

Index

- Acoustic analysis
formant, 78, 181–182, 278, 293
pitch, 50, 57–58, 65, 98, 105, 158–159, 162,
167–168, 170, 181, 242
resonance, 49–50, 57–58, 293, 310
- Adaptation. *See* Learning
- Affordance, 18–19, 24, 26–29, 302
- Ainsworth, M., 154–155, 158, 161–163, 166–167
- Ant, 75, 242, 277
- Attention
gaze following, 227–228
joint, 9, 82, 145–146, 187, 191, 225, 228, 230
joint reference, 224–225, 228–229, 231
mutual gaze, 227, 234
pointing, 71, 82, 153, 224–225, 228, 234, 246, 262
shared, 82
- Austin, J. L., 6, 11, 34–35, 47, 60–62, 64, 327–329,
331
- Avian. *See* Bird
- Babbling, 136–137, 139, 142–143, 147, 150, 172,
177, 191, 300
canonical, 136
in the pygmy marmoset, 136
infant, 142
- Baldwin, J. M., 72, 176, 178–179, 187, 220,
233–234
- Bat, 141, 146–147, 277, 296
- Behavior
assessment and management of, 152–153
behaviorism, 113, 238–239, 311
mutual regulation of, 153, 165
- Bird, 147, 171–172, 176, 178, 180–182, 184,
186–187, 190–191, 293
African grey parrot, 8, 62, 171–172, 177–178, 181,
184, 187, 190–192
avian communication, 184
birdsong, 138, 148, 172, 191, 219, 234, 289
bittern, 306–307, 312
budgerigar, 182, 192
oscine, 179–180
parrot, 8, 145, 172–179, 182, 184–190, 192, 217,
329
passerine, 276, 295
pigeon, 191, 305
songbird, 20, 134, 145, 172, 180, 182, 187, 189,
192, 218, 287
starling, 142, 147
white-crowned sparrow, 180, 185, 187, 189, 191
wren, 180, 188
- Bonobo. *See* Primate
- Bowlby, J., 152, 154–155, 157, 167
- Brain
mirror neuron, 297–313, 315–317, 319–321
neocortex, 144, 259–261, 270–273
neuron, 10, 297–298, 301, 303–304, 306–307,
309–310, 315, 317, 321
plasticity, 21, 137, 139, 141, 145, 148, 154, 185,
211, 219–220, 319, 320
prefrontal cortex, 311
- Bühler, K., 221, 223, 225, 234
- Call
alarm, 5, 17, 51, 140, 142, 144, 147, 149, 234, 276,
280–281, 283, 293–296, 327–328
animal, 326–328
contact, 150, 192, 262–263
distress, 58, 328
food call, 136, 140–141, 280
- Catarrhine monkey. *See* Primate
- Cephalopod
cuttlefish, 196–202, 206, 210–211, 213, 305–307
squid, 8, 197, 199–212
- Cetacean, 142, 150, 171
dolphin, 133, 141, 148, 188, 190, 228, 276, 291,
295
whale, 276, 283, 287, 295
- Child
abuse, 157, 163, 167, 169–170
care, 145, 160
child-directed speech, 98–99, 103, 105
deafness, 137, 145
development, 56
emotion regulation in, 162 (*see also* Emotion)
language, 221 (*see also* Language, acquisition of)
learning, 62, 98 (*see also* Learning)
prelinguistic, 300, 302
rearing, 145, 168
- Chimpanzee. *See* Primate
- Chomsky, N., 70–72, 88, 115, 126, 219, 234, 245,
284, 294, 325, 331
- Cognition
animal, 252, 255
categorization, 40, 46, 85, 127, 172, 185–186, 225,
250, 318
concept formation, 81, 87, 245
conceptual space, 247–253
domain generality, 202
domain specificity, 202, 211
future goals, 237, 241, 243–246, 252–253
inner world, 238, 239, 241–247, 249, 253–254
planning, 10, 69, 115, 200, 231, 237, 239–241,
254–255
- Communication
affective, 23, 41, 44, 92, 99, 142, 150, 163, 164,
169, 176–177, 179, 185
affiliative, 9, 136, 144, 168–169, 257, 265
among kin, 64, 280–281, 289–290, 292
deception in, 10, 131, 227, 244, 256, 275, 277–278,
288, 294, 296

- Communication (cont.)
 dyadic, 121, 123, 226, 259, 268, 270, 330–331
 gestural, 49, 62, 143, 145, 148, 161, 225, 235, 257, 296
 honest, 10, 276–277, 279, 281, 288
 pragmatics of, 15, 29, 69, 73–74, 82, 153, 159, 178–179, 224, 230, 244–246, 248, 285, 317
 triadic, 228, 259, 330–331
- Communication systems
 infrastructure of, 50, 64
 modeling of, 3–4, 6–7, 9, 70, 89, 96, 106–108, 174–176, 187, 190–191, 303, 319, 330
 natural logic in evolution of, 5, 50–51, 54, 56
 power of, 326
- Concealment, 193, 196–198, 200, 204
- Connectionism, 6, 22, 25, 91–93, 96, 98, 106–109, 313, 331. *See also* Neural networks; Dynamical systems; Self-organization
- Connotation, 33. *See also* Meaning
- Construal in human communication, 9, 221, 224, 230–232, 241
- Constructivism, 29, 219
- Crustacean, 202, 293
- Darwin, C., 31, 48, 79, 88, 154, 167, 220–221, 253–254, 275–276, 285–288, 293, 331
- Dawkins, R., 43, 47, 115, 126, 153, 167, 195, 201, 208, 211, 277, 279, 293
- De Condillac, E. B., 3, 11, 54, 64
- De Saussure, F., 52, 65, 298, 313
- Design features of communication systems, 3–5, 11, 49–50, 54, 65, 147, 201, 325, 329. *See also* Properties of communication systems
- Dialect, 138–139, 145, 147, 172, 188, 189, 192, 218, 246, 290–292
- Discretization, 249
- Dog, 24, 27, 226, 251, 294, 310
- Dolphin. *See* Cetacean
- Dynamical systems, 91. *See also* Neural networks; Connectionism; Self-organization
- Elman, J. L., 91, 93–94, 96, 107–108
- Emergence, 9–10, 31, 35, 41–42, 44, 46, 62, 65, 76–77, 79, 89, 96, 105–109, 111–112, 126–127, 148–149, 190, 218, 220–221, 224–225, 227–229, 231–235, 243, 245, 253–255, 262, 320, 331
- Emergentism, 9, 41–42, 46, 62, 106, 112, 166, 185, 192, 218, 220–222, 232–233, 241, 252. *See also* Self-organization
- Emotion
 aggression, 8, 65, 156, 187, 204, 265, 290
 emotional expression, 56, 150, 297
 expression of distress, 5, 51, 58, 151, 154–155, 158–162, 165, 168–169, 328
 facial expression, 5, 17–19, 23, 71, 127, 143, 158, 163, 178, 201, 227, 238, 250, 264–265, 269, 271, 320
 fussing, 151, 158, 162, 165
 laughter, 9, 133, 149–150, 162, 257, 264–273, 307–308, 316
 smile, 150, 162–265, 268, 272–273
 temperament, 158, 167
- Epigenesis, 9, 168, 218–221, 232–234
- Evolution
 convergent, 193
 language, 3, 6–7, 10, 49, 63–64, 72, 88, 91–93, 97, 99, 105–107, 108, 131, 143–144, 146, 149, 171, 230, 244, 253, 255, 257, 262, 271–273, 276, 279, 281–283, 285–288, 295, 297–298, 300, 312, 320, 328, 330–331
- Finite state systems, 136–137, 144
- Fish, 195–197, 199–200, 202–203, 206, 211–212, 238, 303–304, 306–307, 309, 316
- Frege, G., 31, 33–34, 47
- Frug, 132, 287
- Gallistel, C. R., 16–17, 29
- Game theory, 77
- Genetics, 72–75, 127–128, 133, 139, 217–218, 220–221, 233, 275, 277, 279, 281, 285, 290–291
- Genome, 72, 75, 124, 217
- Gibson, J. J., 18, 24, 29, 256
- Gorilla. *See* Primate
- Grice, P., 29, 32, 47
- Group size in human evolution, 9–10, 144, 147, 233, 244, 257, 259–263, 270–272, 286, 293, 330–331
- Hamilton, W. D., 43, 47, 275–276, 280, 288–289, 294, 307, 312, 330–331
- Handicap principle. *See* Signal
- Hockett, C., 3–5, 11, 49–51, 54, 65, 173, 188, 201, 211, 230, 234, 241, 254–255, 325, 328–329, 331
- Hominid evolution, 7, 9–10, 64, 70, 91, 106, 244–245, 257–258, 261–263, 286, 292, 315, 320, 325, 330–331
- Hunting, 131, 145, 171, 187, 209, 246, 254–255, 260, 280, 326
- Illocutionary force, 6, 8, 42, 60–63, 173, 327–329. *See also* Meaning
- Imprinting, 21, 152, 219, 291, 293–294
- Inclusive fitness. *See* Natural selection
- Infancy, 57, 65, 139, 141, 150, 168–170, 219, 228, 232–234, 276
- Infant
 cry, 8, 151–152, 154–156, 158, 161, 164–167, 169–170

- crying and colic, 151, 161, 166, 170
 development, 168, 220
 vocalization, 49
- Infraphonology, 5, 52, 57, 59, 61
- Infrasemiotics, 5, 52, 55–56, 59–60
- Innate, 21, 73, 75, 77, 97–98, 108–109, 138–139,
 142, 152, 219, 222, 227, 232, 254, 284, 300, 303,
 308–310
- Insect
 bee, 17–20, 22, 25, 202, 209, 242
 butterfly, 199, 305
 caterpillar, 305–307
 dances of bees, 19–20, 202, 242
- Instinct, 21, 29, 65, 89, 137–138, 149
- Intelligence, 21, 45, 88, 147–148, 184–188, 191,
 202–203, 208–211, 254, 256, 285–286, 293
 artificial intelligence, 6, 70, 127
 machiavellian, 252, 286
- Intentionality of communication. *See* Communication
- Invertebrate, 209, 213. *See also* Cephalopod; Insect
- Involuntary communication. *See* Communication
- Isomorphism, 16–19, 148
- Kin selection. *See* Natural selection
- Langacker, R. W., 9, 11, 69, 89, 224, 230, 234, 246,
 255
- Language
 acquisition of, 72–73, 88–89, 91–93, 96–97, 99,
 105–109, 146, 177, 180, 188–192, 221, 234
 adjective, 9, 72, 98, 201, 250–252
 change in, 70, 94, 100, 232
 consonants, 132, 178, 182, 190, 300
 detachment in communication, 238, 242
 gossip, 89, 144, 147, 237, 244, 254, 272, 286, 290,
 293
 gossip as grooming, 286
 grammar, 90, 232
 head order in grammatical systems, 95, 101,
 103–105
 historical linguistics, 70
 language game, 79–80, 82, 85–87, 90, 246
 lexical characteristics of, 63, 69, 71, 76, 80, 82–83,
 85, 95, 99–101, 103–105, 109, 189, 192, 230, 282,
 289
 noun, 9, 71–72, 94–96, 98–99, 201, 248–251,
 257
 parameter setting in grammar acquisition, 75
 phonology, 15, 49–50, 65, 77, 94, 97–99, 107–109,
 132, 136–137, 172, 181–182, 187, 189, 220, 255,
 283, 285, 290, 292, 294, 300
 recursion in, 104, 107, 116–117, 172
 sentence, 31–34, 39–40, 47, 69, 93, 95, 98, 100,
 109, 283, 327–328
 sign language, 15–17, 19, 22, 27–28, 32, 36, 39, 54,
 128, 140, 143, 145, 147–148, 162, 173, 218, 224,
 230, 297–298, 308, 316
 syntax, 15, 32, 38–39, 42, 88–90, 95–99, 103,
 105, 107–109, 115, 126, 144, 148–150, 172,
 178–180, 187, 223, 245, 252, 255, 283–286,
 289, 294
 universal grammar, 71, 73, 77, 284, 295
 universals of language, 89, 137
- Larynx, 132, 182, 292–294
- Learning
 inhibition, 155, 164, 197, 303, 309–311
 learnability, 76, 96–97, 99, 104, 108–109, 249
 reinforcement, 79, 85, 88
 scaffolding, 73, 140, 320
 statistical, 109, 138, 147, 149
 unsupervised, 87
- Lewontin, R. C., 106, 108
- Lorenz, K., 10, 18, 29, 54, 64–65, 152, 163, 168,
 291
- Mammal, 8, 24, 26, 39, 182, 185, 226, 239, 278,
 280–281, 283, 286–287, 291, 294, 296, 305
- Marler, P., 134, 138, 148, 150, 158, 169, 172,
 176–179, 186, 189, 218–219, 234, 278, 295
- Meaning. *See also* Connotation; Illocutionary force;
 Symbolization
 extension, 5, 76, 198, 200, 317
 intension, 5, 16, 33
- Memes, 113, 124, 126
- Model of mind, 37, 42, 44–45, 47
- Mollusc, 211, 213
- Mortality, 47, 156–157
- Mother tongue, 237, 244, 275–276, 280–281,
 287–290, 292
- Motivation, 20, 27, 38, 133–134, 145, 160, 163–165,
 179, 205, 221, 232, 240
- Multiple-cue integration, 98–99, 106
- Music, 9, 257, 261, 263, 271–272, 284
- Mutual exclusivity, 177, 189–191
- Nativism, 220
- Natural selection
 adaptation, 17, 43, 46–48, 52, 57, 65, 69, 77, 89,
 91, 96, 99, 106–107, 109, 144, 147, 154–157, 160,
 163, 168, 170, 186, 201–202, 210–212, 233,
 276–278, 281, 284–285, 290–291
 arms race, 286
 inclusive fitness, 10, 275–277, 279–280, 281,
 288–289, 330
 kin selection, 10, 43, 144, 275–276, 281, 288–291,
 293, 330–331
 sexual selection, 146, 237, 253, 286–289, 292,
 294–295, 331

- Natural selection (cont.)
 survival, 51, 111, 156–157, 222, 239, 276, 286, 289, 330
- Neanderthal, 91, 261, 284
- Neophenotype, 163
- Neural networks. *See also* Connectionism;
 Dynamical systems; Self-organization
 feedback in, 73–75, 79–83, 87, 152, 154, 156, 158, 161–162, 166, 174, 178, 205, 291, 300, 319
 recombination, 172, 188, 283
 simple recurrent networks, 94
- Ontogeny, 91, 105, 147, 149, 154, 163, 167, 169, 188, 190–191, 193, 227, 232–233, 284, 300, 310, 313
- Oscine. *See* Bird
- Parrot. *See* Bird
- Passerine. *See* Bird
- Pattern
 detection, 6, 7, 115, 118–119
 hidden, 7, 112, 114, 122
 temporal, 111, 113
- Peirce, C. S., 53, 65, 221, 224, 235
- Perception, 18–19, 22, 24–29, 41, 42, 47, 78, 136, 148, 150, 152, 162, 166–169, 188, 197, 199, 210, 212, 219, 234–235, 240, 252, 254–255, 284, 294, 299–300, 303–307, 309–313, 318
- Phenotype, 219
- Pheromones, 124
- Phonation, 57, 190, 192
- Phylogeny, 91, 105, 111, 150, 171–172, 199, 220, 225, 227, 232, 272, 284, 310
- Piaget, J., 219, 235, 255
- Pinker, S., 72, 74, 89, 91, 97–98, 109, 137, 149, 284–285, 295
- Population, 37, 70, 74–76, 79, 85, 100, 132, 138–139, 145, 255, 275, 294
- Posture, 194, 197, 200
- Pragmatics of communication. *See* Illocutionary force
- Predator, 16, 21, 41–44, 61–62, 142, 144–145, 156, 164, 186, 193, 195–201, 203–204, 207–209, 217, 234, 238, 280–281, 293–295, 306–307, 328
- Primate
 ape, 7, 9, 27, 131–134, 137, 142–144, 146, 148–149, 173, 187, 190, 192, 235, 237, 240, 242–244, 254–256, 258, 260, 262, 269, 272, 293, 302, 330
 baboon, 134, 187, 260, 262, 272
 bonobo, 132–133, 217, 235, 242, 262, 313
 catarrhine monkey, 260
 chimpanzee, 131–133, 140, 146–149, 187, 217–218, 227, 234–235, 238, 240, 244, 253–256, 260, 264–265, 269, 273, 289, 311, 313, 320
 gorilla, 132, 147
 lemur, 142, 149, 188, 211
 macaque, 134–136, 139, 142, 147–149, 156, 273, 293, 298, 301, 307, 309–310, 315, 317
 marmoset, 7, 132, 134–137, 139, 141–144, 147, 149–150
 primatology, 148, 233
 rhesus monkey, 142, 148–149, 156, 167–170, 293
 sifaka monkey, 142, 149
 spider monkey, 260
 squirrel monkey, 160
 tamarin, 7, 134–136, 138, 139–144, 146–150, 191
 titi monkey, 136, 144, 149
 vervet monkey, 34, 38–40, 61, 65, 134, 139, 142, 147, 149, 168, 217, 223, 229, 234, 258, 273, 281, 293, 308, 317, 326, 327–328
- Properties of communication systems
 arbitrariness, 16, 26, 37, 77, 173, 221, 223, 229, 283, 298–302, 309–311, 315, 317, 319–320
 conventionality or conventionalization, 15, 28, 31–34, 37–39, 41–44, 98, 221, 223–224, 228–230, 232, 253, 257, 260–262, 268, 271, 279, 296, 317
 directivity, 56, 58, 329
 displacement, 173, 209, 241, 254
 economy, 76, 249–251
 efficiency, 43, 51–52, 63, 143, 246, 253
 expressivity, 56, 58, 76, 329
 imitation, 56–58, 65, 77–78, 89, 98, 133, 187, 283–284, 287, 291–292, 299–300, 305–306, 312, 320
 indexicality, 39, 42, 53–54, 159, 165, 221, 224–225, 246
 intentionality, 15, 29, 32, 34, 175, 183, 185, 213, 221–222, 224, 226–227, 232, 255, 269–271, 277, 305, 308
 involuntary, 303, 307
 openness, 51–52, 182, 209, 220
 productivity, 16, 37, 43, 51, 221, 283
 purposefulness, 51
 referentiality, 5, 9, 19, 31–33, 37, 39–40, 42, 49–50, 60–63, 74, 83, 108, 144, 160, 167, 172–179, 184–185, 190–191, 198, 221–230, 232, 237, 241–242, 246–247, 250–252, 254, 257, 298, 326–327
 specialization, 54
 voluntary, 15, 309, 311
- Prototype, 78–79, 243, 249, 255
- Psittacine. *See* Bird, parrot
- Psychology, 28, 32, 47–48, 113, 125–126, 128, 188, 195, 201, 211–212, 221, 233, 254, 256, 271, 298, 318
- Recapitulation, 232
- Reflex, 18, 37, 42, 142, 196, 208, 271, 303, 307

- Representation
 cued, 238, 241
 detached, 238–242, 253–255
 mental, 15–18, 20–21, 23, 27–28, 173, 298–299, 301, 316–317
- Robotics, 6, 78, 82, 85, 87, 89, 124, 145
- Searle, J., 17, 29, 235
- Self-organization, 6, 9, 75, 77, 79, 85, 88, 112, 331.
See also Neural networks; Dynamical systems; Connectionism
- Semantics, 5, 16, 31–32, 35, 38, 41–48, 60–64, 90–98, 150, 160, 178–179, 245–246, 252, 255, 275, 285, 290, 295
- Semiotics, 160, 221, 224, 231
- Signal
 communicative display, 51, 58, 61, 131, 138, 142–143, 177, 188, 193–196, 198–201, 203–212, 223, 271, 279, 286–288, 293
 communicative value of, 226
 conventional, 296
 coupling of signal and function, 5, 6, 60–61, 75, 325
 cue integration, 99, 106
 decoupling of signal from function, 5, 6, 8, 52, 54–58, 60–63, 159–160, 325, 329
 fixed, 5, 51, 54, 56, 58, 64, 326, 328–329
 fixed action pattern, 18, 152
 graded cue, 160
 handicap principle in evolution of, 44, 164–165, 278, 282, 295–296
 natural sign, 15, 17, 18, 27, 39, 41, 54
 playback, 135–136, 149–150
 request, 8, 61, 144, 173, 175, 181, 242, 266, 328
 ritualization of, 54, 204, 226, 229, 234
 threat, 58, 61, 64, 136, 144, 155, 157, 200, 208, 279
 warning, 5, 16, 34, 38, 40–45, 47, 61–62, 199, 207, 217, 326–328
- Slobin, D. I., 96, 109, 232, 235
- Sociality
 altruism, 48, 275–277, 289–290, 293
 attachment, 151–152, 154–157, 160, 166–168, 170, 271
 bonding, 9, 141, 142, 151–152, 172, 244, 257, 258–265, 267–268, 270–271, 330–331
 caregiving, 64, 151, 156–161, 163–164, 166–167
 coalition building, 141, 188, 258–259, 270, 291
 cooperation, 10, 43–44, 46–47, 65, 209, 220, 237, 242–244, 246, 252–253, 293, 330
 cooperative breeding, 7, 10, 64, 140, 331
 cultural transmission, 91, 106–107, 147, 218
 culture, 6, 69–70, 72–77, 80, 88, 90–91, 98, 106–107, 124, 131, 147, 150, 166, 168–169, 189, 211, 217–218, 229, 232–235, 255–256, 259, 263, 290, 330
 food sharing, 140–141, 144, 296
 grooming, 9, 89, 144, 147, 226, 237, 244, 254, 257–264, 270–273, 286, 293
 group size, 258–260
 intersubjectivity, 65, 226–229, 232–233, 235, 310
 of animals, 45, 222, 258
 reciprocal altruism, 273, 277, 290, 296
 social interaction, 50, 65, 128, 136–137, 141–142, 144, 146, 172, 174, 175–177, 187, 189–190, 192, 201, 251, 257–258, 261, 273, 312
 social learning, 73–74, 77, 79, 86, 89–90, 140, 147, 192, 310
 social structure, 133, 134, 251
 Socioeconomic status, 157
 Software, 6–7, 118, 128
 Sound image, 298–299, 301–302
- Speech
 articulation, 20–23, 69, 78–79, 107, 182–183, 190, 298–300, 316
 articulatory filter hypothesis, 299–300
 coarticulation, 172, 182–183, 191
 motor theory of speech perception, 294, 299–300, 313, 316
 prosody, 58, 61, 97–99, 107–109
 vowel, 71, 77–79, 89, 98, 132, 178, 182, 190, 192, 300
- Squid. *See* Cephalopod
- Structural coupling, 75, 81, 85, 88
- Syllable, 50, 57–58, 71, 77, 90, 99, 114, 138, 283, 285, 296, 300
- Symbolization, 9, 42, 69, 73, 82, 107, 148, 169, 173, 188, 218, 220–221, 223–225, 228–233, 235, 237, 241–244, 246–247, 252–254, 293, 309, 311–313
- icon, 15, 221
 symbolic elaboration, 9
- Syrinx, 181–182
- Theme software, 7
- Theory of mind, 245, 253, 271–272, 284
- Tinbergen, N., 18, 29, 54, 65, 115, 128, 170, 212, 284, 296
- Tomasello, M., 73, 90, 97–98, 109, 145, 150, 228, 232, 235, 242–243, 245, 256
- Trivers, R. L., 46, 48, 165, 170, 277, 280, 290, 296
- Umwelt, 152, 157
- Vertebrates, 21, 147, 164, 182, 193, 195–200, 208, 276, 278, 287, 294
- Vocal
 development, 49, 134, 136–138, 143, 146, 149, 169
 expansion stage of vocal development, 136
 production, 55, 133, 138–139, 141, 144, 282, 293–294
 repertoire, 133, 135, 142, 147–148

Vocal (cont.)

signals, 52, 58, 134, 142, 278

tract, 71, 78, 91, 182–183, 278, 293, 300

usage, 141, 329

Vocalization, 9, 50, 56, 61, 64–65, 134, 136, 170,
190, 288

Voice, 58, 72, 180, 182, 296

Voicing, 134, 182

Voluntary communication. *See* Communication

Waddington, C. H., 219, 235

Whale. *See* Cetacean

Yawning, 307–308, 316

Zahavi, A., 10, 41, 44, 48, 153, 170, 275, 277–278,
282, 288, 296, 330–331