

Index

- Absorption of sound
in anechoic chambers, 18
in automobiles, 192, 201
canceling effect of, 201
creates multiple arenas, 28
feelings produced by, 146
from humidity, 245, 338, 339
idealized, 108, 109, 115, 116
illuminated, 17
illusion of infinite, 56
music responds to, 111
panels, 51
in Protestant churches, 101
in simulations, 243, 263
statistical assumptions, 253, 263
suppresses reflections, 28
by vegetation, 337
virtual window, 56
- Academic values, 278, 280, 296
- Accidental acoustics. *See* Acoustic accidents
- Acheron Necromancy, 84
- Ackerman, Diana, 4
- Acousmatic music, 182, 183
- Acoustic accidents, 60, 68, 86, 93, 147, 184, 194, 204
- Acoustic adaptation in animals, 352
- Acoustic amplification, 23, 84, 96, 200
- Acoustic archaeologists, 59, 64, 73–77, 82, 85
- Acoustic architects, 5, 237. *See also* Acoustic engineers
- Acoustic arenas, 22–31. *See also* Acoustic horizons
and aural architects, 24, 32
collide, 22
communities in, 26
control of, 33
created by echoes, 94
created by furnishings, 28
and culture, 28, 29
depend on sound barriers, 106
diverge from visual arenas, 55
divided by absorption, 28
and doors, 25, 28, 31
and electroacoustics, 27, 104, 199
enlarged by silence, 32
in factories, 31
with headphones, 191
increased by theatric masks, 96
influence by noise, 22, 28, 32, 34, 65, 103, 106
integrate citizens, 30
intentionally shaped, 23, 54
and large groups, 27, 29
largest manmade, 97
limited communications in, 33
local acoustics, 53
of natural habitats, 27
open windows, 28
ownership and rules, 27, 33, 34
personal preferences, 25
and physical boundaries, 23
private, 26, 29, 31, 59, 106, 191

- Acoustic arenas (cont.)
 size of, 23, 35
 and social spheres, 31, 35
 sonic broadcasts in, 34
 of soundmarks, 29
 in whispering galleries, 54
 who influences, 24, 25, 31
- Acoustic changes, sensitivity to, 217, 233
- Acoustic clouds, multisensory, 65
- Acoustic communities, 26, 27
- Acoustic cues, 36, 44
- Acoustic defects, 228–230
 explained by science, 266
 apparent, 227
 in concert halls, 154, 225, 229
 frequency response, 228, 231
 learned, 231, 266
 and quality, 142, 227
 replicated in simulations, 132, 258, 259
- Acoustic degradation, 339, 340
- Acoustic design, 5, 35, 121, 199
- Acoustic diffusers, 229
- Acoustic dirt, 231
- Acoustic ecology, 30
- Acoustic engineers, 26, 108, 119. *See also*
 Acoustic architects
- Acoustic environments and learning, 327
- Acoustic geography
 adapting to, 27
 amphitheaters, 95
 and citizenship, 29, 30, 68
 ignored, 31
 influenced by weather, 338
 influences social geography, 340
 and rural communities, 30
 for species, 340
- Acoustic habits, exposure to, 332
- Acoustic horizons, 22. *See also* Acoustic arenas
 for animals, 27, 340
 awareness of, 25
 in factories, 28
 influences membership, 340
 measured by social sphere, 49
- Acoustic hot spots, 75, 338
- Acoustic niches, adapting too, 337
- Acoustic objects in musical space, 154
- Acoustic parameters. *See also* Reverberation
 time
 in concert halls, 218, 219
 growth of, 225, 232
- Acoustic questions, difficulties with, 215, 216,
 302, 307
- Acoustic scientists, 26
 changing roles of, 294
 devalued, 119
 ignore assumptions, 239
 as shamans, 104
 slow progress, 78, 215
- Acoustic sculpture, 52, 59, 60
- Acoustic shadowing, 39, 43, 52, 143, 154
- Acoustic space as musical instrument, 150
- Acoustic spaces, tradition dominates, 287
- Acoustic stakeholders, disenfranchised, 119
- Acoustic taste changes, 122
- Acoustic textbooks, trivialized examples, 216
- Acoustic traditions by replication, 88
- Acoustic variability, natural process, 242
- Acoustic vases, 58
- Acoustical assumptions, 252
- Acoustical Society of America, 108
- Acousticians, *See* Acoustic scientists; Acoustic
 engineers
- Acoustics
 announces active life, 62
 assumption of, 253, 254
 of caves, 181
 changes arena, 23
 definition of, 4, 5
 development splits, 117
 difficult to apply, 217
 etymology of, 4
 experienced directly, 16
 in Greek theater, 96
 in historic Greek spaces, 84
 history of, 80
 innovations rejected, 181

- match pictures in caves, 74, 75
- of Mayan structures, 84–86
- measurement problems, 241
- microscope versus macroscopic, 237
- of natural spaces, 337, 338, 340–342, 346, 348
- never static, 342
- as theatrical prop, 98
- unexpected, 19
- unwanted, 110
- Acquaintances, social sphere of, 34
- Active versus passive sonic objects, 150
- Actors, adapt to theatrical spaces, 94, 99
- Aczel, Amir, 287
- Ad hoc
 - art and science, 254
 - reverberator designs, 273
 - rules of reflection density, 256
- Adapting to habitats, 320, 335, 338
- Adolph, Edward F., 350
- Advanced sound systems, 207
- Aeolian harp, 83, 84
- Aesthetic spatiality
 - aesthetic texture, 64
 - and auditory spatial awareness, 12
 - and cultural values, 61
- Aesthetics versus functionality, 282
- Affect, 13, 335. *See also* Emotions
 - in direct sound, 342
 - from failure to localize, 342
 - response to acoustics, 19, 62, 324, 335, 342
- Agendas, multiplicity of, 280
- Agoraphobia, 20
- Aiello, C., 350
- Air
 - as common resource, 337, 338
 - non-ideal medium, 90, 240–242, 270, 306, 338
 - temperature, and measurements, 237
 - turbulence, 242, 270, 337, 338
- Aivilik Eskimo, 4
- Akusmatikoi, 182
- Alexander, Christopher, 11
- Algorithmic rules replace space, 130
- Alice in Wonderland, 75
- Allen, Jont, 244
- Allocentric perspectives, 49
- All-pass filters, 263, 265, 266, 272
- Allusions to natural spaces, 176
- Alte Gewandhaus, 78
- Altered states of consciousness, 73, 178
- Amazon rain forest, 177
- Ambience, 221, 226
- Ambient noise in natural environments, 337
- Ambisonic techniques, 197, 198
- Amphitheaters (open air), 94–97, 108, 114, 354
 - artifact of geography and climate, 95, 97
 - model of ideal acoustics, 111
- Amplification in performance spaces, 200
- Amplitude envelope, perception of, 256
- Amplitude fluctuation in forest, 338
- Amplitude modulation, perception of, 256
- Amplitude and phase measurement, 239
- Amsterdam Concertgebouw, 119
- Amygdala, 333
- Ancestors influences spatial ability, 346
- Ancestral experience of echoes, 341
- Ancient chambers, as ritual sites, 76
- Ancient spaces, otherworldly, 76, 77, 84
- Ancient cultures. *See* Greek theater and culture;
 - Mayan culture; Hausa culture; Malta culture
- Anderson, John W., 344
- Anderson, Richard, 326
- Anecdotal evidence, 37, 303, 326, 330, 335
- Anecdotal wisdom, 276
- Anechoic (echo-free)
 - chambers, 18–20, 22, 62, 110, 134, 310
 - spaces, 18–20, 25, 190, 310
- Animals
 - aware of spatial acoustics, 339, 340, 343–345
 - cave paintings of, 75
 - compete for auditory channel, 338
 - culture parallels human culture, 352
 - strategies unobservable, 345
- Animism, 77
- Anthropological distance, 34
- Anthropologists, 280, 284

- Antiphony, 168
- Apparent source width (mass), 153, 232
- Applicability, concept of, 315
- Applied acoustics in close-form, 237, 294
- Architects
 - attitudes towards acoustics, 55, 120
 - creative type, 282
 - personal agenda of, 280, 282, 283
 - rewards given to, 283
 - traditional, 26
 - utilitarian views, 282
- Architectural acoustics, slow progress, 117
- Architectural elements, multisensory, 65
- Architectural rules, folk science, 78
- Architecture
 - disciplines contributing to, 6, 282
 - factors influencing, 1, 16, 88, 91
 - multisensory, 66
 - patrons of, 283
 - as sculpture, 16
 - sponsors of, 283, 284
- Aristotle, 79–81, 83
- Arnold, Denis, 168
- Art of science, 254, 315
- Art and science, paradox of, 242
- Art of spatiality, 160
- Artificial acoustics merge with electronic music, 124
- Artificial reverberation, *See* Reverberators
- Artificial versus natural acoustics, 198
- Artistic conflicts in concert hall, 116
- Artistic relevance not science, 221
- Artistic space not real, 161
- Artistic subculture, 277
- Artistic taste, not stable, 118
- Artists control spatial attributes, 158
- Ashmead, Daniel, 43
- Aslin, Richard N., 326
- Assisted reverberation, 201, 202
- Associations to aural experiences, 223
- Assumptions
 - destroyed by non-ideal air, 239, 240
 - in disciplines, 276
 - dominate research, 237
 - hidden and ignored, 216, 311
 - internal sensations measurable, 301
 - sufficiently valid, 250, 253
 - violated in sound wave equation, 241
- Atagi, Junko, 272
- Atmospheric turbulence, 338
- Attentive listening, 15
- Audience size
 - consequence of, 97, 118
 - dominates aural architecture, 114
 - and large spaces, 65
- Audience subculture, 225
- Audio degradations, detection varies, 331
- Audio delay, problems with, 200
- Audio engineers
 - acquire auditory skills, 40
 - as artist, 184
 - as auditory subculture, 277
 - as aural architects, 45, 123, 125, 165, 238
 - birth of, 294
 - changing roles, 294
 - contradictory requirements, 116
 - create spatial accidents, 184
 - discipline of, 277, 279, 298
 - hidden from public, 209
 - illusion created by, 310
 - merge cinema and computer, 203
 - pursued signal quality, 207
 - as shamans, 104
 - specialize vocabulary of, 328
- Audio industry
 - borrows from cinema, 203
 - dislike of patents, 273
- Audio reproduction system, 198, 204
- Audio subculture, 7
- Audio subsumed by multimedia, 295
- Audio tools, evaluation of, 269
- Auditorium, multipurpose, 104, 116, 199
- Auditory ability
 - motivated by visual deficiencies, 327
 - extraordinary, 310, 311
- Auditory acuity for spatial attributes, 328

- Auditory arts of prehistoric peoples, 74
- Auditory attention-switching, learning window, 326
- Auditory awareness, 12–14
extension of religion, 82
shift to private, 323
- Auditory channels, 15, 22
competition for, 22, 338
time varying, 338, 341
- Auditory cortex
changes in, 329
enlarged by practice, 36
evolved to identify location, 62, 342
expects variability, 341
limits of, 314
model of the environment, 345
neurological activity in, 328
older evolutionary solution, 318
optimized for echolocation, 345
suppresses irrelevant, 342
- Auditory cues
for hearing space, 36
subtle, 40
- Auditory displays in airplanes, 166
- Auditory expertise, social importance of, 104
- Auditory experts lack language, 310
- Auditory giftedness, 36, 331
- Auditory imagination and visual substrates, 325
- Auditory intelligence, 331
- Auditory learning, very specific, 329
- Auditory memory
and auditory spatial awareness, 17
in aural subcultures, 271
- Auditory neurological adaptation, 325
- Auditory neuroscience, 307
- Auditory perception
across cultures, 70
elusive dimensions, 223
varies among individuals, 309
- Auditory performance norms, 311
- Auditory roughness, perception of, 256
- Auditory scene analysis, 169
- Auditory spatial acuity, specialized substrates, 36
- Auditory spatial awareness, 11–15, 131. *See also* Navigational spatiality; Music spatiality; Social spatiality; Aesthetic spatiality
ancestor lifestyle, 317, 346
in animals, 339, 340, 343–345
and aural architecture, 9, 45
components of, 8, 14, 46, 332
difficult to study, 236, 299, 308, 321, 328, 331
distributed among disciplines, 298
and echolocation, 11, 343
emotional reaction to, 321
experience-expectant learning, 326
experts, 309
historic theater, 99
limits of, 310
as part of music, 11, 216
reflects subculture, 310
research on, 285
and sensory anthropology, 3
and sociocultural factors, 11, 317, 327
subculture of, 354
unconscious of, 14, 48, 318, 322, 361
varies among individuals, 20, 43, 304, 331
vestigial ability, 343
of virtual space, 131
and visual awareness, 46
- Auditory spatial imaging in animals, 345
- Auditory strategy adapted to acoustic environment, 339
- Auditory subculture by experiments, 224
- Auditory subcultures, 7, 277, 310, 314
- Auditory system, evolution of, 336, 347
- Auditory and visual harmonies in early churches, 91
- Augustine, Saint, 91
- Aural, definition of, 5
- Aural architects, 5–7, 217. *See also* Aural architecture
in ancient cultures, 73, 84–86, 275
cannot auralize space, 70, 163
committee of, 118, 131, 147, 159, 187, 275

- Aural architects (cont.)
 electroacoustic flexibility, 203
 evolutionary trajectory, 342, 346, 352
 influence inhabitants, 166, 183, 335
 and musical rules, 125, 128, 158, 165
 personal factors, 5, 113, 275, 296, 359
 and sociocultural forces, 5, 6, 64, 147, 359
 as soundscape architects, 66
 stakeholders and sponsors, 65, 282, 286
 using reverberators, 6, 146, 209, 269, 274
 versus engineers and scientists, 64, 118
 of virtual spaces, 207, 260
- Aural architecture, 2, 5, 6, 8, 16–18, 160. *See also* Aural architects
 adapting to, 27
 and arenas, 106, 354
 based on democracy, 97, 114
 and choice of listening states, 182
 by committee, 118, 131, 147, 159, 187, 275
 dominated by vision, 119
 dual concepts of, 117, 148, 186
 emotional response to, 11, 65, 324, 330, 332, 335
 governance process of, 279, 281, 283, 284, 286, 293, 298
 of historic cultures, 55, 59, 67–70, 82, 88, 319
 influenced by stakeholders, 8, 46, 112, 113, 209, 324
 intellectual foundation of, 8, 77, 283, 284
 is adaptive and dynamic, 16, 24, 32
 lacking science, 81
 links to evolution, 347
 and noise, 108
 and philosophic unity, 88, 93
 relevance to experience, 64, 332
 rise of middle class, 100
 and social cohesion, 317, 348
 and sociocultural factors, 3, 24, 35, 121, 235, 275, 353
 for and by subcultures, 7, 8, 113, 127, 141, 160, 354
 trains inhabitants, 347
 of virtual space, 196
 without science, 80
- Aural artists taste for novelty, 126
- Aural attitudes change, 119
- Aural awareness, stages of, 12
- Aural canvas for virtual spaces, 164
- Aural coloration
 produced by sonic reflections, 229
 in reverberation tail, 259, 260
- Aural designs based on trial and error, 70
- Aural embellishments, 51–53, 58, 61
- Aural environments enhance spatial awareness, 324
- Aural expectations
 depend on experience, 194
 determine reactions, 61
- Aural experience, 68, 70, 71, 77
 of a concert hall, 216
 influenced by lifestyle, 192
 prehistoric, 68, 74, 76, 77, 180, 358
- Aural geometry, 53–55
- Aural icons, 82–87. *See also* Earcons
- Aural illusion of expanded space, 55–58
- Aural image of acoustic spaces, 343
- Aural perception of a wall, 57
- Aural personality, 2, 58, 59, 98, 118, 262
- Aural perspectives in concert halls, 130
- Aural privacy versus large arena, 65
- Aural sculptures, 52, 59, 60, 86
- Aural size conflicts, 65
- Aural space, 160, 164, 166, 216
- Aural spaciousness, 231, 233
- Aural symbolism of dominance, 53
- Aural texture, 58–61
- Aural tribe, 320
- Aural and visual distances diverge, 55
- Aural visualization, 70, 148
- Auralization system, sweet spot of, 189
- Auralize versus visualize, 70
- Auralizing concert hall, 185
- Aureli, Filippo, 356
- Australopithecine anatomy, 349
- Automatic feelings, fast response, 333

- Automobile
 hostile acoustics, 192
 listening environment, 117, 192–194
Averaging as statistical operation, 237, 311, 312, 314
Avery Fisher Hall, 120, 121, 246
Awareness, 14, 321, 323. *See also* Auditory
 spatial awareness
 of body state, 324
 depends on personal agenda, 334
 how to communicate, 321
 in multiple brain substrates, 322, 323
 publically observable, 320, 321
- Background noise and arenas, 22, 28, 34, 65
Bacon, Sir Francis, 99, 100, 164, 183
Bäder, Karl Otto, 124
Bagenal, Hope, 7, 101, 116
Bahn, Paul, 74
Balcony in concert halls, 143, 227
Barkow, Jerome H., 353, 359
Barron, Michael, 223, 241, 245
Barrow, John, 217
Basilicas as architectural model, 89, 90, 92
Bassuet, Alban, 324
Bathroom as defective space, 229
Bats, echolocating, 37, 339, 343
Bauck, Jerry, 190, 191
Bauer, Benjamin B., 206
Bauman, Richard, 33
Baynes, Kathleen, 323
Bech, Søren, 366
Beck, Guy L., 72
Begault, Durand, 189, 191
Behavior, influenced by emotions, 333
Behrmann, Marlene, 50
Bekoff, Mark, 357
Belief systems, who chooses, 305
Bell clocktower as soundmarks, 29
Bell Telephone Laboratories, 190, 200, 293
Bells
 influence on township, 29
 and reliable communications, 32
 as religious earcon, 83
 as soundmarks, 29
Beltrán, Antonio, 74
Beranek, Leo, 26, 101–103, 111, 119–121, 185, 217, 218, 227, 233
Berezan, Jennifer, 178
Berg, Jan, 223, 366
Berkhout, Augustine J., 196, 241
Berlin Philharmonic Hall, 119
Berridge, Kent C., 333
Besmer, Fremont, 13
Binaural
 cues, 40, 326
 headphone format, 188, 189, 191, 195, 211
Binaural processing, 130, 340
Binaural sound field, 190
Binaural systems, range of distance, 211
Binding people together, 353
Binding of sonic events, 152, 157, 158
Biologists, study of, 280
Bipedalism, and social groups, 349
Birds, acoustic adaptation of, 339, 344, 352
Blauert, Jens, 312
Bledsoe, C. Warren, 41
Bleek, Wilhelm, 77
“Blend” in concert halls, 218
Blessner, Barry, 124, 200, 265, 268, 269
Blindfolded, aural behavior when, 1, 43, 48
Blindness, consequences of, 8, 36, 44, 45, 48, 321
Blindsight, 323
Bliven, Bruce, 121, 246
Blumlein, Alan Dower, 205
Boehm, Christopher, 275, 357
Bolk, Louis, 351
Boone, Marinus M., 241, 245
Boorstin, Daniel, 29
Borg, Ingwer, 222
Borish, Jeffrey, 241, 244
Bork, Ingolf, 185
Born, Georgina, 280, 284
Boston Music Hall, 118

- Boston Symphony Hall, 78, 79, 99, 117–119, 143, 144, 181, 185, 250
 Boston Symphony Orchestra, 117, 118
 Boulanger, Richard, 175
 Boulez, Pierre, 169, 170, 284
 Boundaries, spatial, 21, 26
 Bourgeois, Jean-Pierre, 324, 325
 Bowman, Wayne D., 94
 Boyd, Richard, 367
 Boyle, Robert, 80
 Braat-Eggen, P. E., 245
 Bradley, John S., 232
 Brain
 contains evolutionary artifacts, 318, 321, 345, 349
 decoding acoustic cues, 188, 345
 emotions and rationality, 281, 333, 334
 immature and developing, 41, 45, 350, 351
 neurobiology of, 321, 324
 response to melodic patterns, 328
 size increased, 350, 358
 Brain substrates, 14
 auditory acuity of blind, 36
 changed by experience, 45, 325, 327, 328, 330
 of cognitive maps, 47, 50
 destroyed by practice, 330
 evolution of, 317
 hard-wired, 319, 325, 326
 lateral specialization, 321, 322
 limited communications, 321–323
 soft-wired, 319, 325
 vision and auditory imagination, 325
 “Breadth” of applicability, 308
 Bregman, Albert S., 169
 Brennan, David, 329
 Britton, Thomas, 101
 Broadcasting emotions, 334
 Broadcasting sounds in arenas, 34
 Brown, Charles H., 339
 Brute-force computation of a concert hall, 243
 Bryant, Henry, 168, 169
 Buchler, E. R., 344
 Buildings shape inhabitants, 148
 Bulfinch, Thomas, 77
 Bullock, Theodore H., 336
 Buonomano, Dean V., 327
 Burnett, Charles, 81
 Burnham, Denis, 326
 Burns, E. M., 257
 Byrne, Richard W., 358

 Cage, John, 22
 Campbell, Bernard Grant, 353
 Campbell, Nancy, 41
 Campos, Guilherme, 268
 Camras, Marvin, 195
 Capitalism, influence of, 113
 Career management, 279, 286, 287, 290
 Carlson-Smith, Connie, 44
 Carnegie Hall, 112
 Carothers, J. C., 72
 Carpenter, Edmond, 4, 72
 Carrier, David R., 349
 Carrier and modulation decoding, 256
 Carroll, Lewis, 75
 Cascade feedback-delay modules, 263
 “Casual listening,” 182
 Cathedral at Saint-Denis, 91
 Cathedral of Santa Maria del Fiore, 226
 Cathedrals
 as coupled spaces, 254
 equivalent to natural caverns, 89
 geometric symbolism, 91
 Cathedrals, Gods home, 89, 91
 Cavanaugh, William J., 28
 Caverns, as nature’s concert halls, 74, 178, 180
 Caves, 1, 183
 acoustics of, 180, 181, 183
 experience of historic caves, 68, 74, 75
 like science fiction, 180
 as shamanic cosmos, 71, 73
 Center channel in stereophonic format, 206
 Charles, Ray, 39
 Chicago Civic Opera, 111
 Chichén Itzá, pyramid at, 59, 85, 86
 Childhood, drives society, 351

- Chiming clock as soundmark, 29
- Chimpanzee, proto-humans, 352, 353, 355, 356
- Chion, Michel, 182, 183, 366
- Chord, musical, 136, 159, 328
- Chorus, experience of from inside, 152
- Christiansen, Clayton M., 289
- Chu, W. T., 249
- Churches
- acoustics of, 101, 111, 139, 220, 250, 259
 - assisted reverberation in, 202
 - dual meaning of, 91
 - in music, 116, 122, 248
 - role of, 65, 90–94, 100, 281, 363
 - size and congregations, 90, 236, 340
- Churchfield, Sara, 344
- Churchill, Winston, 1, 148, 203
- Cilia, Daniel, 366
- Cinema, and aural space, 131, 160, 166, 204, 206–209
- Cinema film directors, as subculture, 8
- Cinema industry, 204, 279, 295
- Clarinet, lacks temporal spreading, 136
- “Clarity” in concert halls, 218, 223
- Classen, Constance, 3
- Claustrophobia, 2
- Close microphone, avoid acoustics, 112
- Clottes, Jean, 73
- Cocchi, A., 245
- Cognitive burden, 183
- Cognitive frameworks, legacy of, 67–70, 72, 78
- Cognitive judgments of decision makers, 290, 292
- Cognitive map, 46–51
- and aural architects, 50
 - dual, 326
 - fail with virtual spaces, 166
 - and navigational spatiality, 46, 49, 50
 - and operators, 48
 - of owl, 326
 - revealed by behavior, 50
- Cognitive processes, 13
- Cognitive psychology, 299
- Cognitive science, 315
- Cognitive strategies, 44, 302, 319, 324
- for echolocation, 40, 43, 44
 - influence perception, 36, 43, 302
 - inventing, 41, 44
 - of spatial attributes, 36, 37
- Cohen, Morris, 351
- Cohen, S. I., 73
- Cohesive social unit, 277, 340, 352
- Coleridge, Samuel Taylor, 161
- Committee of aural architects, 131
- Communicating emotions, 357
- Compact disc (CD), 204
- Complexity, managing, 291
- Composers
- adjusting statistical parameters, 255
 - as aural architects, 7, 128, 165, 186
 - ignore acoustics, 209
 - incorporate evolutionary artifacts, 342
 - and metainstruments, 103, 137
- Composition and diffusion, 173
- Computer games use virtualized space, 166
- Computer models of enclosed spaces, 228, 236, 242, 243, 245
- Computer music and spectral flutter, 259
- Computers, as rationalization, 284
- Concert halls
- acoustic disaster, 120
 - active electronic in, 58
 - affect created by, 324
 - auditory subcultures in, 227
 - connoisseurs of, 218
 - defects ignored, 229
 - direct and first reflections, 218
 - inflexible binding, 125, 157
 - measurements, limitations of, 241
 - microscope viewpoint, 237
 - models of, 242
 - as musical paradox, 103, 186
 - origin of, 102, 212
 - perception, factor analysis, 221
 - produces slave sonic event, 152
 - quality of, 147, 217, 218, 228, 229

- Concert halls (cont.)
 research questions, 226, 267
 seat determines experience, 130, 227
 secondary resonant enclosure, 136
 shared experiences, 348
 as single arena, 28
 statistical models of, 253, 254
 traditional shoebox shape, 121
 versus forests, 340
 visual importance of, 119
- Concerto, and new aural architecture, 102
- Conch shell as small cave, 58
- Conclusions, strength of, 308, 309
- Conductors, localization ability, 329
- Conflict of interest among stakeholders, 290
- Conflict reconciliation in social groups, 350, 356
- Conflicting values among disciplines, 296
- Conflicts in social spheres, 34, 35
- “Conjunctive interval,” 170
- Consciousness, 14, 323, 333, 334
 ill-defined concept, 12, 304
 limitations, 322, 333, 334
 neurological basis, 301
- Consensus, lack of, 304
- Conservatism, importance of, 287, 288
- Consistency among listeners, 223, 226
- “Construction alternativeness,” 292
- Contemporary composer and space, 160, 164, 208, 238
- Contradictions in professional disciplines, 288
- Contributors to spatial experience, 131
- Conversational sphere, 34, 35
- Cooper, Clair, 52
- Cooper, Duane, 190
- Cooperation in small groups, 357
- Corbin, Alain, 30
- Cori spezzati (divided choirs), 168
- Corpus callosum, 321, 323
- Cott, Jonathan, 172, 180
- Coulson, David, 74
- Countries. research focus, 295
- Coupled spaces, 250
- Cowan, Nelson, 271
- Cox, Trevor J., 221, 225
- Craftsmen as aural architects, 69
- Crane, Diana, 299
- Creativity and emotions, 281
- Cremer, Lothar, 119, 366
- Cross-cultural tolerance, 298
- Cross-disciplinary questions, 276
- Cross-modal plasticity, 325
- Cuff, Dana, 283
- Culhane, John, 207
- Cultural and acoustic geography, 30
- Cultural attitudes, reconstructing, 69
- Cultural boundaries of disciplines, 278
- Cultural changes influence spatial frameworks, 163
- Cultural evolution, 307
- Cultural forces in aural architecture, 126, 215, 279
- Cultural frameworks, reconstructing, 68, 72, 287
- Cultural values of disciplines, 277, 278
- Culture, 277
 as filter of history, 68–71
 hostility toward reverberation, 279
 invests in aural architecture, 328
 learned, 277
 and perceptual abilities, 327
 reproductive advantages, 351
 in small groups, 354
 values and aural experience, 68, 70
- Curio, Eberhard, 352
- Dahl, Luke, 265
- Dalenbäck, Bengt-Inge, 245
- Data types, as evidence, 276
- Dattorro, Jon, 269, 274
- Dauvois, Michel, 75
- Davenport, Wilbur B., 252
- Davidson, Justin, 214
- Davies, William, 229
- Dawkins, Richard, 358
- De Bruin, S. L., 171

- De Forest, Lee, 200
- De Gelder, Beatrice, 48
- De Sousa, Ronald, 281
- De Volder, Anne G., 325
- De Vries, Diemer, 233, 241
- De Waal, Frans, 355, 356
- Deafness, functional, 25
- Deafness, momentary masking, 233
- Decision makers, 278, 283–285
 personality of, 291
 politics of, 285, 286
 private agendas of, 287, 288
 in reverberator design, 286
- Declercq, Niko F., 86
- Decoding distance of vocalizations, 338
- Decoupled spaces, 130
- Defects, acoustic
 in concert halls, 120, 146, 154, 254
 using electroacoustics, 199, 202
 of frequency response, 228–231
 perception of, 142, 256, 258–260
 language of, 225, 227
 learning to hear, 273
 origin of, 132, 212
 in recordings, 121
 in research, 221
 in reverberators, 261, 266, 268, 273
 in simulations, 132, 237, 246
- Delay lines, 200, 262, 263, 269
- Delectability, perception and desirability, 14
- DeLong, Thomas A., 114, 115
- Demany, Laurent, 45, 314, 329
- Democracy, role in aural architecture, 97, 114
- Deprès, Olivier, 327
- Design criteria, 118
- Designers of virtual spaces, 125, 184
- Detection of repeated noise, 270
- Deterministic models, assumptions, 250
- Devereux, Paul, 76, 77
- Devinsky, Orrin, 322
- Diderot, Denis, 37
- Diebel, Carol E., 336
- Diffused sound
 absence of location, 145
 in contemporary music, 172–175, 197
 creating, 65, 89, 120
 in evolution, 338, 342
 in music theory, 134, 135, 142, 153–155, 157
- Digital versatile disc (DVD), 204
- Dimensions of disciplines, 278
- Dimensions of musical space, 149
- Direct sound
 affective component of, 342
 distinct from its reverberation, 134
 dominated by natural acoustics, 180
 and fused reflections, 28, 218, 320
 highly valued, 113
 localizable, 135
 in musicology, 140, 158, 267, 270
 as primary sonic event, 151
- Direct-form reverberator topology, 266–268, 270, 272
- Disciplines, 277–279, 298
 and belief system, 305
 cultural values of, 277–279
 dimensions of, 307, 308
 as a dynamic organism, 295
 evaluation of individuals, 287
 as fiefdoms, 280, 281
 flaws in, 276
 governance process in, 279, 283, 287, 293–295
 growing number of, 299
 hybrid, 299
 and intellectual scope, 278, 294, 299, 307
 kinship networks in, 295
 life-cycle of, 293–295, 297
 personalities of, 296
 as subcultures, 316
 subjectivity in, 281, 291
 support required, 294
 “Disjunctive interval,” 170
- Disney, Walt, 207
- Distances experienced as time, 49
- “Distinct sonic events,” 170

- Dittrich, Winand, 356
 Dittus, Wolfgang P. J., 339
 Diversity of ancestral environments, 318
 Dolphins, echolocating, 37, 343–345
 Donald Laming, 301
 Doors, aural manifestation of, 25, 28, 31, 44
 Downs, Roger, 46
 Dreyfus, Hubert L., 297
 Dry acoustics, idealized, 108, 109, 115, 116
 Dummy-head recording, 188
 Dunbar, Robin, 356, 358, 359
 “Dynamic relief,” 170
- Earcons, 59, 82–84, 86, 88
 Early acoustics, amplification in, 96
 Early Chinese, acoustic insights of, 81
 Early English theaters, aural architecture of, 98
 Early habitats still available, 337
 Early reflections, 53, 142, 156, 233, 244, 246, 255, 261
 match forest acoustics, 341
 in primary sonic event, 156
 in Shakespearean theater, 98
 Early-onset blindness, 325
 Ebeling, K. J., 249
 Echo Hall in Greece, 94
 Echo, myth of, 77
 Echoes, 2
 ancestral experience of, 341
 create small arenas, 94
 dual meaning of, 14, 361
 in early cultures, 74, 75, 77, 79, 86
 location of, 153
 as musical tradition, 168
 perception as slave event, 151, 153, 155
 as spatial announcement, 3
 unbound from direct sound, 56
 Echoic memory, 271
 Echolocation, 36, 37, 42. *See also* Navigational spatiality
 in animals, 1, 343, 344
 begun in childhood, 41
 difficult to study, 345
 face vision, 37, 80
 hearing and vocalization, 343
 infrequently used by blind, 38
 as latent ability, 37, 39
 learning of, 38–43, 45, 326
 methodological problems with, 43
 movement creates time changes, 44
 as sensory subculture, 39
 teaching, 276, 302
 Ecology, 337, 339, 348
 Eddins, David A., 257
 Edwards, George D., 200
 Egocentric perspectives, 49, 50
 Elbert, Thomas, 330
 Electroacoustic presentation of music, 170
 Electroacoustics
 expands arenas, 199, 200
 and instruments, 124
 in performance spaces, 198–200, 202
 Elektronische Musik, 181
 Elevation, ignored, 211
 Eliot, T. S., 67
 Elkin, Robert, 101
 Elkins, James, 335
 Embellishments, religious shrine, 88
 Emmerson, Simon, 175, 182
 Emotional bonds in disciplines, 277
 Emotional brain, 281, 333, 334
 Emotional concepts, 332
 Emotional content of experience, 335
 Emotional intelligence, 281, 357, 358
 Emotional life, 324, 334, 356
 Emotional mood, ignored in paradigms, 298
 Emotional operators and cognitive maps, 48
 Emotional reaction to subjectivity, 292
 Emotions, 281, 332, 335. *See also* Affect
 in active listening, 13
 altered states of consciousness, 73
 broadcast of, 322, 332, 334
 and creativity, 281
 in disciplines, 281
 evolutionary solution, 281
 experienced by older cultures, 77

- influence perception, 333, 334
 - public and private, 321
 - represent body states, 322, 333, 334
- Empirical acousticians, 306
- Empirical data, 276
- Enclosed space, 133, 134
 - reflections versus resonances, 247
 - required assumptions, 241
 - scientific models of, 235–260
- Enclosed spaces
 - expanding, 55
 - measurement of, 232, 239
 - mixing time in, 253, 254
 - modeling, 243
 - modern environment, 62, 341
 - spatial and temporal spreading, 133
 - versus natural habitats, 341
- Energy balance in evolution, 349
- Energy-preserving topologies, 264, 265, 269
- Engaged listening, 13
- Enlarged mass, in Shakespearean theater, 98
- Entrepreneurs as aural architects, 113
- Envelope, perception of variations, 257
- Enveloping
 - reverberance, 62, 145, 153, 211, 216, 235
 - sound, feeling created by, 145, 153
- Envelopment, listener experience, 221, 223
- Epistemology, 297, 298, 304, 307
- Equalization filters, 193
- Equilibrium, multiple definitions of, 252
- Ergodic space (fully mixed), 253, 254
- Ericsson, K. Anders, 301
- Ernst, David, 149
- Escher, Maurits Cornelis, 160, 164, 165, 212
- Ethnocentric bias in arenas, 29
- Ethnoepistemology, 278
- Ethnographic analysis, 284
- Etienne, Ariane S., 344
- Etymology of sonic words, 69
- Evidence, 276, 308, 315
- Evolution, 317, 318, 347, 348
 - adaptation to habitats, 337, 339
 - artifacts produced by, 318
 - couples senses, 348
 - diversity in, 350
 - of echolocation, 8, 343–345
 - emotional communications, 334, 345, 356
 - of energy balance, 349
 - of hearing, 8
 - precedence effect, 342
 - principles of, 319, 320
 - shift to private awareness, 323
 - and social intelligence, 357
 - in subcultures, 277
- Experience-expectant learning, 325–327
- Experience-independent learning, 325
- Experience-dependent learning, 325, 326
- Experimental results, interpretation of, 224, 301, 312
- Experiments, extraneous factors in, 221, 312, 313
- Expert perceivers, 38, 269, 309, 310, 331
- Experts
 - arcane knowledge of, 283
 - subjective preferences of, 222
- Eye-centered reference frame, 326
- Face vision, 37, 80. *See also* Echolocation
- Factor analysis in evaluation of concert halls, 221
- Failure, price of, 287
- Fantasia, 207, 208
- Fantasm, illusions in, 207
- Fay, Richard R., 336
- Federal government, role of, 283
- Feedback, energy recirculation, 263
- Feedback-delay module, 262, 263, 265, 268
- Feelings, 334
 - produced by space, 2, 20
- Feld, Steven, 15
- Fenton, M. Brock, 343
- Fidi, Werner, 123
- Fieldwork, 309, 315
- Financial power, exercise of, 282, 285
- Finkenthal, Michael, 367
- Fish adapting to acoustics, 339

- Florentine, Mary, 73
 Flutter, two mechanisms, 258
 Focal dystonia, 330
 Folk language of emotion, 332
 Folk science, 256, 258, 303–306, 309, 310, 314, 315
 dangers of, 258
 as truth, 256
 utility of, 254, 256, 258, 316
 Foreground sonic events, 105
 Forest acoustics, 337, 338, 340–342, 346, 348
 Forgas, Joseph P., 335
 Formal methods, 226, 236, 292
 Formal science, 303, 304, 309, 314, 315
 Formal theories, 292, 303
 Forrest, Tim G., 340
 Forsman, K. Anders, 344
 Forsyth, Michael, 78, 111, 366
 Fouts, Roger S., 352
 Fox, Robin, 347
 Fragmentation of knowledge, 298, 299, 303
 Franklin, Sarah, 279
 Freed, D. J., 63
 Frequency modulation, sensitivity to, 331
 Frequency response
 as acoustic defect, 228
 errors in, 228, 231
 non-uniform, 229, 249
 Frequency-domain viewpoint, 250
 Frodeman, Robert, 286
 Fuller, Steve, 284
 Functional deafness, 25
 Furnishing, effect on acoustics, 3, 28
 Fused versus decoupled sonic events, 155
 Fusing
 early reflections with direct sound, 320
 interval, 341
 Fusion varies with experience, 157

 Gabrieli, Giovanni, 168
 Gade, A. C., 366
 Gans, Carl, 347
 Gap detection, 257, 331

 Gardner, Howard E., 330
 Gardner, William G., 190, 191, 234, 242, 263, 266, 274
 Garity, William E., 207
 Gazzaniga, Michael S., 321–323
 Genes and culture, evolutionary of, 347
 Genetic
 abilities, 330
 specialization, 314, 346, 352
 German Expressionisms, 119
 German Pavilion, 172
 Gerzon, Michael A., 197, 201, 264, 265
 Gewandhaus, 118
 Gibson, James J., 340
 Gifted listeners, 266, 331
 Gill, Sam, 77
 Giménez, A., 244
 Gish, S. L., 339
 Gladwell, Malcolm, 222
 Globe Theatre, 98, 99, 222
 Golden ears, 266
 Goleman, Daniel, 281, 357
 Gordon, Michael, 43
 Gossip and social cohesion, 359
 Gould, James, 344
 Gould, Stephen A., 318, 351
 Government, influence of, 283–286
 Governmental decision makers, 285
 Greek theater and culture, 94–97, 108
 Green, George, 80
 Gregorian chants, 92, 111, 203
 Griesinger, David, 202, 223, 233, 234, 256
 Griffin, Donald R., 339, 343, 344
 Grooming serves social cohesion, 356
 Gropius, Walter, 361
 Grose, J. H., 257
 Grosser Musikvereinsaal in Vienna, 78
 Grotto of Jeita, 178–180
 Ground reflections, 19, 20, 337
 Groups
 cohesion within, 349, 350, 352, 355, 356
 effectiveness of complex, 350
 evolutionary adaptation of, 348

- and genetic specialization, 346
- maximum size of, 358
- Grout, Donald, 92, 168
- Guitars with reverberation, 123
- Guttman, Newman, 271

- Haas effect, 200, 288, 342
- Haas, Helmut, 200, 288
- Habitats define animal, 340
- Hall, Edward T., 34
- Halmrast, Tor, 229
- Hammond, Laurens, 122, 213
- Hamsters, echolocating, 343, 344
- Hanfei-tzu, 74
- Hanging clouds, role of, 218, 220
- Hanson, O. B., 115, 122
- Hard-wired brain substrates, 319, 325, 326
- Hardy, H. C., 240
- Harley, Maria Anna, 169, 177
- Harmony, social, 356
- Harris, Cyril, 120, 121
- Harris, Gerard G., 257
- Harrison, Jonty, 172, 181
- Harshness, perception of, 180, 257
- Hausa culture, 4
- Hauser, Marc D., 27
- Hauser, Steven, 27, 357
- Hausfeld, Steven, 44
- Hawkes, R. J., 221, 227
- Hayden Planetarium, 202
- Hayes, Samuel P., 37
- Head-centered reference frame, 326
- Headphone listening format, 130, 187, 188, 191
- Head-tracking headphones, 189, 208
- Hearing, 4
 - distance, 42
 - evolutionary value of, 335, 337
 - goal directed view of, 340
 - model, historic, 300
 - for navigation, 336
 - objects, 20, 43
 - soundscapes, 335, 336
- Heinz, Renate, 244

- Heisenberg, Werner Karl, 314, 315
- Helmholtz, Hermann von, 80, 300
- Helmholtz resonators, 58, 76
- Hertz, Bent, 205
- Heuristic models, 233, 234
- Heyer, Paul, 367
- Higginson, Henry Lee, 118
- High frequencies, associations to, 63
- High-energy physicists, anthropology of, 295
- Hill, W. Henry, 274
- Hindu religion, 72
- His Master's Voice, 107
- Historic cultures, cognitive frameworks of, 67
- Historic experience of cathedrals, 68
- Historical artifacts, 59, 132
- Historical aural architecture, unintended designs, 55, 59
- History written by elite, 69
- Hiyama, Koichiro, 204
- Hochachka, Peter W., 346
- Hofman, Paul M., 326
- Hogarth, William, 107
- Holbrook, Rick, 202
- Holistic
 - explanations of early cultures, 46, 82
 - integration of senses, 327
- Holliday, Kent, 113
- Hollywood Bowl amphitheater, 108
- Holman, Tomlinson, 204, 209, 210, 279
- Holophony, 196–198
- Holt, A. Barry, 351
- Home organ with reverberator, 122, 213
- Hominid brain, size increased, 350
- Horace, Petherick, 274
- Horrall, Thomas R., 185
- Hosler, Dorothy, 83
- Hostility to change, 118, 181
- House, Neal, 193
- “How” questions, 307
- Howes, David, 3
- Human auditory system originates from early primates, 336
- Human brain, largest of mammals, 350

- Human culture originates from evolution, 353
 Human infants slow to develop, 350, 351
 Human nature, neurological basis of, 324
 Humans evolved as social animals, 337, 352
 Humans not designed for modern society, 319
 Humidity absorbs high frequencies, 245, 338, 339
 Humphrey, Nicholas, 323
 Humphreys, William J., 241, 338
 Hunningher, Benjamin, 96
 Hunt, Frederick Vinton, 296
 Hunt, Kevin D., 349
 Hypogeum at Hal Salfieni, 89, 178
- Illusions, 300
 degraded by contradictions, 255
 in Fantasound, 207
 versus reality, 272
- Imaginary spaces, 6, 130, 212
 Imaging space by hearing, 35, 42
 Implementers versus sponsors, 282
 Impulse response of space, 239, 241, 242, 266
 In-audience perspective, 209–211
 Individuals in subcultures, 275
 Industrial revolution
 create new discipline, 104
 as sensory revolution, 104
 Industrial soundscape, 103
 Infrasounds, otherworldly experiences, 76
 Inhabitants of space as subculture, 7
 In-head localization, 76, 146, 187, 188, 318, 342, 343
 Inherited attributes, 204, 330, 342, 346
 Innovation
 consequence of, 281, 287, 289, 290
 winners and losers in, 289, 301
 Institute for Music Acoustic Research and Coordination, 284
 Integers rationalize designs, 89, 284
 Intellectual bonds in disciplines, 277
 Intellectual boundaries of disciplines, 278, 298
 Intellectual compromises, 315
 Intellectual fragmentation, 298, 303
 Intellectual frameworks, 12, 71, 277, 278
 of cognitive science, 315
 in disciplines, 277, 278, 297, 298, 307, 315
 musical spatiality, 149
 philosophy of science, 304
 Intellectual objectivity, 280
 Intellectual property, ownership, 288
 Intellectual rights, assigned, 289
 Intelligence
 enhances survival, 349
 of groups and individuals, 277, 349
 types, 330
 Interdisciplinary activity, 276, 281, 297, 307
 Interference from reflections, 228
 Interferences in perception, 301
 Internal experiences, communicating, 131, 226, 324
 Intimacy in concert halls, 218, 221, 223
 Intimate sphere, 34
 Introspection, 38, 226, 300, 301, 305, 309
 using questionnaires, 300
 Intuition, role of, 276, 303, 304, 309
 IPodspace, 214
 IRCAM, 284
 Irrationality, 281
 Irregular surfaces, 337
 Ives, Charles, 168
 Iwamiya, Shin-ichiro, 219
- Jack, Anthony Ian, 301
 Jacob, François, 317
 Jacobson, Marcus, 325
 Jacobson, R. Daniel, 47
 James, Jamie, 88
 James, William, 300
 Jankowicz, Devi, 291, 292
 Japanese Pavilion, 172
 Järvillehto, Timo, 334
 Jaworski, Adam, 33, 365
 Jay, Antony, 281
 Jeita caves, 185
 Jellicoe, Geoffrey, 361
 Jobes, Gertrude, 77

- Joffe, Tracey H., 350
 Johannes, Robert Earle, 304
 Johnson, R. C., 346
 Jones, Stephen, 346
 Jot, Jean-Marc, 201, 267
 Jowett, Benjamin, 94
 Joyce, W. B., 253
 Julesz, Bela, 271
 Jungles, acoustics of, 337, 340, 341
- Kaernbach, Christian, 271
 Kahn, Dianna M., 325
 Kanada, Yasumasa, 242
 Karamustafaoglu, Attila, 189
 Katz, Daniel, 277, 292
 Katz, Pearl, 277, 280
 Keesing, Roger, 295
 Kellogg, Winthrop N., 44
 Kelly, George Alexander, 292
 Kelvin, William Thomson, 301
 Kendall, Gary, 246
 King, Andrew P., 47, 340
 Kirk, Wayne Van, 85
 Kish, Daniel, 39, 41
 Klapholz, Jesse, 207
 Klein, Julie, 367, x
 Kleiner, Mendel, 186, 245
 Kline, Paul, 222, 367
 Klipsch, Paul Wilbur, 206
 Knickrehm, Glenn, 223, 324
 Knowledge
 based on belief, 278, 305
 depends on context, 236
 fragmentation of, 298, 299
 as intellectual property, 280, 296
 Knudsen, Vern Oliver, 240, 248
 Koelsch, Stefan, 328
 Korenaga, Yuji, 185
 Kornblith, Hilary, 278
 Kövecses, Zoltan, 332
 Krautheimer, Richard, 90
 Kresge Auditorium, 146
 Kroodsma, Donald E., 339
 Krylov, Nikolai Sergeevich, 253
 Kudo, H., 358
 Kuhl, Walter, 123, 225
 Kuhn, Thomas, 288, 296
 Kukla, Andre, 304
 Kurtz, Michael, 172, 178, 180
 Kuttner, Fritz, 81
 Kuttruff, Heinrich, 247, 249
- La Scala Opera House, 200
 Laakso, Timo, 269
 Lafleur, L. Dwynn, 241
 Lakatos, Imre, 297, 304
 Lamb, Charles, 105
 Laming, Donald, 301
 Landscapes and soundscapes, 15, 66
 Language
 absence in animal culture, 352
 acoustic defects 225, 227 (*See also* Defects,
 acoustic)
 of aural architecture, 217, 225, 281
 for aural experience, 13, 353
 of concert halls, 218, 221, 225
 dependence on, 225
 of emotions, 332
 of group cohesion, 334, 353
 in intellectual frameworks, 278
 of internal experiences, 226, 324
 lacking for sounds, 219, 225
 meaning changes, 4
 means for binding, 276, 353, 359
 of musical space, 128, 129, 158
 and preference judgments, 222, 223
 of sound, inconsistent, 63, 219
 spatiality concept lacking, 132
 substrate connections to, 323
 using borrowed words, 219
 versus rating scales, 221
 of virtual spaces, 132
 of visual architecture, 6
 Late reflections, 53, 156, 244, 246, 266
 Lateral reflections, 232, 322
 Latour, Bruno, 280

- Lawson, Graeme, 76
- Lawyers, intimidation by, 289
- Le Boeuf, Burney J., 352
- Le Corbusier, 149
- Leadership styles, 293
- Learning
- as adaptation to environment, 324, 327
 - to aurally visualize, 35, 320
 - changes brain, 325
 - echolocation, 39, 41, 44
 - as evolutionary strategy, 319, 352
 - experience-expectant, 325–327
 - experience-independent, 325
 - experience-dependent, 325, 326
 - pattern recognition, 320
 - pitch discrimination, 45, 314
 - psychophysical sensitivity, 45
 - public display of, 321
 - requires relevance, 329, 331
 - reverberation, 341
 - tonal color, 45
 - unobservable, 321
- Lears, Rachel, 30
- Lecture hall acoustics, 53, 78
- LeDoux, Joseph E., 333
- Lee, James B., 253
- Lee, Richard C., 320
- Left brain hemisphere, properties of, 322
- Lehman, Peter, 225
- Letowski, Tomasz, 328
- Levinson, Stephen C., 50
- Lewcock, Ronald, 200
- Lewis-Williams, J. David, 75
- Lexicon Corporation, 124, 212, 286
- Life imitates art, 214
- Limbic system, 333
- Lindskold, Svenn, 34
- Linearity and time invariance, 239
- Lippman, Edward, 88
- Listener envelopment, 232
- Listeners
- adapt to coloration, 193
 - controls spatial spreading, 146
 - inside resonant enclosure, 139
 - non-homogeneous, 7
 - part of social system, 147
- Listening, 4, 15, 328
- culturally relative, 3
 - spaces, 104
 - states, psychology of, 182
 - strategies, 64, 340
- Litovsky, Ruth Y., 276, 306
- Local acoustics, 88, 145, 146
- Localization, 152, 342
- affective response to, 342
 - in an unconstrained environment, 312
 - in animals, 342
 - with binaural headphones, 188
 - by conductors, 329
 - of diffused sound, 145 (*See also* Diffused sound)
 - evolutionary survival value, 62
 - hearing and vision, 206, 348
 - learning, 314, 326
 - models of, 302
- Localized versus diffused, 152
- Location
- influences event fusion, 155
 - of musicians in composition, 167
 - in virtual musical spaces, 167
- Logan, Benjamin, 124, 265
- Long delays produce echoes, 56
- Long-term memory of spaces, 17
- Loomis, W. F., 346
- López, José Javier, 190
- Lopez, M. R., 93
- Loudness discrimination, 327, 331
- Loudspeaker arrays
- in automobiles, 193
 - in performance spaces, 202
 - in reproduction formats, 197, 198
 - for virtual spaces, 57, 164, 170–172, 196
- Loudspeakers
- externalized location, 187
 - panning between, 210
 - and spatial accuracy, 194

- LoVetri, Joe, 228
- Low-frequencies
- associations to, 63
 - infrasounds, 76, 108
- Low-risk strategy in research, 288
- Lubman, David, 59, 85, 86, 92
- Lucas, George, 204
- Lucy, J., 50
- Mace, William M., 340
- Machiavelli, Nicolò, 281
- Machiavellian intelligence, 281, 358
- MacKinnon, Donald W., 282, 283
- Malham, David, 197
- Malta culture, 89, 178
- Managers, self-interest of, 289
- Mann, David A., 336
- Marching bands, 137, 168
- Marketing influences on aural architecture, 112, 113, 209
- Marks, Lawrence, 219
- Mártinez-Sala, R., 60
- Mason, Wilton, 168
- Mathematical formalism, 251, 252, 276, 305
- Mayan culture, 59, 84–86, 275
- McCutchen, B., 200
- Meaningfulness, perceptual relevance of, 14, 212, 332
- Megaphone, acoustic implications of, 23, 96
- Mehta, Ved, 38, 39, 41
- Melodic patterns, brain response to, 328
- Memory
- influence on quality, 227
 - overcoming limitations of, 242
- Meredith, Alex, 345
- Mersenne, Marin, 80
- Merton, Robert K., 288
- Merzenich, Michael M., 325, 327
- Messer-Davidow, Ellen, 367
- Metainstruments, 135–138, 143
- musicians adapt to, 139
- Metaloudspeakers, 196
- Metamicrophones, 196
- Methodological problems, 43, 215
- Meyer, Donald C., 114
- Microphones, 57, 104, 121
- Milgram, Stanley, 47
- Miller, George A., 257
- Miller, Wreford, 33
- Minnaar, Pauli, 188
- Mithen, Steven, 353
- Mixing engineers, 209, 278, 354
- apply spatial rules, 143, 146, 158, 159, 186, 209, 212, 235
 - as aural architects, 6, 146, 209, 269
- Mixing studio, 123, 249
- Mixing time in enclosed spaces, 253, 254
- “mobile distribution”, 170
- Model making as art, 245, 302
- Models of enclosed spaces, 235–260, 311, 312
- Møller, Henrik, 188
- Monastery at Santo Domingo de Silos, 92
- Money controls decisions, 285
- Monkeys, acoustic adaptation of, 339, 352
- Monoideic framework, 72
- Monophonic format, 205
- Monopoly on inventions, 274
- Montgomery, H. M., 346
- Moore, Christopher, 267, 268
- Moorer, James A., 266, 270
- Morimoto, Masayuki, 233
- Morrice, M. G., 352
- Motivation for research, 285, 313
- Moulton, David, 224
- Mountains, acoustics of, 346, 348
- Muckel, Petra, 223
- Multidimensional analysis, 222, 223
- Multimedia presentation, 171, 294
- Multisensory
- art, 57, 60, 66, 74
 - experience, 47, 49, 65, 345
- Multivariate factoring, 312
- Münste, Thomas F., 314, 329
- Murphy, Gregory, 219
- Music changed by acoustics, 92, 103, 111, 116, 144

- The Music Club, 101
- Music creates social cohesion, 147
- Music halls become radio parlors, 113
- Music rooms became concert halls, 102
- Music
 - skills to appreciate, 330
 - as sonic illumination, 128
 - and space, not time aligned, 128
- Music of the spheres, 88
- Musical dimensions of space, 149–157
- Musical fusion and spatial acoustics, 155
- Musical instruments
 - active and passive, 135, 136
 - include space, 7, 135
 - perceived size, 152
 - and space, 124, 160
 - spectrally broad, 249
 - temporal spreading of, 135
- Musical intelligence, subdivided, 330
- Musical language of spatial attributes, 157, 169
- Musical movement as illusion, 170
- Musical rules and spatial acoustics, 127, 156, 158
- Musical space, 7, 64, 126–129
 - as abstraction, 129
 - as acoustic accidents, 147
 - application of aural architecture, 127
 - as artistic element, 125, 137, 164, 203
 - as extension of musical instruments, 7, 135
 - as investment, 101
 - lack of ideal, 147
 - language of, 149
 - musicians adapt to, 119
 - perception of walls in, 145
 - responds to social forces, 128, 147, 209, 214
 - splitting of, 104
- Musical spatiality, 12
- Musical subtleties, awareness of, 330
- Musicians
 - adaptation of, 94, 102, 119, 139, 224
 - anthropology of, 280
 - changing roles of, 7, 294
 - location specified in composition, 167
 - sonic right of, 31, 35
 - subculture of, 224
- Musikverein in Vienna, 119
- Musique concrète, 182
- Muzak, 33

- Nader, Lynn, 279, 280
- Naguib, Marc, 339, 340
- Nakayama, I., 366
- Natural acoustics, 27, 62, 180, 198
- Natural philosophy, 298
- Natural spaces in music, 178
- Navigating space as subculture, 354
- Navigational spatiality, 1, 12, 35, 36, 50, 64, 318, 343. *See also* Echolocation
- Navigational strategy of animals, 345
- Nelson, Mark E., 336
- Neocortex size, 358
- Neues Gewandhaus in Leipzig, 78, 118
- Neural connections, pruning of, 325
- Neurological
 - adaptation to early soundscapes, 340
 - communication, expensive, 322
 - decoding of spatial acoustics, 346
 - development, flexibility in, 324, 325, 351
 - model of perceived acoustics, 340
 - plasticity, 325, 326, 328, 329
 - research, limitations of, 301, 306
 - response of musicians, 328, 329
 - specialization, 319, 320
- Neuron growth, biological exuberance, 325
- The New Atlantis, 164
- Newton, Isaac, 80
- Nicol, Rozenn, 197
- Nind, Timothy, 193
- Noack, Bernd, 202
- Noise, consequences of, 22, 31, 103, 108, 122
- Noise level, 108
- Noise, perception of repeating, 271
- Noise pollution of the public arena, 106
- Noise samples, perceived as unique, 252
- Non-uniform frequency response, 229, 231, 249

- Normal
 hearing, problem of, 313
 science, who controls, 288
- Noson, Dennis, 225
- Novacek, Michael J., 343
- Numeric quantifiability, 301, 308
- O'Brien, Richard T., 268
- O'Donohue, William, 367
- O'Keefe, John, 47
- Objectivity, 280, 290
- Occupants as aural architects, 26
- Offenhauser, William, 205
- Okano, Toshiyuki, 233
- Old evolutionary solutions, influence of, 340
- Old soundscape, battles about loss of, 106
- Older cultures, rich soundscapes of, 69, 103
- Olive, Sean E., 222
- On the Power of Sound, 105
- Ong, Walter J., 72
- Ono, Kazuho, 196
- On-stage perspectives, 210
- Open doorway, perception of, 43, 44
- Open grasslands, 346
- Open meadow as spaceless, 19
- Open window, and sensory conflicts, 65
- Open-air theaters *See* Amphitheaters
- Opera broadcast, 114
- Oracle Chamber in the Hypogeum, 89, 178
- Organ music and spatial acoustics, 137, 259, 329
- Orientation and mobility teachers, 310
- Ormandy, Eugene, 217
- Osaka World's Fair, 173, 185
- Otherworldly experiences, 76, 88
- Ottman, Robert, 40
- Ownership rules of arenas, 34
- Ownership of spatiality, 148
- Owsinski, Bobby, 204
- Pack, Adam A., 345
- Paget, Violet, 127, 226, 300, 301
- Pallasmaa, Juhani, 21
- Panning, principles of, 210
- Pantev, Christo, 45, 328, 329
- Paradigms
 consequence of, 296–298, 306, 308
 influence phenomenon, 306
 in psychoacoustics, 300
- Parlor acoustics, model for spaces, 113
- Pascual-Leon, Alvaro, 48
- Passingham, Richard E., 350
- Passive acoustic objects, 2, 361
- Patents, consequences of, 273, 274, 288
- Patronage in architecture, 283
- Paul, R. C., 339
- Pearson, D. A., 326
- Peer governance, 287, 288, 357
- Peirano, Mariza G. S., 280
- Pepsi Cola Pavilion, 172
- Perceive, etymology of, 69
- Perceived size, 21, 49, 152
- Perceiving artistically irrelevant attributes, 227
- Perception, 13, 302, 321, 333, 334
 aids group survival, 340
 dimensions of, 222, 223, 227
 learned, 314
 limits of, 309
 of reflections, 276
 of repeating noise, 270, 271
 of reverberation flutter, 248, 258
 of smoothness in reverberations, 255, 256
 of sonic decay, 138
 of statistical parameters, 255
 of walls in music spaces, 145
- Perceptual differences and preferences, 222
- Perceptual psychologists, 299, 300, 305, 306, 327
- Perceptual strategies, choosing among, 14
- Perceptual uncertainty principle, 302
- Peretz, Isabelle, 330
- Performance
 spaces, 94, 104, 116, 130, 191
 versus listening spaces, 129, 130
- Performing arts, multisensory, 97

- Perrott, David, 206
- Personality, influence on decision making, 290–293, 296
- Personalized sound fields, 186–191
- Peterson, Aage, 309
- Phantom center channel, 206
- Phantom spaces, 6
- Phenomenological experience of space, 11, 303
- Phenomenology, intellectual formalism, 217
- Phenomenon, as filtered picture, 303, 306
- Philips Pavilion, 149, 171
- Philosophical framework in ancient Greece, 81
- Philosophical rules of inference, 278
- Philosophy, intellectual anchor, 298, 299
- Phonographs, influence on acoustics, 111, 113
- Physical boundaries of space, 21
- Physical processes in acoustic space, 17
- Physical spaces provide consistency, 125
- Physicists, anthropologic study of, 280
- Physics of small space acoustics, 229, 230
- Picasso, Pablo, 74, 163
- Picker, John M., 105
- Pinna (external ear) role in localization, 188
- Pitch
 - perception, learning, 45, 326, 328, 329
 - shift in reverberation decay, 248
- Planck, Max, 217
- Platner, Samuel, 90
- Plato, 94
- Playability of spatial attributes, 149, 152
- Plomin, Robert, 330
- Poème Electronique, 171
- Point source, perception of, 153
- Polack, Jean-Dominique, 245, 247, 253, 254
- Poletti, Mark, 201, 202
- Politics, consequence of, 275, 279, 281, 286, 357
- Pollack, George D., 343
- Popper, Karl R., 288, 304, 317
- Postman, Neil, 104, 105
- Prague Congress Center, 202
- Precedence effect, 288, 306, 342
- Preceda, Kristin, 331
- Predictive power of conclusions, 308
- Predictors of echolocation ability, 44
- Preference judgments, 193, 222, 224
- Pressnitzer, Daniel, 257
- Primary sonic events, 150–152, 156
- Primates similar to people, 353
- Primatologists, 355
- Principles of sound, discovery of, 80
- Private
 - agendas, 275, 288, 290
 - experiences, observing, 321, 323
- Professional disciplines, 275, 277, 278
- Prolonged infancy, importance of, 351
- Protestant churches, 101, 111
- Protestant Reformation, 65, 100
- Protoinstruments, 137, 138
- Proxemics, 34, 35
- Pseudoinstruments, 137, 138
- Psychoacoustic experiments, 300, 307, 311
- Psychological experimenters, 312
- Psychologists, 26
- Psychology discipline, 226, 299–301
- Psychology of personality, 282
- Psychophysical data, misleading, 301
- Public image, influences institutions, 284
- Public relations goals, 284
- Public sphere, 34
- Pujol, Jesús, 330
- Pyramid of Kukulkán at Chichén Itzá, 59, 85, 86
- Pythagoras, 182, 284, 296
- Pythian Temple, 122
- Quadrasonic format, 203, 206
- Quakers value silent prayer, 33
- Quality judgments, 218, 227, 289
- Quantifiability, 301, 308
- Quantz, Johann Joachim, 102
- Questionnaires, 219, 226, 300
 - for evaluating concert halls, 226
 - as research tool, 219
- Quetzal bird in Mayan religion, 59, 85
- Quiatt, Duane D., 352

- Radio broadcasting influences aural architecture, 113–115
- Radio City Music Hall, 109–111, 114
- Raes, Auguste, 92
- Random
 - noise, perception of, 252
 - phase fluctuations, 338
- Randomization
 - as artistic parameter, 138, 272
 - in assisted reverberation, 202
 - of musical sounds, 138
 - in reverberators, 268
- Randomness, 251
- Rasmussen, Steen Eiler, 20, 276
- Rational brain and emotions, 281
- Ratios of integer as design principle, 88
- Rats, echolocating, 343, 344
- Raw sensation, 12
- Ray tracing, 99, 244
- Rayleigh distribution, 248, 249
- Rayleigh, John W. S., 80
- Real life confounds science, 312
- Recanzone, Gregg H., 329
- Recording acoustics, difficulty of, 121, 143
- Recording engineers create unique spaces, 148
- Recordings without acoustics, 112, 116
- Recreating sound fields, 194
- “Reduced listening,” 182, 183
- Reflecting clouds, 65
- Reflection density, 256, 262, 265, 273, 306
- Reflection as echo, 42
- Reflections, 43
 - aural versus visual, 56
 - early, 53, 142, 156, 233, 244, 246, 255, 261
 - enlarge perceived size, 53, 156
 - fuse, 156, 255, 306
 - from ground, universality of, 342
 - increase perceived loudness, 306
 - multiply in enclosed space, 133
 - preference for moving, 272
 - produce coloration, 42, 228
 - random arrival time of, 272
 - from surfaces, 19, 44, 133, 232, 337
- Refractions, 270
- Reifying abstract concepts, 315
- Reilly, Andrew, 212
- Reims Cathedral, 91
- Relative size, 50
- Reliability of conclusions, 308
- Religion, etymology of, 353
- Repeating noise, perception of, 270, 271
- Replicating spaces, 131, 132, 261
- Research
 - paradigm, consequence of, 301
 - unarticulated issues, 237, 284, 288, 291, 297, 312, 314
- Resonance density
 - unmeasurable, 306
 - inadequate, 259
 - of large space, 138, 248
 - requirements, 273
 - in reverberators, 248, 262, 264, 267, 268
 - in small spaces, 2, 249
- Resonances
 - assumptions required, 251
 - compensating for, 230
 - feeling of otherworld, 88
 - preservation of statistics, 259
 - produce beat tone, 259
 - random decay rates, 259
- Resonant enclosures, 135–138
- Resonating oscillators, model of space, 247
- Resources, consequence limitations, 286
- Response to space, affective, 19, 62, 324
- Rettinger, Michael, 122
- ReTurning, 178
- Reverberance, 221, 223
- Reverberate, etymology of, 69, 133
- Reverberation, 139, 142, 246, 247
 - accident of large churches, 93
 - and acoustic arenas, 61, 62
 - algorithm, first invention, 293
 - chambers, 115, 122
 - circle, 249
 - constant energy, 257, 258
 - as cultural taste, 108

- Reverberation (cont.)
- decay, 139, 246, 259
 - depends on application, 127
 - destroys temporal details, 247
 - deterministic versus statistical, 250
 - as dialog with space, 62, 63
 - duration of sustaining, 139, 143
 - electroacoustically assisted, 201, 202
 - and emotional affect, 62
 - energy versus amplitude viewpoint, 251
 - enveloping, 62
 - excess creates aural soup, 227
 - experiential meaning, 61
 - extends musical notes, 16, 122, 157
 - final decay, 143
 - influenced by social changes, 100
 - insufficient, 61, 201
 - language problems, 132
 - local to regions, 61
 - mergers with musical instruments, 102, 123
 - mixed blessing, 61
 - in musical art, 102, 122, 141
 - as noise, 23, 108
 - onset, 139, 143
 - parameters, 250
 - partial filling, 122, 256
 - perception of, 142, 145, 256–258, 310
 - pitch shift in decay, 248, 259
 - as primary event, 157
 - as slave sonic event, 153
 - and social spheres, 62
 - softens attack, 137
 - as sounds of the past, 16
 - soup and mud, 92, 128, 143, 227, 247
 - spatial boundaries not perceptible, 145
 - statistics of, 133, 246, 247, 251, 253
 - tail pitch shifts to active resonance, 260
 - temporal behavior of, 139
 - time, meaning and perception of, 54, 89, 225, 227, 237
 - time in religious spaces, 90, 92, 93, 100, 101
 - time in music, 103, 110, 115, 137, 143, 180, 200–202, 225,
 - time, social view of, 108
 - time, statistics of, 250
 - time, conceptualized, 134, 237, 247, 249, 250
 - time, preferences, 225
 - time in radio studios, 115
 - time in reverberators, 123, 262–265
 - unlocalized source, 62
 - used by birds, 339
 - varies among disciplines, 305
 - as voice of the space, 62
- Reverberators, 260–265, 277, 294. *See also*
- Assisted reverberation; Reverberation chambers
 - algorithms remain secret, 289
 - analogous to real spaces, 263
 - as artistic tool, 269, 272
 - attenuators as absorption, 263
 - aural architects, 262
 - commercial, 277
 - as compromise, 121
 - constant resonance density, 267
 - control of reverberance, 234
 - create illusions, 212, 242, 267, 273
 - dependency on audio delay, 262
 - designs, decision-making in, 286
 - designs, quality, 273
 - designs, who influences, 285
 - digital invention of, 263
 - direct-form topology, 266–268, 270, 272
 - early use of, 116
 - electromechanical, 123
 - energy preserving, 264, 265
 - feedback-delay modules, 263
 - flexibility, 117, 123, 213
 - inexpensive, 290
 - influenced by social context, 272
 - mismatched resonance density, 267
 - modulators used in, 268
 - moving resonances in, 268
 - in performance spaces, 201
 - problem of delay, 123
 - proliferate, 124
 - quality and listener subculture, 272

- random modulation in, 242, 268, 269, 341
randomization to match statistics, 124, 268
randomize matrix, 269, 272
recirculating topologies, 263, 265, 269
reflection density in, 262, 265
reverberation time in, 123, 262–265
replace musical spaces, 124
resonance density in, 248, 262, 264, 267, 268
scientific foundation of, 265
selecting parameters, 265, 266
sonic reflection pattern, 264
spaciousness, 235
topologies, inadequate, 264, 267
unappreciated quality, 231, 274
using digital technology, 124
using unity-orthogonal matrix, 264, 265, 267, 269, 272
waveguide mesh topology, 267
- Reverse engineering reverberators, 274
- Review process controls discipline, 288
- Rewards and punishments as governance, 287
- Rhythmic sequences, variable sensitivity to, 331
- Rice, Charles E., 44
- Richards, Douglas G., 338
- Richardson, Russell, 99
- Richerson, Peter J., 347
- Right brain hemisphere, properties of, 322
- Riley, Donald A., 344
- Rimell, Andrew, 191
- Risk reduction in decision making, 287
- Risks and rewards, 287
- Risks when innovating, 118, 286, 289
- Riso, Don Richard, 293
- Ritchie, Ian, 4
- Ritual space as “binding”, 354
- Rockefeller Center, 114, 115
- Röder, Brigitte A., 45
- Roman Catholic, 100
- Rothafel, Roxy, 110
- Rother, Larry, 177
- Rotunda of Thessaloniki, 92
- Rouget, Gilbert, 13
- Roughness, perception of aural, 256, 257
- Royal Albert Hall, 78, 121
- Rules
for fusion and segregation, 168
for governing in disciplines, 279
of space for classical music, 159
of space in modern music, 165, 166
for spatial events, 158
when applied to spatial design, 159
- Ruling class, and noise, 106
- Rumsey, Francis, 224
- Running reverberance, 140, 141, 234
- Rüsseler, Jascha, 328
- Russon, Anne E., 356, 357
- Ryan, Mike J., 339
- Rybczynski, Witold, 119
- Sabine, Wallace Clement, 54, 78–81, 99, 117, 118, 144, 240, 250, 270
- Sacks, Oliver, 48, 286
- Sacred objects and sacred sounds, 83
- Sadato, Norihiro, 325
- Saint Mark’s Cathedral, 168
- Sánchez-Pérez, J. V., 60
- Santo Domingo de Silos, 93
- Sato, Shin-ichi, 225
- Savannas, acoustics of, 337, 340, 341
- Savioja, Lauri, 185, 245
- Scale models
as an art, 245
of concert hall, 185
of concert halls, 245
problem of scaling, 245
- Scattering, acoustic, 229
- Schafer, R. Murray, 20, 30, 168, 176, 177
- Scharoun, Hans, 119
- Schlaug, Gottfried, 328
- Schmidt, Karen L., 334
- Schooler, Jonathan, 222
- Schools for the blind, 41
- Schroeder frequency, 230, 248, 267
- Schroeder, Manfred R., 124, 190, 223, 229, 241, 248, 249, 256, 257, 263, 265, 266, 293

- Schubert, Gottfried, 96
- Schultz, Theodor J., 228
- Science, 303, 304, 309, 314, 315
 and art diverge, 236, 239, 254
 contrasted with real life, 43, 236
 limitations of, 78, 223, 224, 226, 266, 291, 309
 paradigms used in, 304
 simplify real life, 312
- Scientists, folk, 258
- Scientists as people, 279, 280, 348
- Seals, echolocating, 352
- Seat-dip effect in concert halls, 228
- Secrecy, consequences of, 229, 273, 289, 296
- Secularism motivates aural architecture, 94
- Seeger, Anthony, 4
- “Seeing” with our ears, 2
- Sekiguchi, Katuaki, 244
- Selecting acoustic accidents, 184
- Selective attention, survival value of, 333
- Self-awareness
 of emotions, 333
 weak survival value of, 318, 320
- Self-esteem as reward, 283
- “semantic listening”, 182
- Sempere, Eusebio, 59, 60, 86
- Sensation as contrast with perception and meaning, 14
- Sensing small objects, 44
- Sensitivity to envelope variations, 257
- Sensory anthropology, 3
- Sensory architecture, 21
- Sensory awareness, shift to private, 323
- Sensory cues, interpreting, 47
- Sensory experts, 304, 309
- Sensory integration, learning window, 326
- Sensory learning, 45
- Sensory modality preferred, 331
- Sensory practice changes brain, 45, 328
- Sensory skills, acquisition of, 41, 45
- Sensory subcultures
 determines perception, 223
 like tribes, 279
 using echolocation, 39
- Sensory trade-offs in designs, 65
- Sensory training of children, 45
- Seyfarth, Robert M., 352
- Shadows, acoustic, 17, 39, 43, 52, 143, 154
- Shakespeare, William, 94, 99
- Shakespeare’s Globe Theater, 97, 98
- Shamans as sonic priests, 64, 70, 73, 104
- Shankland, Robert S., 96, 254
- Shaped arenas, 54, 55
- Sheridan, Thomas, 7, 276
- Shinn-Cunningham, Barbara G., 326
- Shively, Roger R., 192, 193
- Shlien, Seymour, 331
- Shoobox-shaped concert hall, 143
- Short-term memory, 229, 271, 329
- Shower stall, acoustics of, 63
- Shrews, echolocating, 343, 344
- Shrine to Saint Werburgh, 59, 87
- Shuter-Dyson, Rosamund, 330
- Sibley, Charles G., 355
- Sight lines influence acoustics, 96, 181, 235
- Sight without seeing, 323
- Signal processing
 in reverberators, 260, 262
 in theaters and concert halls, 198
- Sikorav, Jacques, 265
- Silence
 influences designs, 108
 multiple meanings of, 32, 33
 as precious commodity, 32, 106
- Simulating
 artistic interpretations of, 132
 degenerate geometries, 246
 experience of space, 131
 multiple resonant enclosures, 137
 perceptual equivalence of, 132
 performance spaces, 261
 sound fields, 261
 space, sweet spot of, 186
 spaces as insurance, 237, 238
 specific seat, 185, 212
- Singers, as aural detectives, 63

- Size
 - dominant parameter of basilicas, 90
 - of human groups, 358
 - matters, in aural architecture, 97
 - measured in body parts, 43
 - of resonant enclosures, 138
 - of space, major conflict, 65
- Skills to appreciate music, 330
- Slap echo, 254
- Slave events, 151, 152, 155
- Slawson, David, 66
- Slonimsky, Nicolas, 181
- Small churches and spoken liturgy, 65
- Small distances, measured by arm length, 49
- Small groups, cooperation in, 357
- Small private acoustic arenas, 29
- Small spaces, 20, 151, 230, 248
- Smith, Bruce R., 98
- Smith, William, 90
- Snell, Karen B., 257
- Social accidents, 147, 204
- Social behavior adapts to arenas, 34
- Social changes and reverberation, 100
- Social cohesion, 318, 349, 350, 355, 356, 359
 - in architecture, 21
 - and arenas, 27
 - and auditory spatial awareness, 317
 - created by sharing music, 147
 - degraded by noise, 103
 - evolved with the size of cultures, 354
 - as a framework, 347
 - and gossip, 359
 - and grooming, 356
 - influenced by spatial designers, 26
 - and listening to music, 147
 - with open windows, 30
 - produced by silence, 33
 - provided by auditory channel, 22
 - role of in evolution, 317
 - in small groups, 354
 - supports children, 350
 - using vocalization, 339
- Social connections, 31, 336
- Social contexts influence reverberator designs, 272
- Social design, 282
- Social distance, 34
- Social groups
 - display collective mind, 353
 - energy burden of children, 350
 - and evolution, 317
 - as evolutionary adaptation, 349
 - improve survival probability, 347
- Social groups in a space, 318
- Social harmony, survival value of, 357
- Social intelligence, 349, 350, 352, 357–359
- Social privacy, 26
- Social psychologists, as subculture, 8
- Social skills, 355, 357
 - value of in survival, 357
- Social spatiality, 21
 - and acoustic arenas, 25
 - and arenas for group cohesion, 64
 - evolutionary value of, 318
 - part of auditory spatial awareness, 12
- Social species, group size of, 351
- Social spheres, 31–35
- Social structure of mammals, 336
- Social tensions, reduction of, 355, 356
- Social values, contradictions, 278
- Society as subcultures, 277
- Sociology, 26, 280
- Soft-wired brain substrates, 319, 325
- Sommer, Robert, 282
- Sonic background, 105
- Sonic broadcast in arena, 26
- Sonic competition, 339
- Sonic conduit of curved surfaces, 55
- Sonic events, 2
 - attributes of, 158
 - binding in musical space, 152, 155
 - perception of, 341
 - recognizable, 151
 - as spatial illumination, 15
 - unbound, 56, 152
- Sonic fusion in music, 155

- Sonic hot spots in ancient caves, 75
- Sonic illumination, 15, 65, 332
 - in echolocation, 44
 - enables visualizing space, 17
 - produced by music, 128
 - properties of, 17
 - required for echolocation, 42
 - by vocalizing, 343
- Sonic knowledge, and political power, 105
- Sonic lenses shape arenas, 23
- Sonic philosophers used integers for
 - explanations, 81
- Sonic reflection are modern, 341
- Sonic segregation and fusion, 169
- Sonic shamans, 70, 73, 104
- Sonic warfare, 106
- Sotiropoulou, Alexandra G., 219
- Sound absorbing wall, feel of, 146
- Sound absorption *See* Absorption of sound
- Sound barriers approach ideal, 28
- Sound engineers, 112
- Sound field
 - synthesis of, 194–196
 - personalized, 186–191
 - “sound houses” as prophetic vision, 164
- Sound physics in natural environments, 337
- Sound presentation formats, 186, 187, 192, 194, 204, 211
- Sound reinforcement using electroacoustics, 200
- Sound sculptures, modern, 173
- Sound sources
 - embedded within, 153
 - moving in virtual space, 171
 - as spatial illumination, 15
 - spectrally complex, 341
- Sound stream, unfused, 155
- Sound waves in an enclosed space, 243, 263
- Soundmarks, social role of, 29, 30, 68
- Soundproofing as religion, 108
- Sounds
 - activates visual substrates, 325
 - affective component of, 335
 - associates with a particular space, 176
 - connects to external events, 71
 - ethereal, 69
 - as events, 15
 - externalize experience, 72
 - historic discovery of, 80, 81
 - more complex than light, 16, 215
 - moves slowly, 16, 166
 - mystical quality of, 70
 - of nature, 177, 178
 - neurologically distinct, 329
 - produced by human activities, 16
 - produces spectral flutter, 258
 - represent spirits, 77
 - reveal object interiors, 72
 - for signaling, 336
- Soundscape music and natural acoustics, 169, 176, 177
- Soundscapes, 7, 15–18, 335, 336
 - and aural architecture, 15, 66
 - class struggle in, 106
 - composite of events and acoustics, 15
 - dominated by strong voices, 338
 - dynamic, 15
 - evolutionary adaptation to, 98, 106, 320, 340, 347
 - extracting sounds from, 176
 - and landscapes, 15, 66
 - of older townships, 29
 - and sonic pollution, 30, 103, 105
 - stripped of acoustics in 1920s, 108
- Soupy reverberation in large spaces, 92, 128, 143, 227, 247
- Source broadening
 - explained, model of, 233
 - from early reflections, 232
- Source isolation strategy for, 345
- Sources in combat, 22
- Sousa, David, 281, 331
- Souter, Alexander. A, 69
- Space
 - acoustics matches music, 102, 144
 - for communicating with spirit world, 77

- as coupled subspaces, 130
- creates slave sonic events, 158
- and culture, bilateral relationship, 67
- dedicated to music, 92
- expanders, 55
- in modern music, 213
- modifies primary sonic events, 158
- with multiple arenas, 28
- as part of musical language, 128
- with personal significance, 335
- personality of, 119
- responds to human presence, 16
- selected to be socially useful, 70
- supports social cohesion, 353
- Spacelessness, 18
- Space-time continuum in music, 168
- Spaciousness
 - depends on reproduction format, 235
 - dominant attribute, 231
 - equations for, 232
 - individualized, 235
 - lack thereof as defect, 227
 - language of concert halls, 221
 - and listener envelopment, 232
 - location variability, 234
 - with reverberators, 235
 - strong phenomenon, 231
- Spandöck, F., 245
- Spark gap, used for measurements, 241
- Spatial accuracy irrelevant for music, 148
- Spatial acoustics
 - as abstraction, 81
 - and acoustic arenas, 24
 - announce visitors, 62
 - as artifact of other issues, 212
 - creates reverberation, 156
 - difficult to manipulate, 81
 - as dual process, 156
 - enlarging size of sound source, 232
 - as extension of music, 103
 - influence mental state, 361
 - macroscopic versus microscopic, 236
 - modifies direct sound, 156
 - theatrical personality of, 98
 - variations expected, 341
- Spatial allusions in music, 176
- Spatial attributes, 41–46, 64, 160, 213
- Spatial concepts and religious philosophy, 89
- Spatial consistency and contradictions, 148, 255, 343
- Spatial designs
 - cannot be imagined, 70
 - dominated by traditions, 81
 - exists in social context, 359
 - resource limitations of, 286
 - with social contradictions, 121
 - without science, 78
- Spatial dimension in contemporary music, 168
- Spatial distortions, 53
- Spatial electronics replaces buildings, 148
- Spatial errors lack artistic relevance, 196
- Spatial experiences, 48, 77, 125, 144, 182
- Spatial experts, 310
- Spatial geometry, amplifies size, mass, 53
- Spatial illumination by sound sources, 15
- Spatial images, 46
- Spatial inconsistencies as art, 160
- Spatial inspiration in music, 178
- Spatial legacy, preserving, 132
- Spatial novelty
 - in popular music, 148
 - problem of, 126
- Spatial operator in cognitive maps, 48
- Spatial parameters, decoupled, 138
- Spatial personality, 17
- Spatial perspective, 50, 163
- Spatial resonances, 108, 230
- Spatial rules in music, 157, 166
- Spatial separation in contemporary music, 169
- Spatial simulators
 - as artist tools, 185
 - comparing spaces, 17
 - contain contradictions, 148
 - crude approximations, 227

- Spatial simulators (cont.)
 - learning to appreciation, 326
 - ray tracing in, 244
 - used in perceptual experiments, 227
- Spatial size
 - and mixing time, 254
 - vision versus hearing, 21
- Spatial software, as building materials, 260
- Spatial spreading, 133, 144, 149
 - design of, 147
 - in enclosures, 133
 - illustrated, 134
 - in musical spatiality, 134
 - perception of external world, 144
- Spatial statistics as Gaussian process, 248
- Spatial synthesizers
 - birth of, 294
 - controls perceived size, 154
 - creating slave events, 157
 - and microphone arrays, 57
 - in music schools, 286
 - problem of recording acoustics, 143
 - unrelated to space, 138
- Spatiality, 64
 - cannot be auralized, 148, 160
 - inconsistency, 148
 - internal concepts, 132
 - as musical attribute, 158, 213
 - who controls, 158
- Spatially diffused sound enveloping, 135
- Spatially distributed sound, 144
- Spatiotemporal texture, 168
- Specialization in disciplines, unlimited, 299
- Specialized auditory substrates evolved, 317
- Specialized language of disciplines, 276
- Special-purpose biological structures, 319, 321
- Species adapt to natural environments, 337, 338
- Spectral coloration, 249, 265
- Spectral flutter, 258, 259
- Speculative inferences, 276
- Spirit world, echoes in, 75, 84
- Split brains, 321, 322
- Sponsors of architecture, 283, 284
- Spring reverberators, 123
- Spurious explanations by brain substrates, 322
- Stakeholders in aural architecture, 282, 285
- Stanley, Thomas J., 283
- Statistical acoustics, 250, 251, 254, 276
- Statistical contradictions degrade illusions, 255
- Statistical macroscopic view, 237
- Statistical models of enclosed space, 247
- Statistical parameters and perception, 254, 255
- Statistics
 - for analyzing reverberation, 246, 261, 272
 - assumptions in, 248, 250–252, 254
 - in nature, 255
 - relevant in art of space, 247
 - as research tool, 254, 311
- Statues, experienced as multisensory, 65
- Stautner, John, 265
- Stebbins, Richard Poate, 336
- Stebbins, William C., 118
- Stein, Barry E., 326, 345
- Stereophonic format, 187
 - with headphones, 191
 - and image stability, 205
- Sticks talk, 71
- Stills, David L., 303
- Stimuli in experiments, 312
- Stockhausen, Karlheinz, 164, 169, 172, 173, 178–180, 185
- Stoerig, Petra, 323
- Stone, Herbert, 222
- Stonehenge, imitation of, 168
- Stopped reverberance, 139
- Strategies
 - determines perception, 302
 - for improving harmony, 334
 - for labeling, 328
 - using sound, 337
- Strong aural phenomena, 228, 231, 306, 308
- Studio 8H, 115
- Subculture, 275, 277, 355
 - adapt to stresses, 355
 - of architects, 359

- of auditory spatial awareness, 354
- create context, 275
- create spaces, 359
- created by experiments, 224, 225
- goals of, 236
- influence ignored, 310
- influence individuals, 277
- of intellectuals, 277
- of knowledge monopolies, 104
- and larger culture, 275, 279
- of live music, 147, 148
- of musicians, 224, 280
- of popular music, 148
- and quality judgments, 227
- of recorded music, 147
- as small social units, 354
- viewpoints, 239
- Subjective judgments, 221, 223, 224, 291, 292
- Subjectivity, 281, 290–293
- Subjects in experiments, selecting, 221, 224, 313
- Substrates of brain. *See* Brain substrates
- Supa, Michael, 42
- Surgeons, anthropological study of, 280
- Surreal spatial concepts, 164
- Surround sound formats, 146, 193, 203–205, 208, 210, 211, 273, 296
- Survival value of social groups, 349
- Sustained reverberation, 341
- Svensson, U. Peter, 241
- Sweet spot, 97, 186, 190, 191, 193, 194, 208
- Synthesizers
 - aids auditory memory, 242
 - enhance vocal cavities, 138
 - objections to, 125
 - use of, 57, 137, 138
- Szuchewycz, Bohdan, 33

- Tacit knowledge, 291
- Tak, Willem, 171
- Takahashi, D., 229
- Takeuchi, A. H., 326
- Tannen, Doborah, 365

- Tanner, W. P., 311
- Tapping canes as sonic illumination, 343
- Target sounds, 22, 24
- Taverns, first dedicated music spaces, 101
- Teaching echolocation, 276, 302
- TeamBat, 39, 40
- Technology
 - changes perception of reality, 104, 113
 - means for sonic manipulation, 104
 - proliferates spatial creations, 184
- Teleconferencing, auditory displays, 191
- Temperature changes, influences acoustics, 240
- Temple of Zeus, 93
- Temporal consistency, 167
- Temporal flutter, 139, 256, 258
- Temporal spreading, 133–135, 138, 139, 144, 149
- Tenejapan Mayan, 50
- Terhardt, Ernst, 257
- Tervaniemi, Mari, 328
- “Testability is falsifiability,” 304
- Thayer, Robert E., 13
- Theater
 - acoustics merge with actors’ mouth, 98
 - at Bayreuth, 128
- Theoretical formalisms, 254
- Theories, definition of, 297, 304
- Theory of evolution, 317
- Thermal gradients in air, 177, 240, 241, 338
- Thermal layers change, 270, 341
- Thermal turbulence in air, 240, 242, 251, 269
- Thierry of Chartres, 91
- Thomaskirche in Leipzig, 101, 128
- Thompson, Emily, 108, 110, 112, 115, 117
- Thurlow, Willard, 189
- THX cinema surround sound format, 204, 209
- Tightly bound sonic events, 152
- Time broadcast by bells, 29
- Time invariance, assumption of, 240
- Time and space coupled in music, 166
- Time variations, basis for naturalness, 269
- Time window for energy integration, 257
- Time window for running reverberance, 234

- Time-domain viewpoint, 250
 Todd-AO sound format, 206
 Tomasi, Thomas E., 344
 Tonal color, language of, 63
 Tone Testing, 112
 Torres. Rendell, 245
 Toscanini, Arturo, 115
 Township and acoustic geography, 29, 30, 68
 Trade secrets, 274, 288
 Trained subjects in experiments, 224
 Training alters the brain, 330
 Transaural format, 190, 191, 193, 208
 Translating across disciplines, 278
 Traweek, Sharon, 280, 295
 Treib, Marc, 171
 Tributsch, Helmut, 336
 Tristram, Clair, 242
 Trochimczyk, Maja, 168, 169
 Trout Quintet, 137
 Truax, Barry, 22, 29, 173, 178
 Truth in subcultures, 236, 278, 304, 305, 357
 Tundra acoustics, 346, 348
 Tzekakis, Emmanuel, 92, 96
- Ueda, Yasutaka, 272
 Unconscious awareness, 14
 Unconscious emotion, 333
 Unconscious interference, 300
 Uncontrolled variables, 308, 312
 Unexpected auditory experiences, 342
 Unified philosophical framework, 81
 Unity of consciousness, illusion of, 322, 323
 Unity-orthogonal matrix, 264, 265, 267, 269, 272
 University of Birmingham, 172
 Unusual auditory ability, ignored, 311
 Upper classes and noise, 106
- Van Duyne, Scott, 267
 Van Kirk, Wayne, 85
 Van Lengen, Karen, 7, 276
 Varèse, Edgard, 149, 171, 185
 Variability, artistic relevance of, 270, 272, 341
- Vassilantonopoulos, Stamatis L., 84
 Vegetation absorbs high frequencies, 337
 Venture capitalists, attitudes of, 290
 Vermeulen, R., 200, 201
 Viemeister, Neal F., 257
 Virtual, definition of, 131
 Virtual boundaries, 22
 Virtual motion in virtual spaces, 170
 Virtual partitions as spatial boundaries, 21
 Virtual resonant enclosures, 138, 149
 Virtual spaces, 6, 131
 absence of language, 132
 as adjustable concert halls, 125
 in automobiles, 192
 bind audience, 354
 in cinema, 207
 as compositional element, 166
 decoupled from social spaces, 214
 importance of, 297
 individualized, 186
 and music, 129, 164
 as musical art, 212
 as the norm, 183
 rules of, 213
 simulating physical, 57
 surrealistic, 77, 164
 sweet spot of, 186
 unrefined art, 185
 Virtual window, 56, 57
 Vision, dominant sense modality, 4, 6, 143, 204, 361
 Visual and
 acoustic space, unrelated, 23
 aural experiences, 3
 Visual cortex as inner eye, 48
 Visual deficit motivates to hearing space, 36
 Visual isolation, intensifies acoustics, 88
 Visual techniques supplement acoustics, 97
 Vitruvius, Marcus, 80, 96
 Vocal cavity, enhancement of, 138
 Vocal signaling highly efficient, 27, 358
 Vocalization as sonic illumination, 343
 Vocalization strategies, 338

- Vogel, Stephan, 300
Voice of space spirit, 71, 72
Volkman, John E., 122
Volume of space, perception of, 21
Von Békésy, Georg, 228, 327
Von Helmholtz, Hermann, 80, 300
Von Simson, Otto Georg, 91
Vorländer, Michael, 244
- Wagner, Richard, 128, 177
Wakefield, Jazar, 261
Walcot, Peter, 95
Waller, Steven J., 74, 75
Walls
 acoustically transparent, 20
 added to open basilicas, 90
 coloration produced by, 229
 as defects, 145
 as necessary nuisances, 109
 perception of, 2, 20, 145
Walton, J. Michael, 97
Wang, Clamont, 311
Ward, Darren, 196
“Warmth” in concert halls, 218
Warren, Richard M., 271
Waser, Peter M., 338
Watson, Aaron, 76
Watson, F. R., 109
Watson, John B., 301
Watson, Robert I., 300
Wave-field synthesis, 195–197
Waveguide mesh topology, 267
Weak acoustic attributes, 231
Weak intellectual framework, 307
Weak phenomenon, 228, 308
Weather, influence on acoustic, 240, 338
Webster, Andrew, 280, 298
Webster, Douglas B., 336
Weeks, Robert A., 325
Wegel, R. L., 122, 200
Welch, Walter, 112
Wenger Corporation, 286
Wenzel, Elizabeth, 188, 189
West, Meredith J., 340
Westerkamp, Hildegard, 33, 178
“What” questions, 307
Whispering galleries, 54, 55
Whiten, Andrew, 281, 357, 358
Whorf, Benjamin Lee, 50
“Why” questions, 307
Wiegrebe, Lutz, 257
Wilkens, Henning, 221
Wilkes, Kathleen V., 300
Willaert, Adrian, 168
Williamson, Timothy, 305
“willing suspension of disbelief,” 161
Wilson, David Sloan, 359
Wilson, Robert A., 313
Wind harp, 83
Windows, 25, 26, 28
 multisensory, 65
Winners and losers in innovation, 289, 301
Wishart, Trevor, 169
Wisniewski, Edgar, 119
Wissoker, Ken, 280, 281
Wittkower, Rudolf, 89
Wordsworth, William, 105
Worrall, David, 172
Wright, Wayne M., 241
Wundt, Wilhelm, 300
- Xenakis, Iannis, 168, 172
- Young, Robert M., 280
- Zacharov, Nick, 366
Zaidel, Dahlia W., 322
Zheng, Weimin, 326

