

PHILIP J. KELLMAN

Curriculum Vitae

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EDUCATION

Ph.D., University of Pennsylvania, Experimental Psychology, 1980
M.A., University of Pennsylvania, Experimental Psychology, 1977
B.S., *magna cum laude*, Psychology, Georgetown University, 1976

POSITIONS

Chair, Cognitive Area, UCLA Department of Psychology, 2001-02; 2007-09; 2011 - present
Distinguished Professor of Psychology, University of California, Los Angeles, 2015 - present
Adjunct Professor of Surgery, UCLA David Geffen School of Medicine, 2014 - present
Professor of Psychology, University of California, Los Angeles, 1993 – 2014
Director, UCLA Cognitive Science Research Program, 1993 – 2003
Director, UCLA Psychology Department Honors Program, 1994 -96
Professor of Psychology, Swarthmore College, 1992-93; Associate Professor, 1986-92;
Assistant Professor, 1980-1986
Chair, Division of Natural Sciences and Engineering, Swarthmore College, 1989-91
National Research Council Senior Associate, Aerospace Human Factors Division,
NASA Ames Research Center, 1991-92
Adjunct Professor of Psychology, University of Pennsylvania, 1988-93
Fulbright Senior Scholar, The University of New South Wales, Sydney, Australia, 1987-1988
Visiting Scientist, Psykologiska Institutionen, Uppsala Universitet, Uppsala, Sweden, 1984

SELECTED HONORS AND AWARDS

Fellow, Society of Experimental Psychologists
Fellow, Association for Psychological Science
Fellow, The Psychonomic Society
Distinguished Teaching Award, UCLA Department of Psychology, 2008
Irvin Rock Memorial Lecturer, University of California, Berkeley, 2004
Supervisor: James McKeen Cattell Dissertation Award, New York Academy of Sciences, 2004
(National award given annually for "best dissertation in Psychology" awarded to Evan M. Palmer for
Spatiotemporal reliability in the perception of dynamically occluded objects)
Wolf Aviation Prize, Alfred and Constance Wolf Foundation, 1993

(National award given annually by the for "best new idea benefitting aviation"); awarded for the idea of aviation perceptual learning modules (PLMs)

National Research Council Senior Associateship, 1991-92

Fulbright Senior Scholar, 1987-88

James McKeen Cattell Award, 1988

William Chase Memorial Award, Carnegie-Mellon University, 1987

(National award given biennially for outstanding early career contributions to cognitive science)

Boyd R. McCandless Young Scientist Award, American Psychological Association, 1986

(National award given annually for early career contributions in developmental psychology)

SELECTED INVITED LECTURES

Grand Rounds, UCLA David Geffen School of Medicine, Department of Surgery, July, 2015

Invited Symposium Speaker, Symposium on *Human Mathematical Abilities: From Intuition to the Classroom and Back*, 2015 AAAS Meeting

Keynote speaker, 9th Annual Meeting of the *Configural Processing Consortium*, Long Beach, CA, 2014

Keynote speaker, UCLA Department of Ophthalmology Annual Retreat, Big Bear, CA, 2013

Invited Discussant, Conference on Findings of the National R&D Center for Cognition and Science Instruction, US Dept. of Education, May, 2013.

Keynote speaker, Delaware State Teacher of the Year Awards Ceremony, University of Delaware, April, 2012

Keynote speaker, *Los Angeles Symposium on Educational Reform*, sponsored by New Roads School System, October, 2010; February 2012

Invited Discussant, US Dept. of Education, Institute for Education Sciences, IES R&D Centers Meeting, *Improving Mathematics and Science Outcomes*, 2011

Keynote speaker, *Second Annual Symposium on the Science of Learning in Medical Education*, UCLA David Geffen School of Medicine, October, 2010

Keynote speaker, *Association for Advancement of Artificial Intelligence (AAAI) Symposium on Cognitive Shape Processing*, Stanford University, March, 2010

Invited speaker, *European Conference on Computer Visions (ECCV)*, Symposium on human and computer shape processing, Heraklion, Crete, September, 2010.

RESEARCH GRANTS

Current:

Office of Naval Research (2013-2015), "Combining perceptual and adaptive learning with simulation for training combat medics in hemorrhage control," Role: Co-PI; PI: E. Dutson.

US Dept. of Education, Institute for Education Sciences, *Cognition and Student Learning Program* (2012-2016), "Perceptual and adaptive learning technology in mathematics: Efficacy and Replication" PI: P. Kellman; Co-PI: C. Massey (University of Pennsylvania).

National Science Foundation (NSF) REESE Program (2011-2015), "Adaptive sequencing and perceptual learning technologies in mathematics and science," Role: PI; Co-PI: Christine Massey, University of Pennsylvania.

National Institute of Justice (2010-2014), "Error rates for latent fingerprinting as a function of visual complexity and cognitive difficulty," Role: Co-PI; PI: J. Mnookin.

Selected Earlier Grants and Contracts (since 2004):

Institute for Innovative Technology in Medical Education, "iPAL-GAME (Interactive Perceptual and Adaptive Learning Game-Aided Medical Education): Development and pilot," Role: Co-PI; PI: Sara Kim, 2011-2012; Sally Krasne, 2012.

UCLA Medical School, Center for Advanced Surgical and Interventional Technology (CASIT), (2009-2013), "Perceptual and adaptive learning technology in medical training."

US Dept. of Education, Institute for Education Sciences, Cognition and Student Learning Program R305H060070 (2006-2010), "Integrating conceptual foundations in mathematics through the application of principles of perceptual learning" PI: P. Kellman; Co-PI: C. Massey (University of Pennsylvania).

National Institutes of Health (NIH) ARRA Challenge Grant (2009-2012), "Perceptual and adaptive learning in chemistry education," Role: PI; Co-PI: Arlene Russell, UCLA.

US Army RDECOM (2009-2011), "Adaptive computer-assisted (ACAT) technology for optimal sick call performance," Co-PI; PI: C. Hein.

NSF Research on Learning and Education (ROLE) Program 0231826 (2003 – 2006): "Perceptual Learning in Mathematics and Science: Structure Discovery, Fluency and Integration." PIs: P. Kellman and C. Massey (University of Pennsylvania).

National Eye Institute EY13518 (2001-2005), "Spatial and temporal integration in visual object perception," PI: P. Kellman; Co-PI: Thomas F. Shipley (Temple University).

Office of Naval Research, Multi-University Research Initiative (2001 - 2005), "Integrated decision technology -- Combining and Optimizing Expert Systems, Interfaces and Training." PIs: J. Pearl, A. Darwiche (UCLA Dept. of Computer Science). Co-PIs: R. Dechter, S. Irani, D. Roth, P. Kellman.

NASA Human-Centered Computing Program NRA2-37143, "Multi-media human-computer interfaces for mission-critical systems," (collaborative with NASA/CalTech Jet Propulsion Laboratory). PI: W. Karplus, 2001-2002; P. Kellman, 2002-2004.

PROFESSIONAL AFFILIATIONS

Association for Psychological Science (APS)

Vision Sciences Society (VSS)

The Psychonomic Society

Cognitive Science Society

Configural Processing Consortium (CPC)

Association for Research in Vision and Ophthalmology (ARVO)

Aerospace Medical Association

Aircraft Owners and Pilots Association (AOPA)

Society of Experimental Psychologists

Society for Research in Child Development (SRCD)

SELECTED OTHER PROFESSIONAL ACTIVITIES

- White House Conference on Bridging Neuroscience and Learning, White House Office of Science and Technology Policy (OSTP), February 2015
- Consultant to White House Office of Science and Technology Policy (OSTP) on pull mechanisms in advancing learning technology in STEM education
- Board of Directors, Center for Effective Learning (C4EL), New Roads High School, Santa Monica, CA
- Invited Discussant, US Dept. of Education, Institute for Education Sciences, IES R&D Center Meeting, *Improving Mathematics and Science Outcomes for Middle School Learners*, 2011
- Review Board, Vision Sciences Society, 2000 – present
- Member, Parents Council, Washington University in St. Louis, 2009-2013
- Mentor, Honors Science Mentorship Program, Marlborough School, Los Angeles, CA
- Chair, 2014 and 2007 Configural Processing Consortium (CPC) Annual Meeting
- Founder, Insight Learning Technology, Inc.
- Committee of Visitors* to review the *Cognitive and Behavioral Sciences Division* and the *Human Cognition & Perception Program*, National Science Foundation, 1999
- Member, Panel on *Cognitive Resources for Force-after-Next*, US Dept. of Defense, 1999
- Human factors consultant to CA Attorney General, Exponent Failure Analysis Associates, Inc., Hughes Research Laboratories, Electric Power Research Institute, Merck, Inc., Embry-Riddle Aeronautical University, Federal Aviation Administration; expert witness in numerous legal cases.
- Associate Editor, *Perception & Psychophysics*, 1993-1998
- Panel Member, National Science Foundation Graduate Fellowship Program, 1990-92; 1994-95; 2007
- UCLA Psychology Department positions: Chair, Cognitive Area, 2001 – 2002, 2007-2009; 2011-present; Executive Committee, 1996-1998; 2006 – 2008; Merit Review Committee, 2005 – 2008; Chair, Space Committee, 2000 -2001; Chair, Cognitive Science Major Committee, 1999-2002; Chair, Information Services Committee, 1996-1999
- External Evaluation Committee, Department of Psychology, Gettysburg College, 2000; Department of Psychology, Franklin & Marshall College, 1991
- National Science Foundation Advisory Panel, Human Cognition and Perception Program, Division of Behavioral and Neural Sciences, 1987-1990
- Swarthmore College positions: Chair, Division of Natural Sciences and Engineering, 1989-91; Chair, Computing Services Committee, 1988-89; Chair, Linguistics Search Committee, 1986-87; Sigma Xi Chapter President, 1986-87
- Consultant on NICHD Grant #PHS/HCFA 88-1, "Residential Swimming Pool Protective Systems" to COMSIS Corporation, 1988
- Consultant on US Consumer Product Safety Commission Contract #CPSC-P-87-1143, "Evaluation of Swimming Pool Protective Devices" to COMSIS Corporation, 1987
- Consulting Editor, *Developmental Psychology*, 1986-92
- Grant reviewer for NASA, NSF, NIH, NEI, NIMH, Australian National Research Council

Reviewer for numerous journals, including: *Science*, *Psychological Review*, *Journal of Vision*, *Journal of Experimental Psychology: General*, *Journal of Experimental Psychology: Human Perception & Performance*, *Vision Research*, *Journal of Vision*, *Journal of the Optical Society of America A*, *Perception*, *Proceedings of the National Academy of Sciences*, *Attention, Perception & Psychophysics*, *Psychological Science*, *Spatial Vision*, *Current Directions in Psychological Science*, *Journal of Experimental Child Psychology*, *Child Development*, *Cognitive Development*, *Developmental Psychology*, *Infant Behavior and Development*, *Cognition*, *Cognitive Psychology*, *Cognitive Science*, *Contemporary Psychology*, *Contemporary Psychological Research and Reviews*, *Pragmatics and Cognition*

SELECTED RECENT PRESS / MEDIA / GOVERNMENT COVERAGE

New York Times, 3/2015:

http://www.nytimes.com/2015/03/29/sunday-review/learning-to-see-data.html?_r=0

UCLA Newsroom:

<http://newsroom.ucla.edu/dept/faculty/psychologist-philip-kellman-serves-as-expert-in-white-house-workshop>

UCLA Department of Psychology:

<https://www.psych.ucla.edu/news/highlighting-faculty-member-philip-kellman>

US Dept. of ED, Institute of Education Science, *2012 Director's Report to Congress*

<http://ies.ed.gov/pdf/20126002.pdf>

New York Times, 6/2011:

http://www.nytimes.com/2011/06/07/health/07learn.html?pagewanted=all&_r=0

CBS News: <http://www.cbsnews.com/video/watch/?id=7370719n&tag=mncol;lst;1>

New Scientist: <http://www.newscientist.com/article/mg21328482.100-learning-without-remembering-brain-lab-goes-to-school.html>

E-school News: <http://www.eschoolnews.com/2012/07/24/new-math-software-targets-perceptual-learning/>

National Center for Educational Research (NCER):

<http://ies.ed.gov/ncer/whatsnew/highlights.asp?Date=6/1/2011>

PUBLICATIONS

Books

Arterberry, M.E. & Kellman, P.J. *Development of Perception in Infancy: The Cradle of Knowledge Revisited*, Oxford University Press, expected 2016.

Shipley, T.F. & Kellman, P. J. (Eds.). (2001). *From Fragments to Objects: Segmentation and Grouping in Vision*. Amsterdam: Elsevier Science Press. ISBN 0-444-50506-7.

Kellman, P.J. & Arterberry, M. (1998). *The Cradle of Knowledge: Perceptual Development in Infancy*. Cambridge, MA: MIT Press. ISBN 0-262-11232-9.

Articles and Manuscripts

- Niemann, J.T., Stevens, C.D., Kellman, P.J. & Krasne, S. Mastering ECG Interpretation skills through a perceptual and adaptive learning module. Under review, *Advances in Health Science Education*.
- Son, J., Thai, K-P., Hoffman, J., Devers, C. & Kellman, P. Perceptual learning in early mathematics: Interacting with problem structure improves solving, mapping and fluency. Under review, *Technology, Knowledge and Learning*.
- Carrigan, S.B., Palmer, E.M. & Kellman, P.J. Differentiating global and local contour completion using a dot localization paradigm, Under revision, *Journal of Experimental Psychology: Human Perception and Performance*.
- Mettler, E.M., Massey, C.M. & Kellman, P.J. A comparison of adaptive and fixed schedules of practice. Under revision, *Journal of Experimental Psychology: General*.
- Erlikhman, G. & Kellman, P.J. (in press). Recovery of local edge fragments initiates spatiotemporal boundary formation, *Frontiers in Psychology, Special issue on Perceptual Grouping—the State of the Art*.
- Erlikhman, G. & Kellman, P.J. (in press). Modeling spatiotemporal boundary formation. *Vision Research*, special issue on quantitative approaches in Gestalt perception.
- Thai, K.P., Krasne, S. & Kellman, P.J. (2015). Adaptive perceptual learning in electrocardiography: The synergy of passive and active classification. In Noelle, D. C., Dale, R., Warlaumont, A. S., Yoshimi, J., Matlock, T., Jennings, C. D., & Maglio, P. P. (Eds.) *Proceedings of the 37th Annual Meeting of the Cognitive Science Society*. Austin, TX: Cognitive Science Society, 2350-2355.
- Alibali, M., Kalish, C., Rogers, T.T., Sloutsky, V., Massey, C.M., Kellman, P.J., McClelland, J.L., & Mickey, K.W. (2015). Connecting learning, memory, and representation in math education. In Noelle, D. C., Dale, R., Warlaumont, A. S., Yoshimi, J., Matlock, T., Jennings, C. D., & Maglio, P. P. (Eds.) *Proceedings of the 37th Annual Meeting of the Cognitive Science Society*. Austin, TX: Cognitive Science Society, 19-20.
- Krasne, S., Rimoin, L., Altieri, L., Craft, N. & Kellman, P. (2015). Training pattern recognition of skin lesion morphology, configuration and distribution. *Journal of the American Academy of Dermatology*, 72(3):489-95. doi: 10.1016/j.jaad.2014.11.016. Epub 2015 Jan 13.
- Erlikhman, G., Xing, Y.Z. & Kellman, P.J. (2014). Non-rigid illusory contours and global shape transformations defined by spatiotemporal boundary formation. *Frontiers in Human Neuroscience*.
- Ghose, T., Liu, J. & Kellman, P.J. (2014) Recovering metric properties of objects through spatiotemporal interpolation. *Vision Research*. DOI: 10.1016/j.visres.2014.07.015, published online 8 August 2014.
- Bufford, C.A., Mettler, E., Geller, E.H. & Kellman, P.J. (2014). The psychophysics of algebra expertise: Mathematics perceptual learning interventions produce durable encoding changes. In P. Bello, M. Guarini, M. McShane & B. Scassellati, (Eds.), *Proceedings of the 36th Annual Conference of the Cognitive Science Society*. Austin, TX: Cognitive Science Society.
- Kellman, P.J., Mnookin, J., Erlikhman, G., Garrigan, P., Ghose, T., Mettler, E., Charlton, D. & Dror, I.E. (2014). Forensic comparison and matching of fingerprints: Using quantitative image measures for estimating error rates through understanding and predicting difficulty. *PLoS ONE*, 9(5): e94617.
- Palmer, E. & Kellman, P.J. (2014). The aperture capture illusion: Misperceived forms in dynamic occlusion displays. *Journal of Experimental Psychology: Human Perception and Performance*. 40(2), 502-24.

- Mettler, E.M. & Kellman, P.J. (2014). Adaptive response-time-based sequencing in perceptual learning. *Vision Research*, 99: 111-123.
- Krasne, S., Hillman, J.D., Kellman, P.J. & Drake, T.A. (2013). Applying perceptual and adaptive learning techniques to introductory histopathology for medical students. *Journal of Pathology Informatics*, 4: 34-41.
- Kellman, P. J. (2013). Adaptive and perceptual learning technologies in medical education and training. *Military Medicine*. 178, 10: 98-106.
- Erlikhman, G., Keane, B.P., Mettler, E., Horowitz, T.S., & Kellman, P.J. (2013). Automatic feature-based grouping during multiple object tracking. *Journal of Experimental Psychology: Human Perception and Performance*, 39(6), 1625-37.
- Keane, B.P., Lu, H., Papathomas, T.V., Silverstein, S.M., & Kellman, P.J. (2013). Reinterpreting behavioral receptive fields: Surface filling-in alters visually completed shape. *PLoS ONE*, 8(6), e62505.
- Keane, B.P., Kellman, P.J., Lu, H., & Papathomas, T.V., & Silverstein, S.M. (2012). Is interpolation cognitively encapsulated? Measuring the effects of belief on Kanizsa shape discrimination and illusory contour formation. *Cognition*, 123, 404–418.
- Garrigan, P.B. & Kellman, P.J. (2011). The role of constant curvature in 2D contour shape representations. *Perception*, 40(11): 1290-1308.
- Wise, J. & Kellman, P.J. (2011). Changing the face of learning: Perceptual learning, the path to expert pattern recognition. *California Association of Independent Schools (CAIS) Faculty Newsletter*, Fall, 2011, pp. 4-6.
- Mettler, E., Massey, C. & Kellman, P. (2011). Improving adaptive learning technology through the use of response times. In L. Carlson, C. Holscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*. Boston, MA: Cognitive Science Society, 2532-2537.
- Thai, K.P. & Kellman, P. (2011). Basic information processing effects from perceptual learning in complex, real-world domains. In L. Carlson, C. Holscher, & T. Shipley (Eds.), *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*. Boston, MA: Cognitive Science Society.
- Keane, B. P., Mettler, E.; Tsoi, V., Kellman, P. J. (2011). Attentional signatures of perception: Multiple object tracking reveals the automaticity of contour interpolation. *Journal of Experimental Psychology: Human Perception and Performance*, 37(3), 685-698.
- Kalar, D., Garrigan, P., Hilger, J., Wickens, T. & Kellman, P. (2010). A unified model for contour interpolation. *Vision Research*, 50(3), 284-299.
- Kellman, P.J., Massey, C.M & Son, J. (2010). Perceptual learning modules in mathematics: Enhancing students' pattern recognition, structure extraction, and fluency. *Topics in Cognitive Science* (Special Issue on Perceptual Learning), Vol. 2, Issue 2, 285-305.
- Unuma, H., Hasegawa, H., & Kellman, P. J. (2010). Spatiotemporal integration and contour interpolation revealed by a dot localization task with serial presentation paradigm. *Japanese Psychological Research*, 52(4), 268-280.
- Ghose, T., Liu, J. & Kellman, P.J. (2010). Measuring size of a never present object: Visual object formation through spatio-temporal interpolation. In A. A. Bastianelli, G. Vidotto (Eds.), *Fechner Day 2010. Proceedings of the International Society for Psychophysics*, 2010, 208-212.
- Unuma, H., Kellman, P.J., & Hasegawa, H. (2010). Consideration of geometric and neurophysiological models in visual interpolation. *The Journal of Kawamura Gakuen Women's*

University, Vol.16.

- Kellman, P.J. & Garrigan, P.B. (2009). Perceptual learning and human expertise. *Physics of Life Reviews*, Vol. 6, No. 2, 53-84.
- Palmer, E.M., Brown, C.M., Bates, C.F., Kellman, P.J. & Clausner, T.C. (2009). Perceptual cues and imagined viewpoints modulate visual search in air traffic control displays, *Proceedings of the Human Factors and Ergonomics Society*, Vol. 53, No. 17, 1111-1115.
- Garrigan, P.B. & Kellman, P.J. (2008). Perceptual learning depends on perceptual constancy. *Proceedings of the National Academy of Sciences (USA)*, Vol. 105, No. 6, 2248-2253.
- Fantoni, C., Hilger, J., Gerbino, W. & Kellman, P. J. (2008). Surface interpolation and 3D relatability. *Journal of Vision*, Vol. 8, No. 7, Article 29, 1-19.
- Fantoni, C., Gerbino, W. & Kellman, P.J. (2008). Approximation, torsion, and amodally completed surfaces. *Vision Research*, 48(10): 1196-1216.
- Unuma, H., Hasegawa, H. & Kellman, P.J. (2008). The role of the visual buffer in visual interpolation. *The Journal of Kawamura Gakuen Woman's University*, Vol. 19, No. 1, 55-70.
- Kellman, P.J., Massey, C.M., Roth, Z., Burke, T., Zucker, J., Saw, A., Aguero, K.E. & Wise, J.A. (2008). Perceptual learning and the technology of expertise: Studies in fraction learning and algebra. *Learning Technologies and Cognition: Special issue of Pragmatics & Cognition*, 16:2 (2008), 356–405.
- Palmer, E.M., Clausner, T. C. & Kellman, P.J. (2008). Enhancing air traffic displays via perceptual cues. *ACM Transactions on Applied Perception (TAP)*, Vol. 5(1), 1-22.
- Keane, B. P., Lu, H., & Kellman, P. J. (2007). Classification images reveal spatiotemporal interpolation in illusory figures. *Vision Research*, 47, 3460-3475.
- Kellman, P.J., Garrigan, P.B., Shipley, T.F. & Keane, B.P. (2007). Postscript: Identity and constraints in models of object formation. *Psychological Review*, 114(2): 502-508.
- Kellman, P.J., Garrigan, P.B., Shipley, T.F. & Keane, B.P. (2007). Interpolation processes in object perception: A reply to Anderson. *Psychological Review*, 114(2): 488-502.
- Palmer, E. M., Kellman, P. J., & Shipley, T. F. (2006). A theory of dynamic occluded and illusory object perception. *Journal of Experimental Psychology: General*, 135, 513–541. (Selected for American Psychological Association *Young Investigator Award* – best paper published in *JEP: General* in 2006 by a young investigator (Evan Palmer).)
- Kellman, P.J., Garrigan, P., & Shipley, T. F. (2005). Object interpolation in three dimensions. *Psychological Review*, Vol. 112, No. 3, 586-609.
- Kellman, P.J., Garrigan, P., Yin, C., Shipley, T. & Machado, L. (2005). 3D interpolation in object perception: Evidence from an objective performance paradigm. *Journal of Experimental Psychology: Human Perception & Performance*, 31, 558-583.
- Guttman, S.E. & Kellman, P.J. (2004). Contour interpolation revealed by a dot localization paradigm. *Vision Research*, 44(15), 1799-1815.
- Guttman, S.E., Sekuler, A.B. & Kellman, P.J. (2003). Temporal variations in visual completion: A reflection of spatial limits? *Journal of Experimental Psychology: Human Perception and Performance*, 29, 1211-1227.
- Kellman, P.J. (2003). Perceptual processes that create objects from fragments. *Proceedings of the 2003 IEEE International Joint Conference on Neural Networks*.

- Shipley, T.F. & Kellman, P.J. (2003). Boundary completion in illusory contours: Interpolation or extrapolation? *Perception*, 32(8): 985-999.
- Kellman, P.J. (2003). Interpolation processes in the visual perception of objects. *Neural Networks*, 16, 915-923.
- Kellman, P.J. (2002). Vision - occlusion, illusory contours and 'filling in'. In *Encyclopedia of Cognitive Science*, Oxford, UK: Nature Publishing Group.
- Kellman, P.J. (2001). Separating processes in object perception. *Journal of Experimental Child Psychology*, 78, 84-97.
- Yin, C., Kellman, P.J. & Shipley, T.F. (2000). Surface integration influences depth discrimination. *Vision Research*, 40(15), 1969-1978.
- Kellman, P.J. & Arterberry, M.A. (2000). Learning and developing from innate foundations: Invited commentary on A. Slater's review of *The Cradle of Knowledge*. *British Journal of Educational Psychology*.
- Wise, J.A., Kubose, T., Chang, N., Russell, A. and Kellman, P.J. (2000). Perceptual learning modules in mathematics and science instruction. In D. Lemke (Ed.) Proceedings of the TechEd 2000 Conference, Amsterdam: IOS Press.
- Kellman, P.J., Burke, T. & Hummel, J. (1999). Modeling the discovery of abstract invariants. In Stankewicz, B. & Sanocki, T. (Eds.). *Proceedings of The 7th Annual Workshop on Object Perception and Memory (OPAM)*, 48-51.
- Silva, A.B. & Kellman, P.J. (1999). Perceptual learning in mathematics: The algebra-geometry connection. In Hahn, M. & Stoness, S.C. (Eds.). *Proceedings of the Twenty-First Annual Conference of the Cognitive Science Society*, Mahwah, NJ: Lawrence Erlbaum Associates, 683-688.
- Kellman, P.J., Burke, T. & Hummel, J. (1999). Perceptual learning of abstract invariants. In Hahn, M. & Stoness, S.C. (Eds.). *Proceedings of the Twenty-First Annual Conference of the Cognitive Science Society*, Mahwah, NJ: Lawrence Erlbaum Associates, 264-269.
- Kellman, P.J., Stratechuk, T. & Hampton, S. (1999). Training pilots' pattern recognition skills: Perceptual learning modules (PLMs) in instrument flight training. In Wiggins, M. (Ed.) *Proceedings of the 2nd Annual Embry-Riddle Aeronautical University Flight Instructor Conference*, Daytona Beach, FL: Embry-Riddle University Press.
- Cunningham, D., Shipley, T.F. & Kellman, P.J. (1998). The dynamic specification of surfaces and boundaries. *Perception*, 27(4), 403-415.
- Cunningham, D.W., Shipley, T.F. & Kellman, P.J. (1998). Interactions between spatial and spatiotemporal information in spatiotemporal boundary formation, *Perception & Psychophysics*, 60(5), 839-851.
- Hummel, J. & Kellman, P.J. (1998). Finding the Pope in the pizza: Abstract invariants and constraints in perceptual learning. Commentary on P. Schyns, R. Goldstone, & J. Thibaut, The development of features in object concepts. *Behavioral and Brain Sciences*, 21, 30.
- Kellman, P.J., Yin, C. & Shipley, T.F. (1998). A common mechanism for illusory and occluded object completion. *Journal of Experimental Psychology: Human Perception & Performance*, Vol. 24, No. 3, 859-869.
- Yin, C., Kellman, P.J. & Shipley, T.F. (1997). Surface completion complements boundary interpolation. *Perception*, special issue on surface appearance, 26, 1459-1479.

- Kellman, P.J. (1997). From chaos to coherence: How the visual system recovers objects. *Psychological Science Agenda* of the American Psychological Association, 10(4), 8-9.
- Shipley, T.F. & Kellman, P.J. (1996). Spatiotemporal boundary formation: The role of local motion signals in boundary perception. *Vision Research*, Vol. 37, No. 10, 1281-1293.
- Kellman, P.J. (1995). Infant cognition. In *International Yearbook of Science and Technology*, New York: McGraw-Hill.
- Kellman, P.J. & Kaiser, P.J. (1995). Extracting object motion without distance information: Combining constraints from optic flow and binocular disparity. *Journal of the Optical Society of America (A)*, Vol. 12, No. 3.
- Shipley, T. F. & Kellman, P. J. (1994). Optical tearing in spatiotemporal boundary formation: When do local element motions produce boundaries, form and global motion? *Spatial Vision*, Vol. 7, No. 4, 323-339.
- Shipley, T.F. & Kellman, P.J. (1994). Spatiotemporal boundary formation. *Journal of Experimental Psychology: General*, Vol. 123, No. 1, 3-20.
- Kellman, P.J. & Kaiser, M.K. (1994). Perceptual learning modules in flight training. *Proceedings of the 38th Annual Meeting of the Human Factors and Ergonomics Society*, 1183-1187.
- Slater, A., Johnson, S.P., Kellman, P. & Spelke, E. (1994). The role of three-dimensional depth cues in infants' perception of partly occluded objects. *Early Development*, Vol. 3(3), 187-191.
- Shipley, T. F. Cunningham, D. W., & Kellman, P. J. (1993). Spatiotemporal stereopsis. *Proceedings of the Seventh International Conference on Event Perception and Action*, 279-283.
- Kellman, P.J. & Shipley, T.F. (1992). Visual interpolation in object perception. *Current Directions in Psychological Science*. Volume 1, No. 6, 193-199.
- Shipley, T.F. & Kellman, P.J. (1992). Strength of visual interpolation depends on the ratio of physically-specified to total edge length. *Perception & Psychophysics*, **52**(1), 97-106.
- Hofsten, C. von, Kellman, P.J. & Putaansuu, J. (1992). Young infants' sensitivity to motion parallax. *Infant Behavior & Development*, **15**, 245-264.
- Kellman, P.J. (1992). Perception, conception and self-awareness: A comment on Butterworth. *Psychological Inquiry*.
- Shipley, T.F. & Kellman, P.J. (1992). Perception of partly occluded objects and illusory figures: Evidence for an identity hypothesis. *Journal of Experimental Psychology: Human Perception & Performance*, Vol. **18**, No. 1, 106-120.
- Kellman, P.J. & Shipley, T. (1991). A theory of visual interpolation in object perception. *Cognitive Psychology*, **23**, 141-221.
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PATENTS

- System and Method for Representation of Aircraft Altitude using Natural Perceptual Dimensions*. Inventors: P. Kellman, T. Clausner, E. Palmer. (US PTO# 7408552, awarded, 6/08; assignee: Raytheon Corp.; European patent awarded 3/05.)
- System and Method for Adaptive Learning*. Inventor: P. Kellman. (US PTO #7052277, awarded 4/06.)
- System and Method for Perceptual Learning*. Inventor: P. Kellman (pending).

PRESENTATIONS AT PROFESSIONAL MEETINGS

- Kellman, P.J. Perceptual learning in mathematics. Invited symposium talk, Symposium on *Human Mathematical Abilities: From Intuition to the Classroom and Back*, 2015 AAAS Meeting, San Jose, CA, February, 2015
- Bufford, C.A., Mettler, E., Geller, E. & Kellman, P.J. The psychophysics of algebra expertise: Mathematics perceptual learning interventions produce durable encoding changes. Paper presented at the 2014 meeting of the Cognitive Science Society, July, 2014.
- Thai, K.P., Massey, C.M. & Kellman, P.J. Perceptual learning in mathematics education: Inverse relations and area units. Symposium presentation at the 26th Annual Convention of the Association for Psychological Science, San Francisco, CA: May, 2014.
- Bufford, C.A., Mettler, E., Geller, E. & Kellman, P.J. Capturing mathematics perceptual learning through psychophysics. Poster presented at the 26th Annual Convention of the Association for Psychological Science, San Francisco, CA: May, 2014.
- Thai, K.P., Massey, Krasne, S. & Kellman, P.J. Teaching pattern recognition: Combined effects of perceptual learning and declarative instruction. Poster presented at the 26th Annual Convention of the Association for Psychological Science, San Francisco, CA: May, 2014.

- Krasne, S., Stevens, C. D., Kellman, P., Niemann, J.T. A perceptual and adaptive learning module for training 12-Lead ECG Interpretation. Paper presented at the Association of American Medical Colleges (AAMC) WGEA Regional Conference, University of Hawaii at Manoa, Honolulu, March 22-25, 2014.
- Krasne, S., Stevens, C. D., Kellman, P. J. A continuous assessment tool for teaching and assessing clinical pattern recognition. Poster presented at the 16th Ottawa Conference on Medical Education, Ottawa, Canada, April 25-29, 2014.
- Erlikhman, G., Caplovitz, G., & Kellman, P. Properties of spatiotemporal boundary formation. Poster presented at the 14th Annual Meeting of the Vision Sciences Society, St. Petersburg, FL, May, 2014.
- Ghose, T., Erlikhman, G. & Kellman, P. Perceived occlusion velocity for fully visible and fragmented shapes. Poster presented at the 14th Annual Meeting of the Vision Sciences Society, St. Petersburg, FL, May, 2014.
- Thai, K.P., Krasne, S. & Kellman, P.J. Teaching pattern recognition in medical education: Combined effects of perceptual learning and declarative instruction. David Geffen UCLA Medical School 4th Annual Symposium on the Learning Sciences in Medical Education, November, 2013.
- Kellman, P. Perceptual and adaptive learning technologies in education and training. Paper presented at the 2013 European Conference on Visual Perception (ECVP), Bremen, Germany, August, 2013.
- Ghose, T., Erlikhman, G., Garrigan, P., Kellman, P., Mnookin, J., Dror, I. & Charlton, D. Perception, image processing, and fingerprint matching expertise. Paper presented at the 2013 European Conference on Visual Perception (ECVP), Bremen, Germany, August, 2013.
- Kellman, P. Unifying and applying perceptual learning. Paper presented at *Annual Interdisciplinary Conference*, Jackson, WY, February, 2013.
- Krasne S, Stevens, CD, Kellman, PJ, Craft, N. A tool for teaching pattern recognition in medical education. Paper presented at the Annual Meeting of the American Educational Research Association (AERA). April 27-May 1, 2013.
- Krasne, S., Gu, Z., Burke, T., Kellman, P., Stevens, C. D. Perceptual and adaptive learning modules (PALMs) for training clinical pattern recognition. Poster presented at the Association of American Medical Colleges (AAMC) WGEA/WGSA Regional Conference. University of California, Irvine, May 3-7, 2013.
- Caplovitz, G., Erlikhman, G., Lago, J., & Kellman, P. Neural correlates of spatiotemporal boundary formation (SBF). Poster presented at the 13th Annual Meeting of the Vision Sciences Society, Naples, FL, May, 2013.
- Hasegawa, H., Unuma, H., & Kellman, P.J. Perceptual learning of facial expressions. Poster presented at the 13th Annual Meeting of the Vision Sciences Society, Naples, FL, May, 2013.
- Erlikhman, G., Ghose, T., Garrigan, P., Mnookin, J., Dror, I., Charleton, D., & Kellman, P. Fingerprint matching expertise and its determinants. Poster presented at the 13th Annual Meeting of the Vision Sciences Society, Naples, FL, May, 2013.
- Krasne, S., Burke, T., Kim, S. & Kellman, P.J. Teaching pattern recognition in medical education: A perceptual and adaptive approach. Society of Academic Emergency Medicine, Western Regional Meeting, Long Beach, CA, March, 2012.

- Erlikhman, G., Ghose, T., & Kellman, P. Contours and surfaces affect stereoscopic depth perception in dynamically specified displays. Poster presented at the *12th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2012.
- Kellman, P., Erlikhman, G., Mansolf, M., Fillinich, R., & Iancu, A. Modeling spatiotemporal boundary formation. Poster presented at the *12th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2012.
- Mettler, E., Erlikhman, G., Keane, B., Horowitz, T., & Kellman, P. Further evidence for automatic, feature-based grouping in multiple object tracking. Paper presented at the *12th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2012.
- Papathomas, T., Keane, B., Lu, H., Silverstein, S., & Kellman, P. Measuring the effects of belief on Kanizsa shape discrimination and illusory contour formation: A replication. Poster presented at the *12th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2012.
- Unuma, H., Hasegawa, H., & Kellman, P. Perceptual learning in jigsaw puzzles. Poster presented at the *12th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2012.
- Kellman, P.J. & Erlikhman, G. Modeling spatiotemporal boundary formation. *6th Configural Processing Consortium*, Minneapolis, MN, November, 2012.
- Krasne, S., Gu, Z., Burke, T., Kim, S., Kellman, P. Seeing the forest for the trees: Training clinical pattern recognition. Paper presented at the 2012 Association of American Medical Colleges *Research in Medical Education Conference, (AAMC RIME)*, November 2-7, 2012.
- Krasne S., Burke T., Kim S., Kellman P.J. Teaching pattern recognition in medical education: A perceptual and adaptive learning approach. Paper presented at the *15th Ottawa Medical Education Conference*. Kuala Lumpur, Malaysia, March, 2012.
- Rimoin L., Burke T., Craft N., Krasne S., Kellman P.J. Perceptual and adaptive learning technology in medical education: The efficacy of pattern recognition in teaching dermatology to medical students. Poster presented at the *15th Ottawa Conference on Medical Education*, Kuala Lumpur, Malaysia, March, 2012.
- Kellman, P.J. Adaptive and perceptual learning technology in medical education and training. *Conference on Designing and Using Computer Simulations in Medical Education*, Los Angeles, CA, May, 2011.
- Kellman, P. Stronger climbers or smaller mountains? Discussion of IES-funded centers. Invited symposium presentation, *Society for Research on Educational Effectiveness (SREE)*, September, 2011.
- Kellman, P. Unifying perceptual learning. Invited symposium presentation, *Asia-Pacific Conference on Vision (APCV)*, July, 2011.
- Krasne, S., Hillman J., Rimoin, L., Burke, T., Kim, S., Drake, T., Craft, N. & Kellman, P. Teaching pattern recognition in medical education: A perceptual and adaptive learning approach. Poster presented at the Third Annual Symposium on the Learning Sciences in Medical Education, UCLA Medical School, November, 2011.
- Erlikhman, G., Ghose, T. & Kellman, P. Spatiotemporal contour interpolation in four dimensions. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Keane, B., Silverstein, S. & Kellman, P. Achromatic surface color depends on filling in shape. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Unuma, H., Hasegawa, H. & Kellman, P.J. A comparison of object interpolation in complex

- motions. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Garrigan, P. & Kellman, P.J. Constant curvature parts-based representation of contour shape. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Thai, K.P. & Kellman, P.J. Basic information processing effects from perceptual learning in complex, real-world domains. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Mettler, E., Keane, B., Erlikhman, G., Horowitz, T., & Kellman, P. Automatic feature-based grouping during multiple object tracking. Poster presented at the *11th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2011.
- Kellman, P.J. Perceptual and adaptive learning technologies in medical learning. *AIBS Onsite Review: The Application of Novel Technologies in Computer-Mediated Medicine*, University of California, Los Angeles Center for Advanced Surgical and Interventional Technology, July, 2010.
- Kellman, P.J. From early visual mechanisms to contours and objects. *5th Configural Processing Consortium*, St. Louis, MO, November, 2010.
- Kellman, P.J. Perceiving and representing contours and objects: Segmentation, grouping and shape. Invited symposium presentation, Shape Processing Workshop, European Conference on Computer Vision (ECCV), Crete, Greece, September, 2010.
- Kellman, P.J. Visual perception of contours and objects: segmentation, grouping, and shape. Association for Advancement of Artificial Intelligence (AAAI) Symposium on Cognitive Shape Processing, Stanford University, March, 2010
- Mettler, E., Lu, H. & Kellman, P. Abstract perceptual learning of hidden patterns. Poster presented at the *Annual Meeting of the Cognitive Science Society*, July, 2010.
- Mettler, E. & Kellman, P.J. Adaptive sequencing in perceptual learning, Paper presented at the *10th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2010.
- Keane, B. & Kellman, P.J. Evidence for a modular filling-in process during contour interpolation. Paper presented at the *10th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2010.
- Unuma, H., Hasegawa, H. & Kellman, P.J. Interpolation of expanding/contracting objects behind an occluding surface. Paper presented at the *10th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2010.
- Kellman, P.J. Mystics and bookkeepers: Contrasting approaches to perceptual organization. *4th Configural Processing Consortium Annual Meeting*, November, 2009.
- Kellman, P.J., Burke, T., & Massey, C. Adaptive sequencing technology in item and category learning. Invited symposium talk, *Cognitive Development Society Annual Meeting*, San Antonio, TX: October, 2009.
- Kellman, P.J., Massey, C., Roth, Z., & Burke, T., Building expertise in mathematics through perceptual learning technology, Invited symposium talk, *Association for Psychological Science Annual Meeting*, San Francisco, CA: May, 2009.
- Ghose, T., Liu, J. & Kellman, P.J. Recovering metric object properties through spatiotemporal interpolation: What is the size of an object that is never present in the stimulus? *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009.
- Mettler, E. & Kellman, P.J. Unconscious and abstract perceptual learning of hidden patterns, *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009.
- Unuma, H., Hasegawa, H. & Kellman, P.J. (2009). Strength of contour interpolation behind a

- moving occluder revealed by a dot localization task. *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009
- Kellman, P.J., Keane, B., Lu, H. & Kellman, P.J. (2009). Filled-in regions influence real and interpolated shape via lightness induction. *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009.
- Keane, B. P., Mettler, E., & Kellman, P. J. (2009). Contour interpolation automatically directs attention in multiple object tracking. *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009.
- Palmer, E., Brown, C., Bates, C., Clausner, T., & Kellman, P. (2009). Imagined perspective modulates cue effectiveness in visual search of air traffic control displays. *9th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2009.
- Clausner, T.C., Palmer, E.M., Brown, C.M., Bates, C.F. & Kellman, P.J. (2009). Conceptualization of perceptual cues guided by metaphor, depth, and imagined perspective. *Abstracts of the 50th Annual Meeting of the Psychonomic Society* (p. 102), Boston, MA.
- Mettler, E. & Kellman, P. Adaptive sequencing in perceptual learning. (2009). *Abstracts of the 50th Annual Meeting of the Psychonomic Society* (p. 88), Boston, MA.
- Kellman, P.J. 3D and spatiotemporal object and surface formation. *AFOSR Workshop on Full-Cue Surface Representation in Mid-Level Vision*, San Francisco, CA, October, 2008.
- Clausner, T.C., Palmer, E.M. & Kellman, P.J. Conceptualization in language and its relation to perception. Paper presented at the *30th Annual Conference of the Cognitive Science Society*, Austin, TX, July, 2008.
- Son, J., Massey, C., Roth, Z., Longmire, W., Burke, T., Zucker, J. & Kellman, P. J. (2008). Perceptual learning in mathematics education. Poster presented at the *30th Annual Conference of the Cognitive Science Society*, Austin, TX, July, 2008.
- Massey, C.M., Kellman, P.J., Roth, Z., Burke, T., Longmire, W. & Son, J. Perceptual learning in mathematics education. Poster presented at the *Institute of Educational Sciences Investigators Annual Meeting*, Washington, D.C., June, 2008.
- Hilger, J.D. & Kellman, P.J. Misalignment constraints on visual interpolation, *8th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2008.
- Unuma, H., Hasegawa, H. & Kellman, P.J. Contour and surface integration behind moving occluder, *8th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2008.
- Mettler, E., Keane, B. & Kellman, P.J. Contour interpolation affects multiple object tracking, *8th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2008.
- Keane, B., Lu, H. & Kellman, P.J. Contour interpolation and lightness induction mechanisms interact to produce classification image features in a shape discrimination task, *8th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2008.
- Palmer, E., Clausner, T. & Kellman, P.J. Visual search in air traffic control: Altitude correlated depth cues enhance conflict detection, *8th Annual Meeting of the Vision Sciences Society*, Naples, FL, May, 2008.
- Kellman, P.J. A computational Gestalt agenda for perception and learning. Invited address, *2nd Annual Meeting of the Configural Processing Consortium*, Long Beach, CA, November, 2007.
- Kellman, P.J., Zucker, J. & Massey, C.M. Dynamic sequencing in computer-based learning technology: Optimizing efficiency for item memory and perceptual learning. *American Psychological Association 2007 Annual Convention*, San Francisco, CA, August, 2007.

- Kellman, P.J., Massey, C.M., Roth, Z., Burke, T., Zucker, J., Carpenter, D. & Mettler, E.
Integrating conceptual foundations in mathematics. Poster presented at the *Institute of Educational Sciences Investigators Annual Meeting*, Washington, D.C., June, 2007.
- Kellman, P.J. Abstract relations in perception and perceptual learning. Invited Address, *11th International Conference on Cognitive and Neural Systems (ICCNS)*, Boston, MA, May, 2007.
- Keane, B., Lu, H. & Kellman, P.J. Classification images of spatiotemporal illusory figures: Interpretations and implications. Symposium presentation in “Classification Imaging in Vision Research,” *7th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2007.
- Keane, B., Kellman, P.J. & Elwell, C. Classification images reveal differences between spatial and spatiotemporal contour interpolation. Poster presented at the *7th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2007.
- Unuma, H., Hasegawa, H. & Kellman, P.J. (2007). Spatiotemporal interpolation behind moving occluder. Poster presented at the *7th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2007.
- Mettler, E. & Kellman, P.J. Unconscious discovery in concrete and abstract perceptual learning. Paper presented at the *47th Annual Meeting of the Psychonomic Society*, Houston, TX, Nov., 2006.
- Kellman, P.J. Abstract relations in perception and perceptual learning. *Annual Meeting of the Configural Processing Consortium*, Houston, TX, November, 2006.
- Hilger, J.D., Fantoni, C., Gerbino, W. & Kellman, P.J. Surface interpolation and slant anisotropy. Poster presented at the *6th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2006.
- Keane, B.P. & Kellman, P.J. Classification images reveal interpolation in dynamic displays. Poster presented at the *6th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2006.
- Unuma, H., Hasegawa, H. & Kellman, P.J. Spatiotemporal contour interpolation and shape discrimination. Poster presented at the *6th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2006.
- Fantoni, C., Gerbino, W. & Kellman, P. Amodal unification of surfaces with torsion requires visual approximation. *Paper presented at the 2005 European Conference on Visual Perception*, August, 2005.
- Garrigan, P. & Kellman, P.J. Contour shape effects on search performance: Evidence for constant curvature coding. Poster presented at the *5th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2005.
- Kalar, D.J., Garrigan, P. & Kellman, P.J. Second-order contour discontinuities in segmentation and shape representation. Poster presented at the *5th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2005.
- Fantoni, C., Hilger, J.D., Gerbino, W. & Kellman, P.J. Surface interpolation and 3D relatability. Poster presented at the *5th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2005.
- Hilger, J.D. & Kellman, P.J. (2005). Tolerance for misalignment in contour interpolation: retinal or relational? Poster presented at the *5th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2005.
- Kellman, P. & Massey, C. Perceptual learning techniques in middle and high school mathematics. Poster presented at the *Annual Meeting of Principal Investigators in the Division of Research and Evaluation*, Education and Human Resources Directorate, National Science Foundation, Washington, D.C., October, 2004.

- Kellman, P. & Garrigan, P. Is perceptual learning constrained to operate through perceptual (not sensory) representations? Poster presented at the *4th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2004.
- Fantoni, C., Gerbino, W., & Kellman, P. Approximation, torsion, and amodally-unified surfaces. Poster presented at the *4th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2004.
- Hass, R.W., Shipley, T.F., & Kellman, P.J. Decrease in illusory contour completion with retinal eccentricity is not due to loss of phase information. Poster presented at the *4th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2004.
- Kalar, D.J., Garrigan, P., Kellman, P., & Wickens, T.D. A unified operator for contour interpolation. Poster presented at the *4th Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2004.
- Kellman, P.J., Garrigan, P., Kalar, D. & Shipley, T.F. Good continuation and relatability: Related but distinct principles of perceptual organization. Paper presented at the *Third Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2003.
- Garrigan, P. & Kellman, P.J. Perceptual learning uses interpreted perceptual representations. Paper presented at the 11th Annual Workshop on Object Perception and Memory (OPAM), Vancouver, BC, November, 2003.
- Kellman, P. Perceiving and learning about structure. APA 2003 Mentor Award Symposium: A Tribute to Rochel Gelman, *American Psychological Association 2003 Convention*, Toronto, August, 2003.
- Kellman, P.J. Perceptual processes that create objects from fragments. Invited symposium presentation, *International Joint Conference on Neural Networks*, Portland, OR, July, 2003.
- Kellman, P.J., Garrigan, P., Kalar, D. & Shipley, T.F. Good continuation and relatability: Related but distinct principles of perceptual organization. Paper presented at the *Third Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2003.
- Shipley, T.F. & Kellman, P.J. Retinal anisotropies in illusory contour formation. Poster presented at the *Third Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2003.
- Palmer, E. & Kellman, P.J. (Mis)Perception of motion and form after occlusion: Anorthoscopic perception revisited. Poster presented at the *Third Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2003.
- Guttman, S.E., Kellman, P.J. & Sekuler, A.B. Temporal variations in visual completion: A reflection of spatial limits? Poster presented at the *Third Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2003.
- Palmer, E. & Kellman, P.J. Underestimation of velocity after occlusion causes the aperture-capture illusion. Poster presented at the *Second Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2002.
- Garrigan, P. & Kellman, P.J. Three-dimensional contour interpolation: Testing the 90-degree constraint. Poster presented at the *Second Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2002.
- Guttman, S.E. & Kellman, P.J. Do spatial factors influence the microgenesis of illusory contours? Poster presented at the *Second Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2002.
- Cook, R., Mockrin, M., Blaisdell, A. & Kellman, P. Structure from motion effects in pigeons. *International Conference On Comparative Cognition*, Melbourne Beach, FL, March, 2002

- Kellman, P.J. Integration and interpolation in the visual perception of objects. Invited lecture, *6th International Conference on Cognitive and Neural Sciences*, Boston University, 2002
- Palmer, E. & Kellman, P.J. (2001). The aperture capture effect: Misperceived forms in dynamic occlusion displays. Paper presented at the *First Annual Meeting of the Vision Sciences Society*, Sarasota, FL, May, 2001.
- Guttman, S.E. & Kellman, P.J. (2001). Contour interpolation: necessary but not sufficient for the perception of interpolated contours. Paper presented at the First Annual Meeting of the Vision Sciences Society, Sarasota, FL, May, 2001.
- Choplin, J., Huttenlocher, J. & Kellman, P.J. Perceptual discrimination and memory. Paper presented at the First Annual Meeting of the Vision Sciences Society, Sarasota, FL, May, 2001.
- Kellman, P.J. Object perception from information that is fragmentary across space and time: A theoretical overview. Invited symposium presentation, *24th International Congress of Psychology*, Stockholm, Sweden, July, 2000.
- Kellman, P.J. Four dimensions and three levels in models of object perception. Invited symposium presentation, *31st Carnegie-Mellon Symposium on Cognition*, June, 2000.
- Kellman, P.J., Burke, T. & Hummel, J. Modelling the discovery of abstract invariants. *7th Annual Workshop on Object Perception and Memory (OPAM)*, Los Angeles, CA, Nov., 1999.
- Kellman, P.J. Understanding and creating expertise through perceptual learning. Invited lecture, *NSF Symposium on Technology in Undergraduate Education*, July, 1999.
- Kellman, P. J. Visual grouping in three dimensions. Invited symposium presentation, *Association for Research in Vision and Ophthalmology Annual Meeting*, Ft. Lauderdale, FL, May, 1999.
- Silva, A. B. & Kellman, P.J. Perceptual learning in mathematics: The algebra-geometry connection. Poster presented at *NSF LIS Investigators Conference*, Washington, D.C., April, 1999.
- Kubose, T., Kellman, P.J., Gelman, R. & Wise, J. Perceptual learning in mathematics: Mapping across multiple representations. Poster presented at *NSF LIS Investigators Conference*, Washington, D.C., April, 1999.
- Russell, A. & Kellman, P.J. Perceptual learning in chemistry. Poster presented at *NSF LIS Investigators Conference*, Washington, D.C., April, 1999.
- Russell, A. & Kellman, P.J. What difference does it make? Assessing the effects of the molecular science project learning strategies. *218th American Chemical Society National Meeting*, New Orleans, LA: August, 1999.
- Kellman, P.J., Stratechuk, T. & Hampton, S. Training pilots' pattern recognition skills: Perceptual learning modules (PLMs) in instrument flight training. *Second Annual Embry-Riddle Aeronautical University Flight Instructor Conference*, Daytona Beach, FL, April, 1999.
- Cook, R. & Kellman, P.J. Object perception in humans and avians. Invited lecture, *American Psychological Association Annual Convention*, San Francisco, CA, August, 1998.
- Kellman, P.J. How the world gets to the mind: Constraints and processes in visual object perception. *Center for Visual Science Symposium*, University of Rochester, June, 1998.
- Russell, A.A. & Kellman, P.J. Teaching automatic, 3-D recognition of chemical structures, *American Chemical Society Meeting*, Dallas, Texas, March, 1998.
- Palmer, E., Kellman, P. J. & Shipley, T.F. Effects of velocity in dynamic object completion. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, Ft. Lauderdale, FL, April, 1998.

- Kellman, P.J. Perceptual learning and expertise. Paper presented at the *Second International Conference on Human Performance*. Temecula, CA, March, 1998.
- Yin, C., Kellman, P.J. & Shipley, T.F. Surface and edge interactions in the perception of partly occluded objects. Poster presented at the *38th Annual Meeting of the Psychonomic Society*, Philadelphia, PA, November, 1997.
- Kellman, P.J., Yin, C. & Shipley, T.F. 3-D relatability determines 3-D object completion. Paper presented at the *38th Annual Meeting of the Psychonomic Society*, Philadelphia, PA, November, 1997.
- Cunningham, D.W., Shipley, T.F. & Kellman, P.J. The roles of spatial and spatiotemporal surface information in spatiotemporal boundary formation. Poster presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, Ft. Lauderdale, FL, April, 1997.
- Palmer, E., Kellman, P. J. & Shipley, T.F. Spatiotemporal relatability in dynamic object completion. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, Ft. Lauderdale, FL, April, 1997.
- Kellman, P.J., Shipley, T.F. & Kim, J. Global and local effects in object completion: Evidence from a boundary localization paradigm. Paper presented at the *37th Annual Meeting of the Psychonomic Society*, St. Louis, MO, November, 1996.
- Kellman, P.J. Visual perception of objects and boundaries: A 4-dimensional approach. Invited lecture, *Hans-Lukas Teuber Memorial Symposium*, Massachusetts Institute of Technology, October, 1996.
- Kellman, P.J. Boundary and surface completion in visual object perception. Invited lecture, Image Segmentation Symposium, *1996 Meeting of the Optical Society of America*, Rochester, NY, October, 1996.
- Kellman, P.J. & Shipley, T.F. Depth and motion in object completion. Paper presented at the *European Conference on Visual Perception*, Strasbourg, France, September, 1996.
- Kellman, P.J. An update on Gestalt Psychology. Invited lecture, *Gleitman Festschrift*, University of Pennsylvania, June, 1996.
- Kellman, P.J. The third and fourth dimensions in object perception: Some considerations for next-generation models. Invited lecture, *NEC Institute Summer Symposium*, Princeton, NJ, June, 1996.
- Yin, C., Kellman, P.J. & Shipley, T.F. Surface completion: Evidence from a depth discrimination paradigm. Poster presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, Ft. Lauderdale, FL, April, 1996.
- Cunningham, D.W., Shipley, T.F. & Kellman, P.J. Spatiotemporal boundary formation: The role of global motion signals. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, Ft. Lauderdale, FL, April, 1996.
- Kellman, P.J., Machado, L., Shipley, T.F. & Li, C.C. 3-D determinants of object completion. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, April, 1996.
- Shipley, T.F., Cunningham, D.W. & Kellman, P.J. Perceptual boundary completion: Interpolation of extrapolation? Paper presented at the *36th Annual Meeting of the Psychonomic Society*, Los Angeles, CA, November, 1995.

- Yin, C. & Kellman, P.J. Probing representations of occluded surfaces with a bistable apparent motion paradigm. Poster presented at the *36th Annual Meeting of the Psychonomic Society*, Los Angeles, CA, November, 1995.
- Mather, R., Sinha, S., Sinha, U., Hall, T., Kellman, P.J. & Kangaroo, H. Interactive teaching module integrated with picture archiving and communication systems (PACS), radiology information systems (RIS) and hospital information systems (HIS). Paper presented at the *81st Annual Meeting of the Radiological Society of North America*, November, 1995.
- Mather, R., Sinha, S., Sinha, U., Hall, T., Kellman, P.J. & Kangaroo, H. Development of perceptual skills in the differential diagnosis of congenital heart disease from chest radiographs using an interactive teaching module. Poster presented at the *81st Annual Meeting of the Radiological Society of North America*, November, 1995.
- Yin, C., Kellman, P.J. & Shipley, T.F. A surface spreading process complements boundary interpolation under occlusion. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, 1995.
- Kellman, P.J., Yin, C. & Shipley, T.F. A common mechanism for illusory and occluded figure completion: Evidence from hybrid displays. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, 1995.
- Shipley, T.F., Cunningham, D.W. & Kellman, P.J. Perception of stability in dynamic scenes. Paper presented at the *35th Annual Meeting of the Psychonomic Society*, Washington, D.C., November, 1994.
- Kellman, P.J. & Kaiser, M.K. Perceptual learning modules in flight training. Paper presented at the *Annual Meeting of the Human Factors and Ergonomics Society*, Nashville, TN, October, 1994.
- Shipley, T.F. & Kellman, P.J. Spatiotemporal boundary formation: Evidence for recovery of shape and motion from local motion signals. Poster presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, 1994.
- McBeath, M. & Kellman, P.J. Optimal defensive positioning to limit basketball shooting accuracy. Paper presented at the *34th Annual Meeting of the Psychonomic Society*, Washington, D.C., November, 1993.
- Shipley, T.F. & Kellman, P.J. Competition and cooperation in spatiotemporal boundary formation. Paper presented at the *34th Annual Meeting of the Psychonomic Society*, Washington, D.C., November, 1993.
- Shipley, T., Cunningham, D. & Kellman, P.J. Spatiotemporal stereopsis. Paper presented at the *7th International Conference on Event Perception & Action*, Vancouver, British Columbia, Canada, August, 1993.
- Kellman, P.J. Perceiving objects across gaps in space and time. Invited presentation, *Conference on Object Representation in Visual and Haptic Systems*, Madrid, Spain, May, 1993.
- Shipley, T.F. & Kellman, P.J. Spatiotemporal boundary formation: Temporal integration occurs within a fixed 150 msec window. Poster presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, April, 1993.
- Monterosso, J., Kellman, P.J. & Shipley, T.F. 3-D determinants of object perception under occlusion. Paper presented at the *33rd Annual Meeting of the Psychonomic Society*, St. Louis, November, 1992.
- Shipley, T.F. & Kellman, P.J. Spatiotemporal boundary formation: Evidence for a fixed temporal window for information integration. Paper presented at the *33rd Annual Meeting of the Psychonomic Society*, St. Louis, November, 1992.

- Shipley, T.F. & Kellman, P.J. Constraints on spatiotemporal boundary formation. Paper presented at the annual meeting of the *Association for Research in Vision and Ophthalmology*, 1992.
- Kaiser, M.K., Kellman, P.J., Banks, M.S. & Aiken, W. Perception of target motion by passively moving observers. Paper presented at the *33rd Annual Meeting of the Psychonomic Society*, St. Louis, November, 1992.
- Vishton, P., Kellman, P.J. & Shipley, T.F. Scene perception under dynamic occlusion. Paper presented at the *32nd Annual Meeting of the Psychonomic Society*, San Francisco, CA, November, 1991.
- Shipley, T.F. & Kellman, P.J. Spatiotemporal boundary formation. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, May, 1991.
- Shipley, T.F. & Kellman, P.J. Spatiotemporal interpolation in object perception: Some new phenomena. Paper presented at the *31st Annual Meeting of the Psychonomic Society*, New Orleans, LA, November, 1990.
- Shipley, T.F. & Kellman, P.J. Perception of partly occluded objects and subjective figures: Evidence for a common process. Paper presented at the *Annual Meeting of the Association for Research in Vision and Ophthalmology*, 1990.
- Kellman, P.J., VandeWalle, G., von Hofsten, C. & Condry, K. Perception of motion and stability during observer motion by pre-stereoscopic infants. Paper presented at the *7th International Conference on Infant Studies*, Montreal, Canada, April, 1990.
- Kellman, P.J. & Shipley, T.F. Visual interpolation in the third and fourth dimensions. Paper presented at the *30th Annual Meeting of the Psychonomic Society*, Atlanta, Georgia, November, 1989.
- Kellman, P. Perceiving motion and stability in infancy. Invited paper, *Fifth International Conference on Event Perception and Action*, Miami, Ohio, July, 1989.
- Kellman, P., Power, L. & Shipley, T.F. Visual interpolation in object perception: Evidence from a kinematic occlusion paradigm. Paper presented at the *Fifth International Conference on Event Perception and Action*, Miami, Ohio, July, 1989.
- Kellman, P. Kinematic foundations of infant visual perception. Invited paper, *1989 Carnegie-Mellon Symposium on Cognition*, Pittsburgh, Pennsylvania, June, 1989.
- Shipley, T.F. & Kellman, P.J. Discontinuity theory and the perception of illusory figures. Paper presented at the *29th Annual Meeting of the Psychonomic Society*, Chicago, November, 1988.
- Kellman, P.J. & Shipley, T.F. Interpolation processes in visual object perception: Evidence for a discontinuity theory. Paper presented at the *28th Annual Meeting of the Psychonomic Society*, Seattle, November, 1987.
- Kellman, P.J. Objects, motion and stability in the world of the (moving) infant. Symposium presentation, *Biennial Meeting of the Society for Research in Child Development*, Baltimore, April, 1987.
- Kellman, P.J. Seeing behind and between: Interpolation processes in the visual perception of objects. Invited presentation, *1986 Cornell Symposium on Induction in Perception and Cognition*, Ithaca, NY, August, 1986.
- Kellman, P.J. & Short, K.R. The more things change, the more they stay the same: Infant perception of three-dimensional form from optical changes given by observer movement. Paper presented at the *Fifth Biennial International Conference on Infant Studies*, Los Angeles, California, April, 1986.

- Kellman, P.J. & Loukides, M.G. Configuration and brightness as causal factors in subjective contours: Two direct tests. Invited presentation at the *1985 Adelpi Conference on Illusory Contours*, Garden City, New York, November, 1985.
- Kellman, P.J. & Loukides, M.G. Approaching the edge: An object perception analysis of static and kinetic subjective contours. Invited presentation at the *1985 Adelpi Conference on Illusory Contours*, Garden City, New York, November, 1985.
- Kellman, P.J. Theories of perception and research in perceptual development. Invited discussion, *20th Minnesota Symposium on Child Psychology*, Minneapolis, Minnesota, October, 1985.
- Kellman, P.J., von Hofsten, C. & Soares, J. Principles of infant event perception: Concurrent motion as a specifier of translation in depth. Paper presented at the *Third International Conference on Event Perception and Action*, Uppsala, Sweden, June, 1985.
- Kellman, P., & Short, K.R. Infant perception of partly occluded objects: the problem of rotation. Paper presented at the *Third International Conference on Event Perception and Action*, Uppsala, Sweden, June, 1985.
- Kellman, P. J. An event perception approach to infant perception. Invited address, *Third International Conference on Event Perception and Action*, Uppsala, Sweden, June, 1985.
- Kellman, P.J., & Short, K.R. Infant form perception from perspective transformations. Paper presented at the *Biennial Meeting of the Society for Research in Child Development*, Toronto, Canada, April, 1985.
- Kellman, P.J., von Hofsten, C., & Soares, J. Concurrent motion in infant event perception. Paper presented at the *Biennial Meeting of the Society for Research in Child Development*, Toronto, Canada, April, 1985.
- Kellman, P. J. Kinetic subjective contours. Paper presented at the *Second International Conference on Event Perception*, Nashville, Tennessee, 1983.
- Kellman, P. J. Perception of three-dimensional form in infancy. Paper presented at the *Biennial Meeting of the Society for Research in Child Development*, Detroit, April, 1983.
- Kellman, P. J. & Spelke, E. S. Infants' perception of partly occluded objects: Sensitivity to movement and configuration. Paper presented at the *Biennial Meeting of the Society for Research in Child Development*, Boston, April, 1981.
- Kellman, P. J. & Spelke, E. S. Infants' perception of partly occluded objects. Paper presented at the *Biennial Meeting of the Society for Research in Child Development*, San Francisco, March, 1979.
- Carter, D. E., Kellman, P. J. & Geraghty, J. A. Acquisition and transfer of symbolic hue oddity learning by pigeons. Paper presented at the *Annual Meeting of The American Psychological Association*, August 1978.
- Carter, D. E., Geraghty, J. A., & Kellman, P. J. Is delayed matching performance by pigeons analogous to human short-term memory? Paper presented at the *Eastern Psychological Association Convention*, April, 1976.

SELECTED INVITED LECTURES AND COLLOQUIA

[ADD SYMPOSIUM AT COGNITIVE SCIENCE]

Invited Symposium Speaker, Human mathematical abilities: From intuition to the classroom and back, 2015 AAAS Meeting, San Jose, CA, February, 2015.

Invited Speaker, Stanford University, Center for the Study of Language and Information (CSLI), Workshop on Cognitive Science and Mathematics Education, February, 2015.
 Northwestern University, Department of Psychology, February, 2014
 Technical University of Kaiserslautern, Kaiserslautern, Germany, Department of Psychology, August, 2013
 Delaware State Teacher of the Year Awards Ceremony, University of Delaware, April, 2012
 University of Nevada, Reno, Department of Psychology, September, 2012
 University of Delaware, Learning Technology Group, April, 2012
 Cognitive Science Seminar, University of California, San Diego, March, 2012
 Second Annual Symposium on the Science of Learning in Medical Education, UCLA School of Medicine, October, 2010
 Los Angeles Symposium on Educational Reform, sponsored by New Roads School System, October, 2010
 Shape Processing Workshop, European Conference on Computer Vision (ECCV), Crete, Greece, September, 2010.
 Association for Advancement of Artificial Intelligence (AAAI) Symposium on Cognitive Shape Processing, Stanford University, March, 2010
 Science Exchange Lecturer, The Marlborough School, Los Angeles, CA, Feb., 2010
 University of Pennsylvania, Institute for Research in Cognitive Science (IRCS), Dec., 2009
 California Institute of Technology, Cognition and Neural Systems Group, June, 2008
 Indiana University, Department of Psychology, March, 2008
 Purdue University, Department of Psychology, March, 2008
 Keynote address, Configural Processing Consortium, Long Beach, CA, 2007
 Eleventh International Conference on Cognitive and Neural Systems, Center for Cognitive and Neural Systems, Boston University, 2007
 Configural Processing Consortium, Houston, TX, 2006
 PSI CHI Distinguished Lecture, Georgetown University, Department of Psychology, 2005
 Irvin Rock Memorial Lecture, UC Berkeley, 2004
 International Joint Conference on Neural Networks, Portland, OR, 2003
 International Conference on Cognitive and Neural Systems, Center for Cognitive and Neural Systems, Boston University, 2002
 University of Chicago, Department of Psychology, October, 2000
 International Congress of Psychology, Stockholm, Sweden, July, 2000
 Office of Naval Research, MURI Kickoff Meeting, July, 2000
 31st Carnegie-Mellon Symposium on Cognition, June, 2000
 University of Arizona, Department of Psychology, January, 2000
 Keck Foundation Mathematics and Science Institute, Santa Monica, CA, December, 1999
 NSF Symposium on Technology in Undergraduate Education, July, 1999
 HRL Laboratories, Malibu, CA, November, 1998
 Electrical Power Research Institute (EPRI), Palo Alto, CA, August, 1998
 American Psychological Association Annual Convention, Board of Scientific Affairs, San Francisco, CA, August, 1998
 University of Rochester, Center for Visual Science (CVS) Symposium, June, 1998
 U. of Southern California, Symposium on Learning and Object Recognition, Feb., 1998
 NYU/NECI Symposium on Perceptual Learning and Development, February, 1998
 Merck & Co., Inc., Rahway, NJ, December, 1997
 California Institute of Technology, Cognitive and Neural Systems, October, 1997

University of California, San Diego, Department of Psychology, April, 1997
University of Rochester, Center for Visual Science, February, 1997
Georgetown University, Department of Psychology, February, 1997
Massachusetts Institute of Technology, Hans Lukas Teuber Memorial Symposium, October,
1996
Harvard University, Vision Sciences Group, October, 1996
University of California, Santa Barbara, Department of Psychology, June 1996
University of Pennsylvania, Gleitman Festschrift, June, 1996
NEC Research Institute Symposium, Princeton, NJ, June, 1996