P351: Object Recognition, Categorization, and Perceptual Expertise
Fall 2002
Mon/Wed 10:00-11:30
Wilson Hall 316

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COURSE OVERVIEW

This course will investigate how we recognize objects, how we place objects into learned categories, and how these abilities change as we gain expertise in recognizing and classifying objects. Until quite recently, research on object recognition, categorization, and perceptual expertise have remained largely independent lines of investigation. The goal of this graduate seminar is to attempt to bridge between these various domains both empirically and theoretically. Indeed, the motivation for this course is not simply to convey the contemporary body of knowledge in each of these areas, but also to understand why some of these issues have been studied in isolation from one another and to achieve an understanding of what may have been overlooked because of that isolation and what may be gained by considering these domains together. We hope that the group effort in this seminar will generate ideas for new empirical investigation and new theoretical integration. We will be reading a wide variety of original research articles investigating behavioral studies of normal individuals, behavioral studies of brain-damaged individuals, brain imaging studies, single-unit recordings of awake behaving primates, and formal computational models. Course requirements will focus on readings, discussion, and very short reaction papers.

REQUIREMENTS

No Final Exam. No Final Paper. Your understanding of the concepts will be evaluated through short critical thinking pieces to be prepared for every class and through discussions we have surrounding those pieces and the readings. Do not summarize the papers. Instead, critically evaluate one or two ideas from one paper, integrate similar ideas or reconcile conflicting ideas across several papers, or relate ideas in the assigned papers to something else that was not assigned or that was assigned earlier in the semester. Especially try to come up with opinions, criticisms, or interpretations that are likely to provoke discussion. Be critical. Be insightful. Be provocative. For now, the word limit is strictly set at between 250-300 words (less than one double-spaced page of text), but that limit may decrease later in the semester.

Papers need to be turned in at the end of every class. During class, we will draw from a hat to choose someone to read their paper aloud; when discussion stalls or stagnates, we may ask other people to read their papers as well. You get 2 chances to “pass” during the semester (for whatever reason, without explanation). Additional passes or undocumented class absences can have a negative impact on your final grade.

These papers serve as the starting point for most class discussions. And they serve as a way to assign grades for students taking the course for graduate credit. But more importantly, these papers serve as a vehicle for practicing how to think critically and how to translate those thoughts and ideas into a written form that can also be presented orally. Effective scientific communication requires selecting the most important ideas and communicating those ideas, with all of their inherent complexity, in as concise and as understandable a manner as possible. Many outlets impose strict limits on the length of a manuscript or a grant proposal, so it is critical that you can communicate a complex idea in a relatively small number of words. In addition, the kind of writing that is required in most college courses is too often read by only the professor, never to be seen again. Scientific communication is for public consumption. As a scientist and as an academic, we have to live with our written opinions once they are published as they become part of our official position in the field. One goal of this class is to help buttress the transition from student to academic. Your papers should be written for public consumption.

Finally, we strongly urge all graduate students either to sign up for course credit or to sign up as an auditor. Auditors and other people sitting in on the course are expected to read the assigned material and be prepared to participate in discussions. That said, we do urge postdoctoral fellows and faculty who might sit in on the course to try to restrain their enthusiasm a bit and to allow the graduate students to play a more dominant role in the class discussion whenever possible.

COURSE READINGS

A web-based version of this syllabus is located at:
http://www.psy.vanderbilt.edu/faculty/palmeri/p351/syllabus.html

Some of the newer readings are accessible via the web as PDF files. When you click on one of the links to the papers you will be prompted to log in:

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user:      p351
password:  psych351
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Logging in will give you access to the PDF file. You must have the free Adobe Acrobat Reader in order to open the PDF files (available at www.adobe.com).

Other readings will be available in the mail room on the third floor of Wilson Hall and will be on reserve in the main library. Please borrow these papers only to copy them and return them to their folders promptly.

COURSE SCHEDULE

Wed Aug 28th **Introduction**

Komatzu, L.K. (1992). Recent views of conceptual structure. Psychological Bulletin, 112, 500-526. (read for background on categorization)

Pinker, S. (1984). Visual cognition: An introduction. Cognition, 18, 1-63. (read for background on object recognition)

Churchland, P.S., & Sejnowski, T.J. (1993). The Computational Brain. Cambridge, MA: MIT Press. (read Chapter 2, for background on neuroscience)

Mon Sep 2nd **Background**

Marr, D. (1982). Vision. W.H. Freeman Co. (Chapters 1 and 2.)

Churchland, P.S., & Sejnowski, T.J. (1993). The Computational Brain. Cambridge, MA: MIT Press. (Chapter 3, Computational Overview, pp. 61-82)

Further readings:

Anderson, J.R. (1990). The adaptive character of thought. Lawrence Erlbaum. (Chapter 1.)

Tarr, M.J., & Black, M.J. (1994). A computational and evolutionary perspective on the role of representation in vision. Computer Vision, Graphics, and Image Processing: Image Understanding, 60, 65-73.

Wed Sep 4th **Revealing Representations: MDS and Clustering**

Shepard, R.N. (1980). Multidimensional scaling, tree-fitting, and clustering. Science, 210, 390-398.

Further readings:

Arabie, P., Carroll, J.D., & DeSarbo, W.S. (1976). Three-way scaling and clustering. Sage Publications.

Corter, J.E. (1996). Tree models of similarity and association. Sage Publications.

Corter, J.E., & Tversky, A. (1986). Extended similarity trees. Psychometrika, 51, 429-451.

Kruskal, J.B., & Wish, M. (1978). Multidimensional scaling. Sage Publications.

Sattath S., & Tversky, A. (1977). Additive similarity trees. Psychometrika, 42, 319-345.

Mon Sep 9th **Theories of similarity**

Tversky, A. (1977). Features of similarity. Psychological Review, 84, 327-352.

Shepard, R.N. (1987). Toward a universal law of generalization for psychological science. Science, 237, 1317-1323.

Further readings:

Gati, I., & Tversky, A. (1984). Weighting common and distinctive features in perceptual and conceptual judgments. Cognitive Psychology, 16, 341-370.

Sattath, S., & Tversky, A. (1987). On the relation between common and distinctive feature models. Psychological Review, 94, 16-22.

Tversky, A., & Gati, I. (1982). Similarity, separability, and the triangle inequality. Psychological Review, 89, 123-154.

Wed Sep 11th Shepard-mania

Shepard, R.N., & Cooper, L.A. (1982) Mental images and their transformations, MIT Press. (Chapter 2: On turning something over in one's mind, Chapter 3: Transformational studies of the internal representations of three-dimensional objects).

Shepard, R.N. (2001). Perceptual cognitive universals as reflections of the world. Psychonomic Bulletin and Review, 1, 2-28.

Further readings:

Shepard, R.N. & Cooper, L.A. (1982) Mental images and their transformations, MIT Press, Chap 4. "Chronometric Studies of the rotation of mental images"

Gauthier, I., & Tarr, M.J. (1997). Orientation priming of novel shapes in the context of viewpoint-dependent recognition. Perception, 26, 51-73.

Mon Sep 16th Structural Description Theories (Behavioral Evidence)

Biederman, I. (1987). Recognition-by-components: A theory of human image understanding. Psychological Review, 94, 115-47.

Hoffman, D., & Richards, W.A. (1984). Parts of recognition. Cognition, 18, 65-96.

Wed Sep 18th Structural Description Theories (Computational Models)

Hummel, J.E., & Biederman, I. (1992). Dynamic binding in a neural network for shape recognition. Psychological Review, 99, 480-517.

Stankiewicz, B.J. (2002). Empirical evidence for independent dimensions in the visual representation of three-dimensional shape. Journal of Experimental Psychology: Human Perception and Performance, 28, 913-932.

Further readings:

Sanocki, T. (1999). Constructing structural descriptions. Visual Cognition, 6, 299-318.

Bar, M. (2001). Viewpoint dependency in visual object recognition does not necessarily imply viewer-centered representation. Journal of Cognitive Neuroscience, 13, 793-799.

Peissig, J.J., Young, M.E., Wasserman, E.A.,& Biederman, I. (2000). Seeing things from a different angle: The pigeon's recognition of single geons rotated in depth. Journal of Experimental Psychology: Animal Behavior Processes, 26, 115-132.

Mon Sep 23rd **Image-Based Theories (Behavioral Evidence)**

Tarr, M.J., & Bülthoff, H.H. (1995). Is human object recognition better described by geon-structural-descriptions or by multiple-views? Journal of Experimental Psychology: Human Perception and Performance, 21, 1494-1505.

Tarr, M.J., Kersten, D., & Bülthoff, H.H. (1998). Why the visual recognition system might encode the effects of illumination. Vision Research, 38, 2259-2275.

Tarr., M.J., Williams, P., Hayward, W.G., & Gauthier, I. (1998). Three-dimensional object recognition is viewpoint dependent. Nature Neuroscience, 1, 275-277.

Further readings:

Braje, W.L., Kersten, D., Tarr, M.J., Troje, N.F. (1998). Illumination effects in face recognition. Psychobiology, 26, 371-380.

Rock, I., & DiVita, J. (1987). A case of viewer-centered object perception. Cognitive Psychology. 19, 280-293.

Tarr, M. J. (1995). Rotating objects to recognize them: A case study of the role of viewpoint dependency in the recognition of three-dimensional objects. Psychonomic Bulletin and Review, 2, 55-82.

Wed Sep 25th **Image-Based Theories (Computational Models)**

Poggio, T., & Edelman, S. (1990). A network that learns to recognize three-dimensional objects. Nature, 343, 263-266.

Riesenhuber, M., & Poggio, T. (1999). Hierarchical models of object recognition in cortex. Nature Neuroscience, 2, 1019-1025.

Riesenhuber, M., & Poggio, T. (2000). Models of object recognition. Nature Neuroscience, 3, 1199-1204.

Mon Sep 30th **Structural Description Theories (Neural Evidence)**

Vogels, R., Biederman, I., Bar, M., & Lorincz, A. (2001). Inferior temporal neurons show greater sensitivity to nonaccidental than to metric shape differences. Journal of Cognitive Neuroscience, 13, 444-453.

Grill-Spector, K., Kushnir, T., Edelman, S., Avidan, G., Itzchak, Y., Malach, R. (1999). Differential processing of objects under various viewing conditions in the human lateral occipital complex. Neuron, 24, 187-203.

Vanrie, J., Beatse, E. Wagemans, J., Sunaert, S. & Van-Hecke, P. (2002). Mental rotation versus invariant features in object perception from different viewpoints: An fMRI study. Neuropsychologia, 40, 917-930.

Wed Oct 2nd Image-Based Theories (Neural Evidence)

Perrett, D.I., Oram, M.W., & Ashbridge, E. (1998). Evidence accumulation in cell populations responsive to faces: An account of generalisation of recognition without mental transformations. Cognition, 67, 111-145.

Gauthier, I., Hayward, W.G., Tarr, M.J., Anderson, A.W., Skudlarski, P., & Gore, J.C. (2002). BOLD activity during mental rotation and viewpoint-dependent object recognition. Neuron, 34, 161-171.

Logothetis, N.K., Pauls. J., & Poggio, T. (1995). Shape representation in the inferior temporal cortex of monkeys. Current Biology, 5, 552-563.

Further Readings:

Tanaka K.(1996) Inferotemporal cortex and object vision. Annual Review of Neuroscience, 19, 109-39.

Mon Oct 7th Exemplar-Based Models of Categorization

Nosofsky, R.M. (1992). Exemplar-based approach to relating categorization, identification, and recognition. In F.G. Ashby (Ed.), Multidimensional models of perception and cognition (pp. 363-393), Hillsdale, NJ: Erlbaum.

Lamberts, K. (1997). Process models of categorization. In K. Lamberts & D.R. Shanks (Eds.), Knowledge, concepts and categories: Studies in cognition, Cambridge, MA: MIT Press.

Further readings:

Nosofsky, R.M. (1984). Choice, similarity, and the context theory of classification. Journal of Experimental Psychology: Learning, Memory and Cognition, 10, 104-114.

Nosofsky, R.M. (1986). Attention, similarity and the identification-categorization relationship. Journal of Experimental Psychology: General, 115, 39-57.

Ashby, F.G. (1992). Multidimensional models of categorization. In F.G. Ashby (Ed.), Multidimensional models of perception and cognition (pp. 449-483), Hillsdale, NJ: Erlbaum.

Wed Oct 9th An Exemplar-Based Model of Category Learning

Kruschke, J.K. (1992). ALCOVE: An exemplar-based connectionist model of category learning. Psychological Review, 99, 22-44.

Further readings:

Lee, M.D., & Navarro, D. (2002). Extending the ALCOVE model of category learning to featural stimulus domains. Psychonomic Bulletin and Review, 9, 43-58.

Mon Oct 14th Extensions of Exemplar-Based models

Palmeri, T.J. (2001). The time course of perceptual categorization. In M. Ramscar & U. Hahn (Eds.), Similarity and Categorization, Oxford University Press.

Nosofsky, R. M. (1991). Stimulus bias, asymmetric similarity, and classification. Cognitive Psychology, 23: 94-140

Further Reading:

Nosofsky, R.M., & Palmeri, T.J. (1997). An exemplar-based random walk model of speeded classification. Psychological Review, 104, 266-300.

Nosofsky, R.M. (1988). Exemplar-based accounts of relations between classification, recognition, and typicality. Journal of Experimental Psychology: Learning, Memory, and Cognition, 14, 700-708.

Lamberts, K. (2000). Information-accumulation theory of speeded categorization. Psychological Review, 107, 227-260.

Wed Oct 16th Exemplar-Based Models (Neural Evidence)

Sigala, N., & Logothetis, N.K. (2002). Visual categorization shapes feature selectivity in the primate temporal cortex, Nature, 415, 318-320.

Sigala, N., Gabbiani, F., & Logothetis, N.K. (2002). Visual categorization and object representation in monkeys and humans. Journal of Cognitive Neuroscience.

Op de Beeck, H., Wagemans, J., & Vogels, R. (2001) Inferotemporal neurons represent low-dimensional configurations of parameterized shapes. Nature Neuroscience, 4, 1244-1252.

Mon Oct 21st FALL BREAK

Wed Oct 23rd Distributed Representations

McClelland, J.L., & Rumelhart, D.E. (1985). Distributed memory and the representation of general and specific information. Journal of Experimental Psychology: General, 114, 159-188.

Churchland, P.S., & Sejnowski, T.J. (1992). The computational brain. Cambridge, MA: MIT Press. (Selected Chapters.)

Mon Oct 28th. McClelland visit

Wed Oct 30th Distributed Representations (Neural Evidence)

Haxby et al. (2001). Distributed and overlapping representations of faces and objects in ventral temporal cortex. Science, 293, 2425-2430.

Tsunoda, K., Yamane, Y., Nishizaki, M., & Tanifuji, M. (2001) Complex objects are represented in macaque inferotemporal cortex by the combination of feature columns. Nature Neuroscience, 4, 832-838.

Further Reading:

Ishai, A., Ungerleider, L.G., Martin, A., Schouten, J.L.,& Haxby, J.V. (1999). Distributed representation of objects in the human ventral visual pathway. Proceedings of the National Academy of Science, 16, 9379-9384.

Mon Nov 4th Semidistributed Representations

French, R.M. (1999). Catastrophic forgetting in connectionist networks. Trends in Cognitive Science, 4, 365-377.

Thomas, E., Van-Hulle, M.M., & Vogels, R. (2001). Encoding of categories by noncategory-specific neurons in the inferior temporal cortex. Journal of Cognitive Neuroscience, 13, 190-200.

Further Reading:

Rolls, E.T., & Tovee, M.J. (1995). Sparseness of the neuronal representation of stimuli in the primate temporal visual cortex. Journal of Neurophysiology, 57, 132-146.

Rolls, E.T., & Treves, A. (1990). The relative advantage of sparse versus distributed encoding for associative neuronal networks in the brain. Network, 1, 407-421.

Wed Nov 6th Hierarchical Feature Representations

Rolls, E.T., & Deco, G. (2002). Computational neuroscience of vision. Oxford University Press. (Chapter 7, Neural Networks and Chapter 8, Models of Invariant Object Recognition.)

Ullman, S., Vidal-Naquet, M., & Sali, E. (2002) Visual features of intermediate complexity and their use in classification. Nature Neuroscience, 5, 682 – 687

Mon Nov 11th Representation as Representation of Similarities

Edelman, S. (1999). Representation and recognition in vision. Cambridge, MA: MIT Press. (Selected chapters)

Wed Nov 13th Modularity, Dissociations, and Double Dissociations

Cain, M.J. (2002). Fodor: Language, mind, and philosophy. Cambridge University Press. (Chapter 7, The Modularity Thesis.)

Shallice, T. (1988). From neuropsychology to mental structure. Cambridge University Press. (Chapter 11, Delusions about dissociations?)

Bedford, F.L. (1997). False categories in cognition: The not-the-liver fallacy. Cognition, 64, 231-248.

Further readings:

Coltheart, M. (1999). Modularity and cognition. Trends in Cognitive Science.

Sternberg, S. (2001) Separate modifiability, mental modules, and the use of pure and composite measures to reveal them. Acta Psychologica, 106, 147-246.

Mon Nov 18th Modularity in Neural Networks

Plaut, D.C. (1995) Double dissociation without modularity: Evidence from connectionist neuropsychology. Journal of Clinical Experimental Neuropsychololology, 17, 291-321.

Bullinaria, J.A. & Chater, N. (1995) Connectionist modelling: Implications for cognitive neuropsychology. Language and Cognitive Processes, 10, 227-264.

Rueckl, J.G., Cave, K.R., & Kosslyn, S.M. (1989). Why are "what" and "where" processed by separate cortical visual. Journal of Cognitive Neuroscience, 1, 171-186.

Wed Nov 20th Modularity of Feature Representations?

Schyns, P.G., Goldstone, R.L., Thibaut, J.P. (1998). The development of features in object concepts. Behavioral and Brain Sciences, 21, 1-17.

Goldstone, R.L. (2000). Unitization during category learning. Journal of Experimental Psychology: Human Perception and Performance, 26, 86-112.

Further readings:

Medin, D.L., Goldstone, R.L., & Gentner, D. (1993). Respects for similarity. Psychological Review, 100, 254-278.

Schyns, P. (1998). Diagnostic recognition: task constraints, object information, and their interactions, 67, 147-179.

Mon Dec 2nd Modularity of Perception and Conception?

Barsalou, L.W., (1999). Perceptual symbol systems. Behavioral and Brain Sciences, 22, 577-660.

Martin, A., Wiggs, C.L., Ungerleider, L.G., Haxby, J.V. (1996). Neural correlates of category-specific knowledge. Nature, 379, 649-52.

Further readings:

Martin, A., Chao, L.L. (2001). Semantic memory and the brain: structure and processes. Current Opinion in Neurobiology, 11,194-201.

Amedi et al. (2001). Visuo-haptic object-related activation in the ventral visual pathway. Nature Neuroscience, 4, 324-30.

James, T.W., Humphrey, G.K., Gati, J.S., Servos, P., Menon, R.S., Goodale, M.A (2002) Haptic study of three-dimensional objects activates extrastriate visual areas. Neuropsychologia, 40,1706-1714.

Wed Dec 4th **Modularity of Memory and Knowledge?**

Rouder, J.N., Ratcliff, R,, & McKoon, G. (2000). A neural network model of implicit memory for object recognition, Psychological Science, 11, 13-19.

Nosofsky, R.M., & Zaki, S.R. (1998). Dissociations between categorization and recognition in amnesic and normal individuals: An exemplar-based interpretation, Psychological Science, 9, 247-255.

Palmeri, T.J., & Flanery, M.A. (1999). Learning about categories in the absence of training: Profound amnesia and the relationship between perceptual categorization and recognition memory. Psychological Science, 10, 526-530.

Mon Dec 9th **Expertise in Object Recognition and Categorization**

Gauthier, I., & Tarr., M.J. (2002). Unraveling mechanisms for expert object recognition: Bridging Brain Activity and Behavior. Journal of Experimental Psychology: Human Perception and Performance, 28, 431-446.

Johansen, M.K., & Palmeri, T.J. (2002). Are there representational shifts in category learning? Cognitive Psychology.

Kanwisher, N. (2000). Domain specificity in face perception. Nature Neuroscience, 3, 759-763.

Further readings:

Moscovitch, M.,. Winocur, G., & Behrmann, M. (1997) What is special about face recognition? Nineteen experiments on a person with visual object agnosia and dyslexia but normal face recognition. Journal of Cognitive Neuroscience, 9(5), 555-604.

Gauthier, I., Tarr, M.J., Anderson A.W., Skudlarski, P. & Gore, J. C. (1999). Activation of the middle fusiform "face area" increases with expertise in recognizing novel objects. Nature Neuroscience, 2(6): 568-573.

Tanaka, J., & Gauthier, I. (1997). Expertise in object and face recognition. The Psychology of Learning and Motivation, 36, 83-125.

Wed Dec 11th **Critiques of Computational Modeling**

Estes, W.K. (2002). Psychonomic Society Keynote Address. Traps in the route to models of memory and decision, Psychonomic Bulletin & Review, 9, 3-25.

Roberts & Paschler (2000) How persuasive is a good fit? A comment on theory testing. Psychological Review, 107, 358-367.

Rodgers, JL, & Rowe, D.C. (2002) Theory development should begin (but not end) with good empirical fits: A comment on Roberts and Pashler. Psychological Review, 109, 599-604.

Uttal, W.R. (1990). On some two-way barriers between models and mechanisms. Perception & Psychophysics, 48, 188-203.