
 242 Thus, all attempts to teach primates to actually  
 243 talk have failed; it is impossible to harness pri-  
 244 mate vocalisations for other kinds of communica-  
 245 tion because they are not under the animals' volun-  
 246 tary control. Chimpanzees are actually intelligent  
 247 enough to be taught to communicate to some ex-  
 248 tent using their extensive repertoire of voluntary  
 249 gestures, but never by vocalisations.

250 It is highly significant that this emotionally con-  
 251 trolled medial system does not involve the monkey  
 252 homologue of Broca's speech area in the left lat-  
 253 eral frontal cortex. Indeed, lesions in this area do  
 254 not affect the ability of monkeys to make their vo-  
 255 calisations at all. The development of the human  
 256 motor speech area has followed a different course.  
 257 This has been powerfully illuminated by the discov-  
 258 ery of "mirror" neurones [5]. These unequivocally  
 259 place the development of human language in the  
 260 province of gesture and facial expression.

261 Mirror neurones are found in the ventrolateral  
 262 frontal lobe just in front of the face and arm repre-  
 263 sentation in the primary motor cortex. Their impor-  
 264 tant characteristic is that they fire not only when  
 265 a monkey reaches out to grasp an object, but also  
 266 when the monkey observes somebody else doing the  
 267 same thing; however, not when the same goal is  
 268 achieved in a different way, for instance using a pair  
 269 of pincers. In humans, likewise, this area appears  
 270 to be activated both when the subject reaches to  
 271 grasp something, but also when he imagines doing it  
 272 and also when he sees somebody else doing it. Thus,  
 273 mirror neurones could underlie how we learn to pro-  
 274 duce speech by enabling us to imitate our parents'  
 275 speech. In addition, they offer unexpected support  
 276 for Lieberman's motor theory of speech perception  
 277 [4]. Mirror neurones would enable us to interpret  
 278 speech because the very same cells would be acti-  
 279 vated by observing speech as those that we would  
 280 employ to make the same speech sounds.

281 In addition, Corballis and others have argued very  
 282 convincingly that these mirror neurones show that  
 283 speech evolved from gesture and not from vocali-  
 284 sations [3]. The argument runs as follows: by rep-  
 285 resenting a particular gesture, mirror neurones en-  
 286 able other people to imitate it and thus to com-

287 municate by means of these gestures. Lieberman,  
 288 Studdert-Kennedy and their colleagues at the Hask-  
 289 ins laboratory of speech science have long argued  
 290 that the basic elements of speech are not, as gen-  
 291 erally assumed, consonants and vowels, but rather  
 292 the vocal gestures that generate them, namely the  
 293 movements of the lips, tongue and larynx [4]. Thus,  
 294 mirror neurones in Broca's area could come to rep-  
 295 resent lip, tongue and laryngeal gestures, and these  
 296 could generate the phonetic elements of speech. In  
 297 fact, most of us still gesture with our hands when  
 298 speaking and when we gesture our vocal production  
 299 is synchronised with our hand gestures. These vol-  
 300 untary movements of the vocal tract are mediated  
 301 by this lateral system, and they have been superim-  
 302 posed on the older emotional system for automatic  
 303 vocalisations mediated by more medial brain struc-  
 304 tures. The latter still supply the basic intonation  
 305 and prosody for sentences.

306 This account of the development of speech from  
 307 gesture has received further support from the re-  
 308 cent discovery that the gestures of sign language  
 309 used by the deaf are controlled by the same left  
 310 hemisphere centres, particularly Broca's area, that  
 311 speech occupies in those who can hear. One can  
 312 even see in the way in which the order of ideas and  
 313 syntax is expressed in the trajectory of a sign lan-  
 314 guage gesture, how language syntax and grammar  
 315 may also have been founded in the way that the  
 316 structure of a signed sentence is determined by the  
 317 evolution of a gesture from shoulder to fingers.

318 The final step in this history is to consider the in-  
 319 vention of writing. This is truly a cultural invention,  
 320 and probably not at all enshrined in our genome  
 321 because it was only invented about 5000 years ago  
 322 and was not common until the last century. Be-  
 323 ing able to read and write carried no particular  
 324 selective advantage; and, it is therefore most un-  
 325 likely that we would ever find a gene or genes for  
 326 reading, contrary to what is sometimes claimed.  
 327 But, like speech before it, writing depends on prior  
 328 adaptations, in particular the development of ar-  
 329 ticulatory gestures controlled from Broca's area.  
 330 In addition, its invention probably depended on  
 331 the development of right-handedness. Despite the  
 332 choice in most animals of left-brain structures for  
 333 the control of both automatic emotional vocalisa-  
 334 tions and voluntary speech, no lower animal shows  
 335 such strong right-handedness as humans do. Many  
 336 animals choose to use either left or right hands for  
 337 particular tasks, but not even chimpanzees choose  
 338 the right so systematically.

339 Probably the main reason why right-handedness  
 340 was so important for the invention of writing is that  
 341 hieroglyphs and letters are very impoverished vi-  
 342

343 are pointing to the left or to the right. It is easiest  
 344 for us to agree which way round they should be if  
 345 we all write from the same side. Ambidextrous ani-  
 346 mals and children therefore have extreme difficulty  
 347 knowing which way round bs and ds should go.

348 This is not to say that right-handedness only  
 349 evolved 5000 years ago. Many of the Stone Age  
 350 hand axes from 100,000 years ago show signs of  
 351 having been shaped for right-handers. Likewise the  
 352 beautiful cave paintings of Lascaux and Altamira  
 353 flowered at about the time that speech evolved;  
 354 but most of the people depicted seem to have  
 355 been right-handed. Like speech, therefore, writing  
 356 has clearly piggybacked on an adaptation that oc-  
 357 curred a lot earlier for a different purpose, perhaps  
 358 gesture.

359 Reading and writing are much more difficult to  
 360 learn than speaking is because the written word  
 361 does not map so easily onto articulatory gestures as  
 362 speech does. As Lieberman and Studdert-Kennedy  
 363 point out, the phonemes that are represented by  
 364 letters are artificial subdivisions of the articulatory  
 365 gestures that generate them, and these subdivisions  
 366 have to be taught and learnt. Hence, a very large  
 367 proportion (some 10–20%) of humans never master  
 368 this art properly; it is the most difficult thing that  
 369 most of us ever have to learn.

370 Let us now return to Chomsky [2]. We can now  
 371 see that his idea that the human acquisition of lan-  
 372 guage and literacy resulted from a single mutation  
 373 that endowed us with a linguistic processor, all in  
 374 one jump, is clearly inconsistent with recent dis-  
 375 coveries. Speech and language evolved gradually,  
 376 coat tiling on a series of adaptations that evolved  
 377 for completely different purposes and occurred mil-  
 378 lions of years earlier.

379 Nevertheless, Chomsky was not entirely wrong.  
 380 I've always been a great admirer of him, and  
 381 his insights concerning phonology, deep grammar  
 382 and syntax come out of our current concepts of  
 383 the development of language rather well. The  
 384 pre-eminence of phonology follows from the de-  
 385 scent of the larynx and the specialisation of Broca's  
 386 area for the voluntary control of articulatory ges-  
 387 tures. Syntax and grammar can be viewed as a  
 388 direct consequence of the evolution of sentences  
 389 out of gestures that can involve the whole body  
 390 from axial back muscles to distal finger-movers.  
 391 In rather the same way that identical Chinese lo-  
 392 gographs can represent totally different sounding  
 393 words in Chinese and Japanese, so the same deep  
 394 structure, the same flow of ideas conveyed by a  
 395 particular gesture, could be represented by differ-  
 396 ent strings of articulatory gestures producing the  
 397 thousands of different languages that have devel-  
 398

399 What makes this whole enterprise more than just  
 400 curiosity is that it provides new insights into what  
 401 can go wrong with language. Because ontogeny re-  
 402 peats phylogeny to some extent, elucidating how  
 403 language gradually evolved from archaic gestures  
 404 means that potentially we now have a new approach  
 405 to understanding developmental disorders of lan-  
 406 guage. Counter-intuitively, both speech production  
 407 and comprehension seem to depend on our mir-  
 408 ror neurones being able to represent articulatory  
 409 gestures. Hence, although comprehension clearly  
 410 makes greater demands on the auditory system,  
 411 and speech production makes greater demands on  
 412 Broca's area and the motor vocalisation system,  
 413 Broca's area is engaged in both, and this is what  
 414 modern imaging methods have shown clearly. As ex-  
 415 pected therefore, children with developmental dys-  
 416 phasia are significantly worse at deciphering articu-  
 latory gestures, as in lipreading. Also, whereas good

speakers' hearing of a phoneme is greatly altered if 417  
 the speaker's lips appear to be generating a differ- 418  
 ent one, the McGurk effect (in developmental dys- 419  
 phasia, the mishearing of the phonemes) is much 420  
 less apparent, because in them the mirror system 421  
 is not working as well as it ought to be. 422

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