Index

Aboutness, 6fn
Active spatial representation (ASPAR), 119, 147
 externalist theory of, 179–204
Adaptation, perceptual-motor, 187
Adding new predicates, 15, 15fn
Address, in computer, 67
Affordance, perceiving, 111
Aglioti, S., 118
al-Kindi, 2
Allocating attention, 61
Allocentric space, ability to reach for fixed points in, 199
Allport, D. A., 193
Alvarez, G. A., 89, 99, 182
Ambiguous figures, explaining, 99
Ames room illusion, 108, 109fn, 109–110
Ames trapezoidal window, impossible motion, 55
Amodal completion, and attention spread in, 64
Analog movement of attention, 63
Analog representation
 of magnitudes, 169
 problems in characterizing, 163fn
 of space, 162–163, 163fn (*see also* Encrypted space)
Anchoring imagined space to real perceived space, 182
Andersen, R., 191, 195, 197, 199, 201, 203
Animacy detection and natural constraints, 98
Animated demos, URL, 33
Annan, V., 182
Anorthoscopic presentations, vs. visual perception, 142–143
Anosognosia, denial of impairments, 115
Ant navigation, 175
Anton's syndrome, 115
Apparatus of concepts, 32
Apparatus of individuation, 53
Apparent motion, and correspondence problem, 46
Apparent movement of attention, alternative theory of, 63
Appearances vs. beliefs, 99
Architecture and constraints on explanatory mechanisms, 79
Architecture- vs. representation-based explanation, 79
Area painting, technique to judge "inside," 24
Aristotelian physics, in imagery, 129fn
Array in a computer, as functional space, 127. *See also* Matrix
 dense array of points, space as, 149
Arsenio, H., 89
Ashmead, D. H., 197
Atherton, D., 84
Attention, 34
 adheres to and moves with objects, 65
 and the binding problem, 85, 87

Attention (cont.)
as cause of visuomotor adaptation, 187
cuing and movement, 62
and empty locations, 63
and figure-ground separation, 60
as filter (Broadbent), 60
locus of, for selection, 44
needed because of limited capacity, 60
not directed to phenomenal objects, 64
as perception-cognition interface, 59
selects objects for coordinate transformations, 196
spreads to cover perceived object, 64
Attentional priority, of tagged objects, 22, 23
resolution, 24, 25
Attneave, F., 3fn, 77fn, 120, 133, 182
Audet, D., 36, 89, 182
Auditory localization and structured spatial information, 193
Austen, E. L., 77fn
Avant, L. L., 65, 190, 202
Ayers, M., 51

Bahrami, B., 37, 68, 182
Baillargeon, R., 50
Ball, T. M., 140
Ballard, D. H., 22, 182, 189
Ballistic movements, 200
Bannon, L., 135
Bartlett, F., 114
Bartolomeo, P., 190, 198, 202
Basketball, and use of indexes, 21, 22
Batista, A. P., 194, 197, 203
Baud-Bovy, G., 199
Baylis, G. C., 64
Bee navigation, 175
Behrmann, M., 192
Bekkering, H., 203
Berkeley, G., 126
Berlin, B., 100
Berthoz, A., 198
Best, C. T., 44
Bibliography of MOT studies, 36fn
Biederman, I., 70
Binding arguments of predicates and motor commands to objects, 17, 34, 183
Binding problem, 61, 85
by colocation of properties, 87
and linking objects to object-files, 84
object-based selection to, 85
and occlusion, 84
Bizzi, E., 195
Black, A., 36
Blake, R., 63fn
Blaser, E., 40–41
Blindsight, 115, 116
Blind spots and scotomas, 115
Block, G., 77fn
Block, N., 107, 108, 110, 125
Blocks world, 102
Bly, B. M., 139
Bonatti, L., 51, 98, 185fn
Booth, K. S., 77fn
Borisyuk, R., 84
Bornstein, R., 116
Boundary identification and object selection, 87
Bracewell, R. M., 199
Brain space
assumption of if spatial properties cited in explanation, 162
as explanation of spatial imagery effects, 139
as explanation of scanning effect, 158
option, defined, 162
problems with, 156
Brandt, S. A., 139, 172, 179
Brentano, F., 6fn, 8
Brewer, B., 122, 148
Bridgeman, B., 119, 192
Broadbent, D., 44, 60, 199fn
Brooks, L., 197

Buchanan-Smith, H. M., 147
Building blocks of spatial understanding, points, lines, and congruity, 150
Buneo, C. A., 199, 203
Burke, D., 200
Burkell, J., 28, 84, 182

Campbell, J., 29fn, 60, 94, 124, 173, 173fn
Canon, I. K., 187
Capturing generalizations, 2, 4
Capturing (grabbing) indexes, 39, 44
Cardinality of sets, 32
Carey, S., 50–52, 94
Carlson-Radvansky, L. A., 203
Carrying information
 about something, 4
 vs. representing, 74
Cartesian coordinates, and conditions on ASPARs, 173
Causality and agency, nonconceptual examples, 154
 detection and natural constraints, 98
 recognition by 6–month babies, 54
Causal relation, effect on mental state, 89, 90
 vs. information link, 57
 vs. representational role, 73
Cause, experiences as possible, 101
Causes and codes, 68–69
 attributable to format of ASPAR?, 173
 of index grabbing, need not be encoded (conceptualized), 206
Cavanagh, P., 24, 59
Cell phone, as example of selecting without location, 81
Cells in V1, distribution as explanation of oblique effect, 137–138
Change blindness, 106
Chapanis, A., 100
Cheng, K., 176, 177
Chiang, W.-C., 51
Chieffi, S., 193
Children, MOT in, 36
Chokron, S., 190, 198, 202
Chomsky, N., 152
Christ, K., 190
Churchland, P. M., 44
Circadian cycle, example of internalization, 154
Clarity vs. conviction of percept, 123
Clark, A., 61, 72, 89, 92–94, 166fn, 167, 168
Clatworthy, J. L., 44
Closed world assumption, 106fn
Clusters, as nonrepresented, 72
Codes, extrinsic and intrinsic properties, 69
Cognitive penetrability
 of perception, 44
 of spatial representations, 164
Cohen, E., 182
Cohen, J., 63
Coherence of representations, 15
Colby, C. L., 191, 192, 196, 200, 201fn, 203
Cole, J., 71, 200
Collet, M., 175
Collet, T. S., 175
Collinearity, detecting, 24
Colliot, P., 190, 198, 202
Collocation of properties, binding conjunctions, 87
Color mixing example in mental image, 129, 130
Compliance and conscious contents (experimenter or task demands), 108
Computational vision, role in explicating visual module, 152
Computing equivalence of motor actions, 166–168, 196, 198
Concept(s)
 approximation to, 53
 grounding of, based on nonconceptual indexing, 206
 how connected to world, 1–4

Conceptual representations and thoughts, 70–71
Concurrent spatial perception and sense of space, 148, 178, 181, 182–186, 191, 201
Conditional probability, finding property pairs, 80
Conditions of individuation, 31, 46
Conditions on active spatial representations (ASPARs), 169–173
Conditions on spatial representation, 75–79
Confabulation, widespread, 115
Conjoined properties
 marking of, 61
 as necessarily ''superimposed,'' 93
Conjunction detection among moving objects, 89
Conjunction search, 28
Conjunctions of features, finding, 87
Connectedness of space (causal structure of space), 173
Conscious and unconscious states, differences not principled, 145
Conscious content and information processing, 72, 100, 110
Conscious experiences
 ambivalent role in vision science, 101
 as containing interpretation and confabulation, 114
 as justification of perceptual beliefs, 124
 as level of representation, 144
 of map-navigation, 174
 as misleading source of evidence, 101
 required for knowledge of demonstration, 124
 of space, immersive and global, 149
 whether we can be unaware of them, 106
 and why things happen, 128
Consciousness, Association for Scientific Study of, 103fn
Consciousness of mental processes, 112
Consciousness of things vs. facts, 105
Conscious perceptual experience, as cognitively penetrable, 144, 145
Conscious states, nonperceptual (intransitive), 143fn
Constraint propagation method, in computational vision, 101
Constraints, as reduction in free parameters, 98, 153, 154, 159, 161, 174
Content, as condition on representing, 75
Content of experience as a level of representation, 100, 104
Content of representations, 1–8, 17–19, 69–70, 77–79
Contiguity, as basis for association in Hume, 126
Continuous movement of attention, questioned, 63
Contour tracing, 24
Conversion-on-demand principle, 196, 201
Conviction and clarity, distinction blurred, 110
Coordinate transformation, as efficient function of the brain, 168–169, 193–197, 199, 203
Correspondence computation, model of, 54
Correspondence problem, 12, 33, 46, 47
 as a stage in MOT, 47, 49
 as nonattentive, 49
 as nonrepresentation, 75fn
Cortical resolution, and image size, 132
Counting vs. subitizing, 25
Count nouns, 53
Cramer, A. E., 176fn
Crawford, J. D., 191, 194, 197
Criteria of distinctiveness and reidentification, 53
Cromwell, J. A., 137

Cross-modal priming and interference, 171
Cullicover, P., 153
Currie, C. B., 29, 203

Dales, L., 36, 89, 182
Dalla Barba, G., 123
Danckert, J., 37
Data-driven (exogenous) attention switching, 61
Davis, D. L., 197
Dawson, M. R., 54, 77fn
Deafferented patients, 71fn, 200
Deford, J. K., 137
Degrees of freedom, and explanatory power, 78
Dehaene, S., 25
Delay time of sensors, and storage, 84
Demonstrative identification, 34, 92
 reference, and FINSTs, 11, 29fn, 122
 thoughts, and perception, 18
Demonstratives, 16, 18, 19, 94, 95, 204
De Morgan's cannon, 79fn
Denis, M., 133, 159, 165, 183
Dennett, D. C., 52fn, 110
Dennis, J., 37, 182
Depictive representation, 127, 156fn, 162
Descartes, R., 6, 150
Descriptions, definite, 14–16
DeSouza, J. F. X., 118
Despres, O., 190, 193
Detection
 of patterns in a spatial display, 170
 of properties and locations, 68
Devitt, M., 79fn
DeVos, J., 50
Diagram, encoding, 10
Di Lollo, V., 44
Direct realism, theories (Gibson), 111
Direct reference, and FINSTs, 29fn
Disappearance, as cause of location encoding, 80
Discontinuities in apparently blank regions of a scene, 189
Distal and proximal stimuli, 5
Distal causes of perceptual beliefs, 99
Distance on image and scan time, due to "pretend seeing," 133
Distinguishable colors vs. potential concepts, 100
Distractor objects (nontargets), 34
Distribution of location, statistical, 89
Dretske, F., 3, 6, 76fn, 82, 90fn, 105, 107, 108
Driver, J., 48, 64, 66, 171
"Droodles" (visual puns), 105
Dubbing event
 intentional, vs. FINST grabbing, 96
 for proper names, 6
Dufour, A., 190, 193
Duhamel, J.-R., 191, 200, 201fn, 203
Dynamic systems theory, 75fn
D'Zmura, M., 122

Early vision, 13, 21, 33, 46, 95
 and correspondence problem, 46
 as site of object selection, 17
Ebbinghaus illusion, 118
Ecological niche, 53
Eilan, N., 122, 148
Elcock, E., 10
Emmert's law, failure of in imagery, 141
Empty places and causal powers, 89
 in depictive representations, 127
 in mental images, 128
 representation of in ASPARs, 172
Encoding locations, and tracking, 36
Encoding properties in MOT, 89fn
 as requiring focal attention, 206
"Encrypted space" option, 157fn, 161–165
Endogenous (voluntary) attention allocation, 61
Enduring individuals, 33, 44, 49
Enns, J. T., 44, 77fn

Episodic theory of attention switching, 63
Epstein, W., 101
Equivalence classes, of motor actions, 166
Error type, in tracking, 46
Essock, E. A., 137
Euclid, 150
Evans, G., 34
Evolutionary advantage of preestablished harmony, 154
Exogenous (automatic) attention allocation, 61
Experience
 of conscious will, 112
 constrained by format, 126
 of imagery, similar to vision, 125–145
 and seeing, 105, 111
 of self as agent of others' actions (rubber hand illusion), 113
 of *why* and *how* of personal actions, 114
 of willing an action, 112, 113
Experience, characterizing, 123
 of change in position vs. other properties, 166, 166fn
 during image scanning, 164
Experience that vs. *experience as of*, 113, 114
Explanatory adequacy and image format, 127
 advantage of representation, 78
 gap in standard vision story, 1, 2
Explicitly represented rules, 123
Expressing the contents of perceptual experience, 102
Externalize representation (use of term), 151fn
Eye, processes in, 6
Eye-centered coordinates, 197
Eye movements in examining a mental image, 139, 172, 179

Fallibility, reports of content of experience, 103
Farrar, P., 120, 133
Farrell, M. J., 180, 193
Feature integration theory (Treisman), 86–88
Feature maps, 86
Feature-placing language, 91, 93
Feature space, tracking through, 40–41
Fechner's law, 169
Feeling-of-knowing (or not knowing), 116
Felch, L., 129fn
Feldman, J., 95, 98
Figure-ground separation, and individuation, 31
Filter theory of attention (Broadbent), 60
Fine grain, argument for nonconceptual representations, 73
Fingers (Poincaré), 167
FINGs (FINSTed things), 56, 67, 91, 182
 as possibly not a natural kind, 96
Finke, R., 135, 187
FINST (FINGers of INSTantiation) theory, 9, 13, 21, 23, 37, 51, 56, 182, 206
FINST index
 as allowing epistemic access to individual things, 206
 as epistemic instrument, 29fn
 as nonconceptual pointer, 206
 as providing a direct reference to individuals, 96
FINSTing
 and argument binding, 23
 duration of FINST binding, 39
 and moving focal attention, 23
 small number (4–5) available, 35
 selecting moving objects, 89
 sound sources, 197
 why/when needed, 56
Fisher, B. D., 77fn
Fleishman, E. A., 200
Flombaum, J., 48

Focal attention and selection, 14, 59
and demonstrative reference, 206
use of in locating conjunctions of features, 89
Fodor, J. A., 7, 14, 56, 72, 112, 124, 126, 128, 163fn
proposed solution to the *which link* problem, 97fn
Form of representation, as reflection of phenomenology, 122
4-D object(s), failure to imagine, 140fn
Frame of reference, 10, 75, 76, 148, 191, 193, 194
allocentric, 148, 171, 179–181, 191–199, 204
multiple, 192–193, 195
peripheral, 194
transforming, 168–169, 193–197 (*see also* Coordinate transformation)
unitary, 19, 179–180, 191–193
within one modality, many, 195
Frame problem for spatial properties, ameliorated by literal spatial display, 158
Franconeri, S. L., 37, 61, 77fn, 68, 80, 84, 182
Free will, experience of, 112
Frisby, J. P., 44
Functional significance, phenomenology, 123
Functional space proposal, 127, 156–165
and conditions on ASPARs, failure to meet, 173
as equivalent to brain space assumption, if simulating real space, 160, 165
and introspective evidence, failure to comport with, 164
not constrained, except by stipulation, 160, 173
relation *time* = *distance/speed* is unmotivated, 163
as *simulation* of real space, 160
Gabor patches, tracking, 40–41
Gain fields, and modification of coordinates by body position, 191
Galilean physics in imagery, 129fn
Galileo's (apocryphal) experiment at leaning tower of Pisa, 128
Gallistel, C. R., 176, 176fn, 195
Gandevia, S. C., 200
Ganis, G., 131, 134, 137–138, 162
Ganzfeld, structureless display, 190
and impairment of orientation, 66
Gap in standard vision story, 1, 2
Gazzaniga, M., 117
Gelade, G., 86, 87
Generalized objects, 40
Gentaz, E., 137
Geodesics in 6-D space, 155
Geometrical-optical constraints, 10, 55
module in navigation, 176
thinking with images: example of slicing a rectangle, 181
Geons; elements of shape, 70
Gerbino, W., 105
Gestalt clusters, 75fn
as nonconceptually computed, 71, 72, 77
principles, application of to neural layouts, 77fn
Ghahramani, Z., 195, 199
Gibbs, B. J., 38fn, 49, 66
Gibson, J. J., 105, 111
Gilchrist, A., 104, 145
Gilden, D., 63fn
Given, the, 103
Gnadt, J. W., 199, 201
Gold, M. E., 153
Goldberg, M. E., 191, 192, 196, 200, 201fn, 203
Goldman, A., 151fn
Goodale, M., 118, 172, 191
Goodman, N., 163fn
Gordon, R. D., 29
"Grabbing" an index, 39, 44, 67

Grammaticality judgments and conscious contents, role as evidence, 146
Grandmother cell, 86
Grasping imagined objects, pantomimed movements, 172
Graziano, M. S. A., 192
Green, C. D., 103fn
Gross, C. G., 192
Grounding concepts, 51
Gul, E., 84
Gumperz, J., 144
Gunther, Y. H., 72, 122

Haladjian, H., 66, 183
Hall, D. G., 50, 69, 177
Halsey, R., 100
Hand-centered frame of reference in vision, 193
Hannus, A., 199
Hansen, B. C., 137
Haptic oblique effect, 137
Hartje, W., 190
Hatwell, Y., 137
Haugeland, J., 52fn
Hayhoe, M. M., 22, 182
Heeley, D. W., 137
Hierarchical encoding, 85
Henriques, D. Y. P., 191, 199, 201, 201fn
Hermer, L., 177
Higher cognitive functions, in explanations, 79fn
Higher order thoughts (HOTs), theory of consciousness, 108
Hirsch, E., 51
Hirstein, W., 115
Hochberg, J., 4, 101
Hoffman, D. D., 54, 122
Hoffman, J. E., 36
Holcombe, A. O., 40–41
Hollingsworth, A., 61
"Holy grail," cause of behavior as, 7
Homeomorphism and maps, 74, 76fn. *See also* Neural layout
Hood, B. M., 198
Horn, B. K. P., 152
Horowitz, T. S., 89
How things look, as not constitutive of perception, 144
Hubel, D. H., 138
Hume, D., 4, 126
Hummel, R. A., 152
Humphreys, G. W., 22, 48, 182
Huntley-Fenner, G., 51
Hurst, G., 63, 63fn
Husserl, E., 6fn
Huttenlocher, J., 170
Hysteresis in sensors, and storage, 84

Iconic storage, nonconceptual, 73
Identification of objects, by identifying their locations, 79
Identity of individuals, 21fn
Identity of targets in MOT, recall of, 45
Identity tracking, 13
Illusion of automatic mental image dynamics, 119
Illusion of free will, 112
Image(s), 120. *See also* Mental image
 and activation of the retina, 139
 as constructed from description, not visually recognized, 142, 143fn
 cortex and explanation of imagery, 136–137
 determination of its behavior by individual, 130
 different properties of when eyes open, 190
 dynamics, architecture or tacit knowledge, 130
 as engaging the motor system, 172
 as essentially 3-D, 141
 as fixed in extrapersonal space, 139
 as intentional objects, 141
 not reinterpreted by vision, 141–142

not retinotopic, 139
scanning, in functional space, stipulated, 158
scanning of, problems with, 133–134, 140, 165
size effect and assumed amount of visible detail, 131–132
size of, question of sense, 132
superimposed on vision, problems with, 141
Image format, vs. language of thought, 127
Imagining
and attentional movement, 63, 63fn
of 4-D space, reason for failure of, 140fn
implicit imagery task, to ''pretend see,'' 133
pointing from a new vantage point, 179
as pretend seeing, 120, 133
as seeing, suggesting there is *something that is seen*, 126
Impossible figure perception, when parts are off-fovea, 142
Impossible motion, perception of, 55
Inattentional blindness, 106
Index(es)
as anchoring objects of thought in real space, 182
assigned to visible objects, 185
vs. attention, are 4–6 of them (*this*$_1$, *this*$_2$, *this*$_3$), 206
as binding predicate arguments to things, 95, 206
as demonstrative reference, 206
as functioning like *name*, *indexical,* or *demonstrative*, 16fn
importance of to visual-motor skills, 21
as ''marking'' objects, can be visually detected, 182
Indexical locative *here*, and selection under a concept, 17, 91
Indexing of empty locations, 189
as requiring an information channel, 83
selection without use of location, 80
Index projection hypothesis, 148, 179, 181
in nonvisual modalities, 197–201
Individuals (Strawson), 53
Individuate, 31
note on use of term, 21fn
Individuate and track, two stages in MOT, 21
Individuating, act of
as a function of indexes, 206
of faces, 51
vs. identifying, 50–51
as selecting space-time ''worms,'' 49
Inertia, of sensor, vs. storage, 84
Infants
as able to individuate and track, 49–52
as sensitive to cardinality (for $n \leq 3$), 50
as using color to individuate, but not to recognize, 69
Information, as correlation and entropy, 3, 3fn
Informational link, and dependency, 18, 82
required for assigning and maintaining indexes, 81
Ingle, D., 202
Inhibition
moving nontargets, 46–48
of return, object-based, 48, 66
Inhibitory neural connections, as explanation of ''image size'' effect, 131
Intensional vs. causal relation, 6, 7
''Intensional'' vs. ''intentional,'' meaning and use of terms, 6fn
Intention to move to *X*, representation of, 200
Intermediate frames of reference, retained, 194

Internal "functional space" proposal, 127, 156
Internalizing spatial constraints (Marr, Shepard), 151–155
 externalist, behaviorist approach, 151
 kinematic geometry (Shepard), 155
 only principles/constraints internalized, 155
Interpenetration of solids, permitted by natural constraints, 55
Interpretation of observations
 as guided by theories, 146
 as guided by natural constraints, 205
Interrupt, 17, 42, 68–69, 89, 95
 as illustrating bottom-up stage, 17, 42
 as not encoding its cause, 68
 vs. test in computers, 17, 68–69, 84
Intrilligator, J., 24
Introspective method, 103
Inverted image, problem of, 2, 4
Inverted image experience, dependence on how produced, 145
Irwin, D. E., 29
Ishai, A., 202
Iverson, G. J., 122

Jackson, F., 61, 85
Jacobson, J. S., 172
Johnson, D. N., 182
Johnson, S. P., 31
Jolicoeur, P., 134
Jones, E., 22, 182
Jordan, M. I., 195, 199
Judgment of location, on viewed vs. imagined figure, 186, 187
Julesz, B., 47
Justification of perceptual beliefs, consciousness as, 124
Justification of *P* vs. justification of *making the claim that P*, 124

Kahneman, D., 38fn, 49, 65
Kanizsa, G., 105
Kant, I., 150
Kaplan, D., 86
Kappers, A. M. L., 137
Kargon, R., 129fn
Karnath, H. O., 190, 199
Kay, P., 100
Kazanovich, Y., 84
Keane, B., 53, 80, 84, 93
Keeble, S., 98
Keeping track of token things, 12, 34
Keillor, J. M., 172
Kepler, J., 2, 6, 120, 121, 150
Kinematic geometry, 155, 155fn
Kinetic depth effect, 47
Klein, R. M., 48
Klier, E. M., 197
Koch, C., 75fn, 153fn
Koenderink, J. J., 137, 152
Kohler, P., 75
Kolers, P. A., 47, 75
Kosslyn, S. M., 124–125, 127, 130fn, 131–135, 137–140, 140fn, 156fn, 159, 162, 183–184, 198
Krekelberg, B., 202
Kripke, S., 6, 68
Krojgaard, P., 50
Kuhn, T., 129fn

Label consistency (constraint), 101, 205
Labeling, parts of diagram, 19
Labels as contents of perceptual representation, 102
Labels on targets, recalling, 45
Lackner, J. R., 187
Làdavas, E., 192, 193
Landau, B., 36
Landmarks, direction-specific use of by ants, 175, 177
Laws of color mixing, 7, 129, 130. *See also* Color mixing
Leonard, C., 183
Lepore, E., 18
Leslie, A. M., 50, 54, 55, 69, 98, 154, 177
Levels of explanation, 2, 145

Levin, D. T., 106
Levine, J., 97
Levinson, S., 144
Levy, J., 202
Lewis, D., 163fn
Libet, B., 112, 199
Lightness and color, conscious experience of, 145
Lindberg, D. C., 2, 150
Lines and vertices, 10–11
Linguistic categories (NP, VP, A) as subpersonal, 71
Liu, G., 77fn
Local support, processes using, 47, 47fn, 75fn
Locating
 as basis of selection, 14, 81
 in an image, question of, 180
 of image, in extrapersonal allocentric space, 179
 and individual, confounded, 80
 of intended motor actions, represented, 198, 203
 and shape, problem of, 86
 as specified in depictive representation, 127
 updating and tracking, strategy of, 36
Location on a neural layout, what it represents, 76
 used within a perception module, 84
Locke, J., 126
Locus of reconstruction of visual experience, 121
Loffler, G., 137
Long-term memory for spatial information in navigation, 175
Looking time method, 50
Lormand, E., 106
Luce, R. D., 122
Ludwig, K., 18

MacCarthy, R. A., 148
Mack, A., 106, 119
Madigan, S. C., 129fn
Magnet, example of selection without location, 81
Magnitudes, nonconceptual, 72
 analog representation of, 170
 encoding by the dorsal visual system, 118, 192
 representation of, 169
Manuel, S., 44
"Many properties" problem, 61
Map(s)
 feature maps (feature integration theory), 86–88
 ASPARs as, 175
 master map for coordinating feature maps, 86–88
 road map, misrepresentation in, 76fn
 and lack of specification of landmarks, 176
 what (who) interprets the map, 76fn
 what makes something a map, 76, 76fn, 173–179
Maplike behavior, taking shortcuts and detours, 174, 177, 178
Mapping (function), 3, 5, 53
 retinotopic, 74
 world-to-neural-layout, 76
Marking objects, 22, 23, 182
Marotta, J. J., 191, 194
Marr, D., 13, 23, 33, 52fn, 76fn, 105, 152, 205
Maruff, P., 37
Master map (feature integration theory), 86, 87
Mather, J. A., 187
Matrix data structure, as functional space, 159. *See also* Array
 and representation of empty places, 160
 as seeming natural for representing space, 160
Mazzoni, P., 197, 199
McCarthy, R. A., 122
McCloskey, M., 129fn
McConkie, G. W., 203

McDaniel, K. D., 115
McDaniel, L. D., 115
McKenna, F. P., 188, 189
McLeod, D. I. A., 137
McMahon, M. J., 137
Medendorp, W. P., 191, 194
Meltzoff, A., 171
Memorized map, imagined, 184
Memory images, already interpreted, 142
Memory representations, reconstructions, 99
 active spatial memory (ASPAR), 169
 as conceptual, 208
 distinct from inertial lag of sensors, 84, 85
 iconic, rehearsal memory, 199fn
 long-term, 13
 persisting location memory, 202
 working, 10
Mental image. *See also* Image
 event dynamics, due to tacit knowledge, 129
 form of, assumptions about, 126
 as having real metrical distance, 184
 principles governing dynamic events, 128–139
 scope as ''cycloramic'' (360°), 120, 133
 single-point-of-view constraint, 155fn, 156fn
 size of, vs. size of neural display, 131, 132
 as stable panoramic display, 120
 what is special about underlying representations, 124
Mental rotation affected by motor gestures, 198
Mental scanning and ''imagining seeing,'' 133–134, 183, 186
Mental screen, 131
Menzel, R., 174, 178
Metcalfe, J., 116
Metrical and Euclidean axioms, relation to ASPARs, 172
Metrical properties of spatial representations, 157
Metzler, J., 170fn
Michotte tunnel effect, relation to ASPARs, 54, 113, 173
Milner, D., 118, 191
Mirror-image ambiguity, in map representations, 176
Misperception
 by neural layouts, 75, 77fn
 problem of, 76fn, 112
 signature of representation, 73
Mitchell, J. F., 176fn
Mitroff, S. R., 66, 183
Mittelstaedt, H., 200
Molyneux problem, cross-modal pattern recognition, 171
Moore, C., 64
MOT (multiple object tracking), 34–58
 explanation of tracking, 39–40
 list of publications (URL), 36
 performance of subjects, 37
 simulated updating strategy, 37
Motion of objects in MOT, unpredictable (different types), 35
 apparent, 33, 46–49, 54
Motion through adapted region, imagined and real, 63fn
Motivation for picture-theory, phenomenology as, 125
Motor action(s), interference with spatial recall, 197
Motor-action equivalence classes (Poincaré), 166
Motor intentions, 197
Motor skills, and representation, 72
Mounts, J. R., 44
Mouse whiskers, as example of size effect, 131
Movements of imagined objects, 172
Moving attention, and FINSTs, 39
Moving hand to eye-centered locations, 199fn

Mueller, H. J., 62
Müller-Lyer illusion, 29
Multimodal indexes, 182
Multiple attention loci and FINSTs, 60
Multiple object tracking. *See* MOT
Multiplying large numbers, phenomenology of, 124
Multiscale information in navigation, 175
Mussa-Ivaldi, F. A., 195
Musseler, J., 199

Nadal, J.-P., 167fn
Nadel, L., 195fn
Natural constraints, 52, 53, 54, 76fn, 152, 205
 on mental imagery, 56, 56fn
Naturalizing semantics, 8
Navigation, and spatial representation, 173–179
 online measurement, 175
 route-planning, offline, 176fn
 and short-cuts, 175
 when no perceived landmarks, 177
Necker cube, change in appearance of, 99, 100
Neggers, S. F., 203
Neglect
 tactile exploration as shifted vs. neglected, 190
 unilateral spatial, altered by concurrent perception, 190
Neural layout (NL), homeomorphic, 74–77, 193fn
 and multiple frames of reference, 192
 and representation, 74
Neural network, implementation of indexing, 83
Neural pathways, 6
Newell, A., 114
New Look movement in perception, 144
Newsome, W. T., 201
Nico, D., 198
Nicod, Jean, 150
Nisbett, R. E., 115
Nissen, M.-J., 79
Noë, A., 105, 167fn
Noles, N. S., 66, 183
Nonaccidental property, 54
Nonconceptual access, and FINSTs, 1–9, 18, 56
Nonconceptual content, and indexes, 69, 207
Nonconceptual grounding, need for, 57, 58, 90
 for link between vision and world, 1–18, 69, 122
Nonconceptual individuating and tracking, 46, 49
Nonconceptual representations, 1–9, 18, 56, 69, 207
 as iconic, 99
 as perceptually derived, 99
 and unconscious contents, 72
Nonrepresented properties, 71
Nonvisual modality and indexes (Anchors), 183
Northington, A., 197
Noticing
 and encoding, 31
 over time, 10
Numerical identity, 32–33, 80

Oberle, C. D., 129fn, 167fn
Object(s)
 as bearers of properties, 17
 concept of, 32, 51, 57
 imagined as being *out there* in the world, 179
 priming, and attention spread, 64
 properties of, encoded in MOT, 68
 selected without use of location, 14, 80
Object files, 37–40, 49, 51
Object-specific priming benefit (OSPB), 65

Oblique effect, observed in imagery, 137–138
Occam's razor, 79fn
O'Connell, D. N., 47
Off-foveal images, not visually interpreted, 142
Offline navigation, route-planning, 176fn
Ogawa, H., 48
O'Hearn, K., 36
O'Keefe, J., 195fn
Optics of the eye, 2
O'Regan, K., 167fn
Orientation
 poor in low gravity, 190, 191
 use of vision, audition, proprioception, and other sensors, 198
Orientation-sensitivity of cells, as derived from their connection to retinal cells, 137–138
"Our kind of world" (natural constraints), 53, 54

Paillard, J., 123, 148
Pairwise translation between multiple frames of reference, 194
Pandemonium, 85
Panoramic display theory of vision, falsity of, 120
Particulars, identifying, 52
Pashler, H., 79
Patches of color, edges of light and shadow, 111
Path integration, in navigation, 175
Pattern(s)
 detection of in spatial display, by template matching, 170
 explicit in a depictive representation, 127
Peacocke, C., 16fn, 92, 123, 173fn
Pebayle, T., 190, 193
Peephole nature of visual input, 100
Pelisson, D., 119
Percept(s)
 incremental construction of, 10–14
 and stimulus, independence of, 73
Perception
 cognitively impenetrable, 144
 constructed over time, 12
Perceptual beliefs as abstract, categorical, variable grained, 99
 concepts inadequate for perception (e.g., color), 100
Perceptual experience, 104
Perceptual presence, 105
Peripersonal frame of reference, 192
Perl, T., 36
Perry, J., 19
Phenomenal (P) and access (A) consciousness, 107
Phenomenal experience
 does not capture functional information, 123
 of mental image, 125–145
 vs. nonphenomenal consciousness, 106
 of seeing, as a reconstruction, 120
Phenomenology of "savant" process, 123
Philipona, D., 167fn
Physics examples, imagining, 128–130
Picking out, two stages of, 29
Picture theory and the intentional fallacy, 121, 122, 125
Pinker, S., 135
Pittman, T., 116
Place cells in rat hippocampus, acts like a GPS, 195fn
Plan generation, reactive plans in artificial intelligence, 176, 178fn
Plasticity of imaginal thinking, problem of, 154
Plastic Man, 182
Plastic man, fingers, 13, 14, 37
Podgorny, P., 186
Poggio, T., 153fn
Poincaré, H., 150, 165

Pointers
in computers, 67, 81–82
and functional space, 67
and locations, 67
as singular terms, 67
Pointing to things in one's image, 172
Pook, P. K., 22, 182
Poor knowledge of causes of own behavior, 115
Popout search, in subset, 28
Posner, M. I., 62
Post-constancy and post-filling-in, 104
Potential motor commands, 203
Pouring or slinking motion, failure to track, 96
Preblanc, C., 119
Precategorical storage, nonconceptual, 73
Pre-constancy unconscious states, making conscious, 145
Predicates, 52
Preparation for making a motor gesture, as distinct stage, 197, 199
"Pretend seeing," implicit task of, 133
Prevor, M., 50
Price, R., 105
Primal sketch, 72
Priming in MOT, 66
Primitive tracking, 34
Prinz, W., 199
Problem-solving (thinking out loud) protocols, 114
Productivity, 8fn
Program of motor commands, as distinct from action, 200
Properties of indexed objects
encoded as *properties of objects*, 85
as encoded and stored in object files, 207
as not encoded, 90
as not a natural kind, 96
as responsible for tracking, 68, 68fn
used by for individuating but not recognizing, 50
Property P at location R, feature-placing language frame, 93
Property space, tracking through, 40–41
Propositional attitudes, 70
Proprioceptive FINSTs ("anchors"), 197
Proprioceptive properties, unconscious, 70
Proprioceptive signals, equivalence classes of define "objects," 204
Proximal clusters, arising from same distal cause, 46
Psychophysical complementarity (Shepard), 154
Pulfrich pendulum illusion, 55
Pylyshyn, Z. W., 7, 13, 14, 21fn, 25, 28, 29, 36, 37, 40–41, 44, 45, 48, 52, 52fn, 54, 58, 63, 65, 66, 68, 70, 73, 75fn, 77fn, 78, 80, 83, 84, 85, 95, 102, 105, 112, 123, 126, 128, 136, 139, 152, 161, 163fn, 167fn, 170fn, 180, 182
Pylyshyn's razor, 78fn
Pythagorean theorem, applied to spatial representation, 157

Qualitative locations of imagined objects, for indexing real objects, 183
Quantitative representation of space, 149, 157
Quantized display, problems with, 161fn
Quine, W. V. O., 52, 86, 93, 94
Quint, N., 50

Rabbitt, P. M., 62
Random dot stereogram, 47
Rao, R. P. N., 22, 182
Rauschenberger, R., 62
Reaching for a moved spot, 119
Reacting vs. encoding, 68
"Reading off" properties from mental image, 124
"Reading off" properties from spatial representation, 157

Real space and principled spatial properties, 127
Reasons we believe we do things, confabulation, 115
Recall target labels/locations in MOT, failure to, 45
Receptive field neuron anticipates intended movement, 200
Recognizing cardinality, role of early vision, 53
Recognizing which token is which, 10, 11
Record of locations, in tracking, 40
Red fire engine cell, problems about, 8fn
Reference
 demonstrative, 17–22, 67, 92–94, 112, 124
 and focal attention, 59
 to individuals, without using their properties, 23
 vs. individuating, 49
 to objects, not locations, 67, 69
 relation of, 5
Region selection, requires object selection, 93
Registering vs. representing, 74
Registration, neural layout as, 75fn. *See also* Neural layouts
Regularization, as a general mathematical constraint, 153fn
Rehearsal memory, 199fn
Reidentification of objects, by FINSTs, 13, 32
Reification of perceptual experience, 120
Reiser, B. J., 140
Relational predicates, indexes and, 22
Relevance problem, partly solved with real spatial representation, 158
Remapping, only needed for attended objects, 201
Rensink, R. A., 44, 77fn, 106, 196
Replica, 3-D, not worse than 2-D picture, 125fn
Reporting by early vision, of properties, 86
Reports of conscious contents, problems with, 108
Representational content, 3–5
Representational momentum, in imagery, 131
Representation of shape, size, orientation, in a depictive representation, 127
Representations and explanations, 75–76
 as referring to fictional objects, 181
 of space, problem of, 148
 of visible surfaces ($2\frac{1}{2}$-D sketch), 105
 strong sense, 78
Re-recognizing tokens, 12
Resemblance, as reference in a depictive representation, 127
 failure as a basis for semantics, 126
Residual effect, multiple frames of reference, 194
Retinal disparity, correspondence problem in, 46
Retinal image (Kepler), 2
Retinal vs. perceived size, no conscious experience of, 145
Retinotopic map, 74
Reversibility of visual motion by motor actions, 166, 167fn
Reynolds, J. H., 176fn
Richness of phenomenal experience of seeing, 100
Right-hemisphere confabulation to explain left-hemisphere actions, 117
Robertson, I. H., 198
Robinson, J. O., 55
Rock, I., 101, 106
Romney, A. K., 123
Rosenfeld, A., 152
Rosenthal, D., 107fn, 108
Rosenthall, D., 123
Rossetti, Y., 199fn

Rubin-Spitz, J., 44
Russell, B., 15, 150fn

Saarinen, J., 36
Saccade, as following actual (not illusory) motion, 119
Sagi, D., 202
Salimando, A., 51
Salinas, E., 191
Sameness of location, as demonstrative identification, 93
Sapir-Whorf Hypothesis, 144
Sartre, J.-P., 6fn
Satisfaction, relation of, 5, 7, 8
Savant, report of experience of, 124
Scalar variability (variance/magnitude is constant), 169
Scanning effect, 134–136
Scenario content, 92, 123
Schindler, I., 190
Scholl, B. J., 36fn, 37, 48, 51, 66, 68, 80, 84–85, 95, 98, 182–183
Seeing
 building vs. façade, 105
 and imagining, parallel between, 133
 small details in a "small image," 132
Selecting
 because of P vs. *as P*, 90fn
 and the binding problem, 60
 and consciousness, 94
 by location, 79
 necessary to individuate and refer, 60
 physical objects, 91
 reasons for, 59–61
 as requiring an information link, 82
 of *things* vs. places, 60
 under no description, 90
 voluntary vs. automatic, 24
 without knowing location, examples of, 81
 without knowing what is selected, 90
Selective attention, as object-based, 64
Selfridge, O., 85
Sellars, W., 103
Semantic vs. causal relations, 5
Sensation
 as feature-placing, 92, 93
 as having no predicates, identity, divided reference, or tenses, 92
Sense of space, 167
 concurrent spatial stimulation needed, 179–204
 creating, from sensory information, 150
Sensors, 7
Sensory geometry (sensible geometry, Nicod), 150
Sensory individuals, 9
 and experience, 92
 as nonconceptual representation, 92
 processes, and space-time regions, 92
Sethi, N., 36
Shadlen, M. N., 201
Shapiro, L., 84
Shepard, R., 154, 170fn, 186
Shimamura, A. P., 116
Short-term nonconceptual memory, vs. sensor inertia, 16fn, 39, 73, 84, 207
Signal detection theory, separating bias and sensitivity, 108
Similarity in appearance, as basis for semantics, 3–5
Simon, H., 114
Simons, D. J., 61, 106
Simple, complex, and hypercomplex cells, 85
Simplicity, in choosing among theories, 79fn
Simulating updating strategy, in MOT, 37
Simultaneous neglect in different frames of reference, 192
Single object advantage, 41, 64
Single spatial frame of reference, assumption of, 171, 191

Singleton feature selection, and focal attention, 44
Size effect of image, functional space does not explain, 164
Size illusion, and familiarity (in Ames room), 110
Skinner, B. F., 152
Slezak, P., 142
Smith, A. D., 111
Smith, B. C., 33
Snyder, L. H., 191, 195, 197, 203
Sortal concept, 31, 51, 53
Sound localization improved with visual input, 190
Sound patterns, 70
Source of principles for image properties, cognitive architecture, 127
Space. *See also* Sense of space; Spatial properties of images; Spatial representation(s)
 as part of architecture, but not literal, 161–165
 as dense array of points and lines, 149
 formalism, no role if constraints are extrinsic, 160, 161
 as receptacle, 149
 represented qualitatively in long-term memory, 208
Spatial properties of images, 147
 as deriving from layout in brain space, 181
 as deriving from indexing of perceived objects, 181, 208 (*see also* Active spatial representation [ASPAR])
 as deriving from tacit knowledge, 181
 inheritance of from concurrently perceived scene, 182
Spatial recall, 197
Spatial relations, unaccountable for by brain space, 158fn
Spatial representation(s)
 competence with does not depend on concepts, 149
 concurrent spatial inputs in, 148, 178, 181, 182–186
 constraints, theories of Marr, Shepard, 151–155
 dynamic properties of, 158
 externalist theory of, 179–204
 and motor actions, impairment of recall by, 197–198
 multimodal, dependent on coordinate transformations, 198
 paralogic use of, 158
 sense and the frame stability problem, 199
 and sensorimotor coordination, 165
 updated by moving without vision, 180
Spatiotemporal regions (worms), traced out by objects, 89
Spelke, E., 51, 177
"Spelke object," defined, 51–52
Spence, C., 171
Sperling, G., 62, 73, 199fn, 202
Split brains, 117
Split visual system (ventral vs. dorsal system), 118
S-R compatibility effect (Simon effect version), 188
Starbucks cartoon, Sipress, 20
Stark, L. W., 139, 172, 179
States of knowledge and problem behavior graph, 114
Stein, Gertrude, 180
Stereovision, correspondence problem in, 46
Stimulus error, in introspection, 103
Stimulus-to-appearance mapping, ambiguity of, 99
"Storage" due to sensor latency, not representational memory, 73, 148
Storm, R., 37
Strawson, P., 32, 52–53, 86, 91, 93
Stricanne, R. A., 197, 199
Structure from: motion, shading, stereo, contours, 153

Studdard-Kennedy, M., 44
Subitizing, requires automatic individuation, 25
Subpersonal
 codes, 69
 concepts, 52fn
 representations, of proximal properties, 70
Subset search, 28
Subset selection
 and FINSTs, 19, 28–29
 retained despite eye movement (Currie), 29
Sugar, T. G., 129fn
Sukel, K. E., 139
Sundberg, K. A., 176fn
Superimposed objects, tracking, 40–41
Swets, J. A., 145
Systematicity, 8fn

Tacit knowledge, and explanation of image properties, 127–139
Tacit theories and our understanding of conscious experience, 101
Tactile stimuli, located in 3-D extra-personal space, 171
Tagging objects, 22, 23
Tags vs. FINSTs, 23
Takeda, Y., 48
Tammett, Daniel, 124
Target objects
 vs. distractors, 34
 identified by blinking, 35
 indicated by horizontal/vertical bars, 42
Target-target vs. target-nontarget confusion, 46, 48
Task demands, of image scanning experiments, 164
Template matching, 170
Tenses (distinguishing this-now and this-before), 32, 53
Their, P., 191
"There it is again" vs. "here is a new one," 15
Things, need to pick out individual, 9
Thistlewaite, W. A., 137
Thompson,W. L., 131, 134, 137–138, 162
Thomson, J. A., 180, 193
Thoughts in dogs or chimpanzees, 56
3-D model of world, 125f
3-D scanning and rotation, 170, 170fn
Three-term series problems, 170
"Time = distance/speed" only applies to real space, 134
"Time = representation of distance/representation of speed," 159
Time measures in imagery experiments, 129, 131, 136
Time-to-contact estimation skill, 63
Time to report details, and image size, 131
Tip-of-the-tongue phenomenon, 116
Tipper, S., 48, 66, 192
Titchener, E. B., 103
Tlauka, M., 188, 189
Token element, same over time, 38
Token individual, 10, 38. *See also* Object(s); FINGs (FINSTed things)
Tokens, need to represent and refer to, 10
Tolman, E., 174, 177
Tootell, R. B., 139
Top-down construction of image, 125
Top-down vs. bottom-up, 3, 17
Topographical projection, 5
Torre, V., 153fn
Tracking, 182. *See also* MOT (multiple object tracking)
 conditions for, 33
 in feature space, 41
 as function of early vision, 52, 85
 individual things, 15
 vs. label recall, 46
 nonflashed objects, in MOT, 42
 as requiring FINSTs, 206

Tracking (cont.)
role of, 33
when object disappears behind occluding surface, 33
Transducer, 7, 8
Treisman, A., 38fn, 49, 61, 65, 86, 87, 86, 87
Tremoulet, P. D., 50, 69, 98, 177
Tresillian, J. R., 63
Triangle inequality, in spatial representation, 157
Triangulation, to solve "which link" problem, 97fn
Trick, L., 25, 36, 84, 89, 182
Tsang, E., 102
Tuning fork example, selecting without locating, 82
Turing machine architecture, 78
$2\frac{1}{2}$-D representation (Marr), 72
Tye, M., 125
Tyrrell, R. A., 202

Ullman, S., 22, 23, 47fn, 75fn, 77fn, 83, 182
Unawareness of unexpected events, 106
of inferred properties (negation as failure), 106fn
Unconscious perceptual processes, 144
Understanding, goal of, 2
Unilateral spatial neglect (USN), 190
in many different frames of reference, 192
Unique description, problem of finding, 12
Unitary amodal frame of reference, 168
first-person experience of space, 171
frame of reference, not necessary, 191
global representation, not needed, 171
Universal Turing machine, 78
Universal Grammar (UG), 153, 205
Updating coordinates of imagined objects, when we move, 179
Updating descriptions, 15fn
Updating locations, method of tracking in MOT, 36
Updating of pointing, by moving, 193

Valins, S., 115
Van de Walle, G., 50
vanMarle, K., 51, 95
Vaughan, B., 64
Ventral-dorsal visual systems, 191
Vervet monkey, 176
Violation of expectation, method, 50
Virtual space, 158–165. *See also* Functional space
Visetti, Y.-V., 123
Vision, required for observing unilateral spatial neglect, 198
Vision module, early vision, 33, 95
Visual
angle of mind's eye, 131–133
appearance, as panoramic and fine-grained, 99
cortex and explanation of imagery, 136–137
index theory (FINST theory), 9, 34
information, peephole view, 120
memory task and mental imagery, 135
objects, 9 (see also Object(s); FINGs [FINSTed things])
persistence in extrapersonal space, 202
representation of visible surfaces ($2\frac{1}{2}$-D sketch), 105
routines (Ullman), 23, 24
short-term memory, as visual workspace, 169fn
Visual systems, recognition and motor control, 118
Visual-tactile frames, move together in *extinction*, 192
Visuomotor adaptation to wedge prism, 187
Visuomotor (dorsal) system not susceptible to illusions, 118
Viviani, P., 199

Volumes, volume-inclusion, spatial axioms (Nicod), 151
Voluntarily enabled interpretation, selection, 42, 44
V1, homeomorphic mapping of retinal activity in, 139
von Grunau, M., 47
Von Holst, E., 200
Voss, P., 197

Wallach, H., 47
Waltz, D., 102
Wang, H., 197
Warren, D. H., 190, 191, 193
Washburn, A., 129fn
Washburn, M. F., 103
Watson, D. G., 22, 48, 182
Watt, D. G. D., 191
Weaver, B., 48, 66
Weber-Fechner law, 169
Wegner, D., 112
Wehner, R., 177
Weichselgarter, E., 62
Weisel, T. N., 138
Weiskrantz, L., 116
Well-defined features, may not be tracked, 95
Wertheimer, M., 75
Wexler, K., 153, 198
"What do you see?" problem of meaning of, 102, 103, 111
What FINSTs select, 94
What is an object, question of, 57
What it is like vs. accessible information, in consciousness, 107
Where's Waldo? game, 48
Which link in a causal chain does the FINST refer to, 96, 97
Whorf, B. L., 144
Why images have the properties they do, question of, 181
 geometrical axioms appear to be respected by image, 181
 does space have 3 dimensions, question of (Poincaré), 167
Wiggins, D., 51
Wilkinson, F., 137
Wilson, H. R., 137
Wilson, J. A., 55
Wilson, T. D., 115
Window on the mind, mental scanning as, 133, 165
Wired-in capacities, architecture, 53
Wittreich, W. J., 108
Wolfe, J. M., 89
Wolpert, D. M., 195, 199
Wong, E., 119
Woodlin, M., 193
Wright, J. S., 137
Wright, R. D., 77fn
Wynn, K., 51

Xu, F., 32, 50, 51, 94

Yagi, A., 48
Yantis, S., 22, 64, 182
Yellow Brick Road, location of, 181

Zooming in on a mental image, 124, 131
Zucker, S. W., 152