

The Neural Bases of Knowledge

Psychology 770G
Emory University
Fall Semester, 1999

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Thursdays, 10:00 - 12:50 AM
Psychology, Room 302

This seminar begins by reviewing lesion studies which show that brain damage in particular sensory-motor areas produces deficits in corresponding conceptual knowledge. Thus, damage to visual object processing areas produces deficits in knowledge of visual categories (e.g., *birds*), whereas damage to somatosensory and motor areas produces deficits in functional categories (e.g., *tools*). The seminar also reviews more recent neuroimaging studies that test the same thesis. Of interest is whether processing a particular category tends to activate relevant sensory-motor areas in the intact brains of normal humans. Finally, the seminar addresses computational models developed to explain these results, namely, neural net models of knowledge that incorporate sensory-motor distinctions in their representation schemes. Of interest will be how well these models account for the extant findings, whether they provide novel insights into them, and whether they motivate useful untested predictions.

Seminar materials will be a collection of readings on reserve in both electronic and paper format. Students can access all readings in pdf format over the web, as long as they are logged into the library's website from an Emory account (either on or off campus). Once you have opened a reading on your computer, you can print it locally or save it to disk.

Short presentations of papers will be assigned regularly throughout the semester. All participants are expected to present papers equally. No tests or term papers will be assigned. Students are encouraged to take the seminar P/F but may take it for a grade by writing a term paper.

Basic background material on cognitive neuroscience not covered in the seminar can be found in:

Gazzaniga, M.S., Ivry, R.B., & Mangan, G.R. (1998). *Cognitive neuroscience: The biology of the mind*. New York: Norton.

Bear, M.F., Connors, B.W., & Paradiso, M.A. (1996). *Neuroscience: Exploring the brain*. Baltimore: Williams and Wilkins.

Basic background material on neural nets (in a very elementary form) not covered in the seminar can be found in:

Bechtel, W., & Abrahamsen, A. (1991). *Connectionism and the mind* (pp. 1-146). Cambridge, MA: Basil Blackwell. [this material is on library reserve]

A more advanced treatment can be found in:

Anderson, J.A. (1995). *An introduction to neural networks*. Cambridge, MA: MIT Press

Relevant literatures in cognitive neuroscience not covered include:

- a large literature on the distinction between episodic and semantic memory
- a large literature on left and right hemisphere differences in semantic processing
- a large literature on lexical categories in language processing
- a small but growing literature on the acquisition of artificial categories

Week	Date	Topic / Readings
1	9/2	Introduction: Research and theory on knowledge in cognitive science
2	9/9	<p>Localizing category-specific deficits in modality-specific mechanisms (I)</p> <p>Warrington, E.K., & McCarthy, R.A. (1987). Categories of knowledge: Further fractionations and an attempted integration. <i>Brain, 110</i>, 1273-1296.</p> <p>Farah, M.J., McMullen, P.A., & Meyer, M.M. (1991). Can recognition of living things be selectively impaired? <i>Neuropsychologia, 29</i>, 185-193.</p> <p>Farah, M.J., Meyer, M.M., & McMullen, P.A. (1996). The living/nonliving dissociation is not an artifact: Giving an a priori implausible hypothesis a strong test. <i>Cognitive Neuropsychology, 1</i>, 137-154.</p> <p>Cappa, S.F., Frugoni, M., Pasquali, P., Perani, D., & Zorat, F. (1998). Category-specific naming impairment for artifacts: A new case. <i>Neurocase, 4</i>, 391-397.</p> <p>Gainotti, G., Silveri, M.C., Daniele, A., & Giustolisi, L. (1995). Neuroanatomical correlates of category-specific semantic disorders: A critical survey. <i>Memory, 3</i>, 247-264.</p>
3	9/16	<p>Localizing category-specific deficits in modality-specific mechanisms (II)</p> <p>Tranel, D., Damasio, H., & Damasio, A.R. (1997). A neural basis for the retrieval of conceptual knowledge. <i>Neuropsychologia, 35</i>, 1319-1327.</p> <p>Tranel, D., Logan, C.G., Frank, R.J., & Damasio, A.R. (1997). Explaining category-related effects in the retrieval of conceptual and lexical knowledge for concrete entities: Operationalization and analysis of factors. <i>Neuropsychologia, 35</i>, 1329-1339.</p> <p>Farah, M.J., & McClelland, J.L. (1991). A computational model of semantic memory impairment: Modality specificity and emergent category specificity. <i>Journal of Experimental Psychology: General, 120</i>, 339-357.</p> <p>Kurbaat, M.A., & Farah, M.J. (1998). Is the category-specific deficit for living things spurious? <i>Journal of Cognitive Neuroscience, 10</i>, 355-361.</p>
4	9/23	<p>Roles of access and structural similarity in category-specific deficits</p> <p>Forde, E.M.E., & Humphreys, G.W. (1997). A semantic locus for refractory behaviour: Implications for access-storage distinctions and the nature of semantic memory. <i>Cognitive Neuropsychology, 14</i>, 367-402.</p> <p>Riddoch, M.J., & Humphreys, G.W. (1987). A case of integrative visual agnosia. <i>Brain, 110</i>, 1431-1462.</p> <p>Humphreys, G.W., Riddoch, M.J., & Quinlan, P.T. (1988). Cascade processes in picture identification. <i>Cognitive Neuropsychology, 5</i>, 67-103.</p> <p>Humphreys, G.W., Lamote, C., & Lloyd-Jones, T.J. (1995). An interactive activation approach to object processing: Effects of structural similarity, name frequency, and task in normality and pathology. <i>Memory, 3</i>, 535-586.</p>

Week	Date	Topic / Readings
5	9/30	<p>Guest: Sharon Thompson-Schill (University of Pennsylvania, Psychology)</p> <p>Thompson-Schill, S.L., Aguirre, G.K., D'Esposito, M.D., & Farah, M.J. (1999). A neural basis for category and modality specificity of semantic knowledge. <i>Neuropsychologia</i>, <i>37</i>, 671-676.</p> <p>Thompson-Schill, S.L., & Gabrielli, J.D.E. (1999). Priming of visual and functional knowledge on a semantic classification task. <i>Journal of Experimental Psychology: Learning, Memory, and Cognition</i>, <i>25</i>, 41-53.</p> <p>Thompson-Schill, S.L., Swick, D., Farah, M.J., D'Esposito, M.D., Kan, I.P., & Knight, R.T. (1998). Verb generation in patients with focal frontal lesions: A neuropsychological test of neuroimaging findings. <i>Proceedings of the National Academy of Sciences, USA</i>, <i>95</i>, 15855-15860.</p> <p>Thompson-Schill, S.L., D'Esposito, M.D., & Kan, I.P. (in press). Effects of repetition and competition on activity in left prefrontal cortex during word generation. <i>Neuron</i>.</p>
6	10/7	<p>Deficits in structural versus functional properties</p> <p>Moss, H.E., Tyler, L.K., & Jennings, F. (1997). When leopards lose their spots: Knowledge of visual properties in category-specific deficits for living things. <i>Cognitive Neuropsychology</i>, <i>14</i>, 901-950.</p> <p>Coltheart, M., Inglis, L., Cupples, L., Michie, P., Bates, A., & Budd, B. (1998). A semantic subsystem of visual attributes. <i>Neurocase</i>, <i>4</i>, 353-370.</p> <p>Sheridan, J., & Humphreys, G.W. (1993). A verbal-semantic category-specific recognition impairment. <i>Cognitive Neuropsychology</i>, <i>10</i>, 143-184.</p> <p>Laws, K.R., Evans, J.J., Hodges, J.R., & McCarthy, R.A. (1995). Naming without knowing and appearance without associations: Evidence for constructive processes in semantic memory? <i>Memory</i>, <i>3</i>, 409-433.</p>
7	10/14	<p>Miscellaneous deficits (medical, abstract, body part, numeric, person concepts)</p> <p>Crosson, B., Moberg, P.J., Boone, J.R., Rothi, L.J.G., & Raymer, A. (1997). Category-specific naming deficit for medical terms after dominant thalamic/capsular hemorrhage. <i>Brain and Language</i>, <i>60</i>, 407-442.</p> <p>Tyler, L.K., & Moss, H.E. (1997). Imageability and category-specificity. <i>Cognitive Neuropsychology</i>, <i>14</i>, 293-318.</p> <p>Thioux, M., Pillon, A., Samson, D., de Partz, M.P., Noël, M.P. (1998). The isolation numerals at the semantic level. <i>Neurocase</i>, <i>4</i>, 371-389.</p> <p>Shelton, J.R., Fouch, E., & Caramazza, A. (1998). The selective sparing of body part knowledge: A case study. <i>Neurocase</i>, <i>4</i>, 339-351.</p> <p>Kay, J., & Hanley, J.R. (1999). Person-specific knowledge and knowledge of biological categories. <i>Cognitive Neuropsychology</i>, <i>16</i>, 171-180.</p>

Week	Date	Topic / Readings
8	10/21	<p>Roles of autobiographical memory and action in category-specific deficits</p> <p>Snowden, J.S., Griffiths, H.L., & Neary, D. (1995). Autobiographical experience and word meaning. <i>Memory</i>, 3, 225-246.</p> <p>Graham, K.S., Lambdon Ralph, M.A., & Hodges, J.R. (1997). Determining the impact of autobiographical experience on “meaning”: New insights from investigating sports-related vocabulary and knowledge in two cases with semantic dementia. <i>Cognitive Neuropsychology</i>, 14, 801-837.</p> <p>Buxbaum, L.J., Schwartz, M.F., & Carew, T.G. (1997). The role of semantic memory in object use. <i>Cognitive Neuropsychology</i>, 14, 219-254.</p> <p>Magnié, M.N., Ferreira, C.T., Giusiano, B., & Poncet, M. (1999). Category specificity in object agnosia: Preservation of sensorimotor experiences related to objects. <i>Neuropsychologia</i>, 37, 67-74.</p>
9	10/28	<p>Semantic dementia and Alzheimer’s disease (I)</p> <p>Hodges, J.R., Graham, N., & Patterson, K. (1995). Charting the progression in semantic dementia: Implications for the organisation of semantic memory. <i>Memory</i>, 3, 463-495.</p> <p>Chan, A.S., Butters, N., & Salmon, D.P. (1997). The deterioration of semantic networks in patients with Alzheimer’s disease: A cross-sectional study. <i>Neuropsychologia</i>, 35, 241-248.</p> <p>Done, D.J., & Gale, T.M. (1997). Attribute verification in dementia of Alzheimer type: Evidence for the preservation of distributed concept knowledge. <i>Cognitive Neuropsychology</i>, 14, 547-571.</p> <p>Moss, H.E., & Tyler, L.K. (1995). Investigating semantic memory impairments: The contribution of semantic priming. <i>Memory</i>, 3, 359-395.</p>
10	11/4	<p>Semantic dementia and Alzheimer’s disease (II)</p> <p>Gonnerman, L.M., Andersen, E.S., Devlin, J.T., Kempler, D., & Seidenberg, M.S. (1997). Double dissociation of semantic categories in Alzheimer’s disease. <i>Brain and Language</i>, 57, 254-279.</p> <p>Garrard, P., Patterson, K., Watson, P.C., & Hodges, J.R. (1998). Category specific semantic loss in dementia of Alzheimer’s type: Functional-anatomical correlations from cross-sectional analyses. <i>Brain</i>, 121, 633-646.</p> <p>Tippett, L.J., & Farah, M.J. (1994). A computational model of naming in Alzheimer’s disease: Unitary or multiple impairments. <i>Neuropsychology</i>, 8, 3-13.</p> <p>Devlin, J.T., Gonnerman, L.M., Andersen, E.S., & Seidenberg, M.S. (1998). Category-specific semantic deficits in focal and widespread brain damage: A computational account. <i>Journal of Cognitive Neuroscience</i>, 10, 77-94.</p> <p>Perry, C. (1999). Testing a computational account of category-specific deficits. <i>Journal of Cognitive Neuroscience</i>, 11, 312-320.</p>

Week	Date	Topic / Readings
11	11/11	<p>Localizing category-specific deficits in memory mechanisms</p> <p>Caramazza, A., Hillis, A.E., Rapp, B.C., & Romani, C. (1990). The multiple semantics hypothesis: Multiple confusions? <i>Cognitive Neuropsychology</i>, <i>7</i>, 161-189.</p> <p>Caramazza, A., & Shelton, J.R. (1998). Domain-specific knowledge systems in the brain: The animate-inanimate distinction. <i>Journal of Cognitive Neuroscience</i>, <i>10</i>, 1-34.</p> <p>Samson, D., Pillon, A., & De Wilde, V. (1998). Impaired knowledge of visual and non-visual attributes in a patient with a semantic impairment for living entities: A case of a true category-specific deficit. <i>Neurocase</i>, <i>4</i>, 273-290.</p> <p>Moss, H.E., Tyler, L.K., Durrant-Peatfield, M., & Bunn, E.M. (1998). 'Two eyes of a see-through': Impaired and intact semantic knowledge in a case of selective deficit for living things. <i>Neurocase</i>, <i>4</i>, 291-310.</p>
12	11/18	<p>Neuroimaging (I)</p> <p>Martin, A., Ungerleider, L.G., & Haxby, J.V. (in press). Category-specificity and the brain: The sensory-motor model of semantic representations of objects. In M.S. Gazzaniga (Ed.), <i>The cognitive neurosciences</i> (2nd ed.). Cambridge, MA: MIT Press.</p> <p>Martin, A., Haxby, J.V., Lalonde, F.M., Wiggs, C.L., & Ungerleider, L.G. (1995). Discrete cortical regions associated with knowledge of color and knowledge of action. <i>Science</i>, <i>270</i>, 102-105.</p> <p>Chao, L.L., & Martin, A. (1999). Cortical regions associated with perceiving, naming, and knowing about colors. <i>Journal of Cognitive Neuroscience</i>, <i>11</i>, 25-35.</p> <p>Martin, A., Wiggs, C.L., Ungerleider, L.G., & Haxby, J.V. (1996). Neural correlates of category-specific knowledge. <i>Nature</i>, <i>379</i>, 649-652.</p> <p>Silveri, M.C., Gainotti, G., Perani, D., Cappelletti, J.Y., Carbone, G., & Fazio, F. (1997). Naming deficit for non-living items: Neuropsychological and PET study. <i>Neuropsychologia</i>, <i>35</i>, 359-367.</p>
13	11/25	Thanksgiving, no class

Week	Date	Topic / Readings
14	12/2	<p>Neuroimaging (II)</p> <p>Mummary, C.J., Patterson, K., Hodges, J.R., & Price, C.J. (1998). Functional neuroanatomy of the semantic system: Divisible by what? <i>Journal of Cognitive Neuroscience</i>, <i>10</i>, 766-777.</p> <p>Spitzer, M., Kischka, U., Gückel, F., Bellemann, M.E., Kammer, T., Seyyedi, S., Weisbrod, M., Schwartz, A., & Brix, G. (1998). Functional magnetic resonance imaging of category-specific cortical activation: Evidence for semantic maps. <i>Cognitive Brain Research</i>, <i>6</i>, 309-319.</p> <p>Perani, D., Schnur, T., Tettamanti, M., Gorno-Tempini, M., Cappa, S.F., & Fazio, F. (1999). Word and picture matching: A PET study of semantic category effects. <i>Neuropsychologia</i>, <i>37</i>, 293-306.</p> <p>Kiefer, M. (1999). Perceptual and semantic sources of category-specific effects: Event-related potentials during picture and word categorization. Universität Ulm technical report.</p>
15	12/9	<p>General Theories (optional meeting, classes technically end 12/8)</p> <p>Damasio, A.R. (1989). Time-locked multiregional retroactivation: A systems-level proposal for the neural substrates of recall and recognition. <i>Cognition</i>, <i>33</i>, 25-62.</p> <p>Pulvermüller, F. (1999). Words in the brain's language. <i>Behavioral and Brain Sciences</i>, <i>22</i>, 253-279. [pp. 280-336 optional].</p> <p>Barsalou, L.W. (1999). Perceptual symbol systems. <i>Behavioral and Brain Sciences</i>, <i>22</i>, 577-609. [pp. 610-660 optional]</p>

Other Relevant Readings

Localizing category-specific deficits in modality-specific mechanisms

- Woodward, T.S., Dixon, M.J., Mullen, K.T., Christensen, K.M., & Bub, D.N. (1999). Analysis of errors in color agnosia: A single-case study. *Neurocase*, *5*, 95-108.
- Kurbat, M.A. (1997). Can the recognition of living things really be selectively impaired? *Neuropsychologia*, *35*, 813-827.
- Gainotti, G., & Silveri, M.C. (1996). Cognitive and anatomical locus of lesion in a patient with a category-specific semantic impairment for living beings. *Cognitive Neuropsychology*, *13*, 357-389.
- McCarthy, R., A., & Warrington, E.K. (1988). Evidence for modality-specific meaning systems in the brain. *Nature*, *334*, 428-430.
- Warrington, E.K., & Shallice, T. (1984). Category specific semantic impairments. *Brain*, *107*, 829-854.
- Warrington, E.K., & McCarthy, R.A. (1983). Category specific access dysphasia. *Brain*, *106*, 859-878.

Also see many older articles cited in the following two reviews:

- Gainotti, G., Silveri, M.C., Daniele, A., & Giustolisi, L. (1995). Neuroanatomical correlates of category-specific semantic disorders: A critical survey. *Memory*, *3*, 247-264.
- Damasio, A.R., Damasio, H. (1994). Cortical systems for retrieval of concrete knowledge: The convergence zone framework. In C. Koch & J.L. Davis (Eds.), *Large-scale neuronal theories of the brain* (61-74). Cambridge, MA: MIT Press.

Role of access in category-specific deficits

- Forde, E.M.E., & Humphreys, G.W. (1995). Refractory semantics in global aphasia: On semantic organization and the access-storage distinction in neuropsychology. *Memory*, *3*, 265-307.
- Cipolotti, L., & Warrington, E.K. (1995). Towards a unitary account of access dysphasia: A single case study. *Memory*, *3*, 309-332.
- Hillis, A.E., & Caramazza, A. (1995). The compositionality of lexical semantic representations: Clues from semantic errors in object naming. *Memory*, *3*, 333-358.

Role of structural similarity in category-specific deficits

- Dixon, M.J., Bub, D.N., Chertkow, H., & Arguin, M. (1999). Object identification deficits in dementia of the Alzheimer type: Combined effects of semantic and visual proximity. *Journal of the International Neuropsychological Society*, *5*, 330-345.
- Forde, E.M.E., Francis, D., Riddoch, M.J., Rumiati, R.I., & Humphreys, G.W. (1997). On the links between visual knowledge and naming: A single case study of a patient with a category-specific impairment for living things. *Cognitive Neuropsychology*, *14*, 403-458.

Deficits in structural versus functional properties

- Tyler, L.K., & Moss, H.E. (1997). Functional properties of concepts: Studies of normal and brain-damaged patients. *Cognitive Neuropsychology*, *14*, 511-545.
- Laws, K.R., Humber, S.A., Ramsey, D.J.C., & McCarthy, R.A. (1995). Probing sensory and associative semantics for animals and objects in normal subjects. *Memory*, *3*, 397-408.
- Powell, J., & Davidoff, J. (1995). Selective impairments of object knowledge in a case of acquired cortical blindness. *Memory*, *3*, 435-461.

Role of action in category-specific deficits

- Jervis, C., Bennett, K., Thomas, J., Lim, S., Castiello, U. (1999). Semantic category interference effects upon the reach-to-grasp movement. *Neuropsychologia*, *37*, 857-868.
- Klatzky, R.L., Pelligrino, J.W., McCloskey, B.P., & Doherty, S. (1989). The role of motor representations in semantic sensibility judgments. *Journal of Memory and Language*, *28*, 56-77.

Semantic dementia and Alzheimer's disease

- Lambdon Ralph, M.A., Howard, D., Nightingale, G., & Ellis, A.W. (1998). Are living and non-living category specific deficits causally linked to impaired perceptual or associative knowledge? Evidence from a category-specific double dissociation. *Neurocase*, *4*, 311-338.
- Tyler, L.K., & Moss, H.E. (1998). Going, going, gone...? Implicit and explicit tests of conceptual knowledge in a longitudinal study of semantic dementia. *Neuropsychologia*, *36*, 1313-1323.
- Laiacina, M., Barbarotto, R., & Capitani, E. (1998). Semantic category dissociations in naming: Is there a gender effect in Alzheimer's disease? *Neuropsychologia*, *36*, 407-419.
- Lambon Ralph, M.A., Patterson, K., & Hodges, J.R. (1997). The relationship between naming and semantic knowledge for different categories in dementia of Alzheimer's type. *Neuropsychologia*, *35*, 1251-1260.
- McRae, K., de Sa, V.R., & Seidenberg, M.S. (1997). On the nature and scope of featural representations in word meaning. *Journal of Experimental Psychology: General*, *126*, 99-130.
- Gainotti, G., De Betta, A.M., & Silveri, M.C. (1996). The production of specific and generic associates of living and nonliving, High- and low-familiarity stimuli in Alzheimer's disease. *Brain and Language*, *54*, 262-274.
- Hodges, J.R., Patterson, K., Graham, N., & Dawson, K. (1996). Naming and knowing in dementia of Alzheimer's type. *Brain and Language*, *54*, 302-325.
- Montanes, P., Goldblum, M.C., & Boller, F. (1996). Classification deficits in Alzheimer's disease with special reference to living and nonliving things. *Brain and Language*, *54*, 335-358.
- Cox, D.M., Bayles, K.A., & Trosset, M.W. (1996). Category and attribute knowledge deterioration in Alzheimer's disease. *Brain and Language*, *52*, 536-550.
- Smith, S., Faust, M., Beeman, M., Kennedy, L., & Perry, D. (1995). A property level analysis of lexical semantic representation in Alzheimer's disease. *Brain and Language*, *49*, 263-279.
- Silveri, M.C., Leggio, M.G. (1995). Influence of disorders of visual perception in word-to-picture matching tasks in patients with Alzheimer's disease. *Memory*, *3*, 326-334.
- Funnell, E. (1995). Objects and properties: A study of the breakdown of semantic memory. *Memory*, *3*, 497-518.

Tippett, L.J., McAuliffe, S., & Farah, M.J. (1995). Preservation of categorical knowledge in Alzheimer's disease: A computational account. *Memory*, 3, 519-533.

Localizing category-specific deficits in memory mechanisms

- Caramazza, A. (1999). The interpretation of semantic category-specific deficits: What do they reveal about the organization of conceptual knowledge in the brain? *Neurocase*, 4, 265-272.
- Shelton, J.R., & Caramazza, A. (1999). Deficits in lexical and semantic processing: Implications for models of normal language. *Psychonomic Bulletin and Review*, 6, 5-27.
- Hillis, A.E., Rapp, B., & Caramazza, A. (1995). Constraining claims about theories of semantic memory: More on unitary versus multiple semantics. *Cognitive Neuropsychology*, 12, 175-186.
- Rapp, B.C., Hillis, A.E., & Caramazza, A. (1993). The role of representations in cognitive theory: More on multiple semantics and the agnosias. *Cognitive Neuropsychology*, 10, 235-249.
- Shallice, T. (1993). Multiple semantics: Whose confusions? *Cognitive Neuropsychology*, 10, 251-261.
- Rapp, B., & Caramazza, A. (1993). On the distinction between deficits of access and deficits of storage: A question of theory. *Cognitive Neuropsychology*, 10, 113-141.
- Chertkow, H., Bub, D., & Caplan, D. (1992). Constraining theories of semantic memory processing: Evidence from dementia. *Cognitive Neuropsychology*, 7, 191-243.
- Riddoch, M.J., Humphreys, G.W., Coltheart, M., & Funnell, E. (1988). *Cognitive Neuropsychology*, 5, 3-25.

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- Binder, J.R., Frost, J.A., Hammeke, T.A., Bellgowan, P.S.F, Rao, S.M., & Cox, R.W. (1999). Conceptual processing during the conscious resting state: A function MRI study. *Journal of Cognitive Neuroscience*, 11, 80-93.
- Royet, J.P., Koenig, O., Gregoire, M.C., Cinotti, L., Lavenne, F., Le Bars, D., Costes, N., Vigouroux, M., Farget, V., Sicard, G., Holley, A., Mauguiere, F., Comar, D., & Froment, J.C. (1999). Functional anatomy of perceptual and semantic processing for odors. *Journal of Cognitive Neuroscience*, 11, 94-109.
- Damasio, H., Grabowski, T.J., Tranel, D., Hichwa, R.D., & Damasio, A.R. (1996). A neural basis for lexical retrieval. *Nature*, 380, 499-505.
- Rösler, F., Heil, M., & Hennighausen, E. (1995). Distinct cortical activation patterns during long-term memory retrieval of verbal, spatial, and color information. *Journal of Cognitive Neuroscience*, 7, 51-65.
- Note.* Given the large amount of neuroimaging work on categories reported recently at conferences, many additional papers should begin appearing in print soon.