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Engineering & Scientific Consulting

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Professional Profile

Dr. Madeleine Keehner is a cognitive psychologist with expertise in human factors and user research, grounded in knowledge of human-computer interaction, working memory, visual-spatial reasoning, learning, construct measurement, and skills acquisition. An industry scientist since 2011, she helps clients understand their users by thoughtfully applying a flexible range of methodologies, both qualitative and quantitative. She has expertise in the science of validity, which she applies to evaluating and modeling thinking, behavior, learning, and skills acquisition in domains such as surgery, dentistry, medicine and medical education, technology use, and general education and training. She has extensive experience of envisioning, planning, leading, conducting, and delivering research projects, from small rapid studies to large multimodal research programs. She has led high stakes work for clients who need to understand their customers, users, stakeholders, and learners, and she has a strong track record of providing actionable and valued insights to support business decisions.

Academic Credentials & Professional Honors

B.Sc., Psychology, University of London, 2023

Ph.D., Experimental Psychology, University of Bristol, UK, 2002

Prior Experience

Educational Testing Service (ETS), Research Director, Cognitive and Learning Sciences, 2011-2023

University of Dundee, UK, Asst. Prof. (UK equivalent), Dept. of Experimental Psychology, 2007-2011

Curtin University, Western Australia, Asst. Prof. (Australian equivalent), Dept. of Psychology, 2005-2007

Postdoctoral Researcher, Dept. of Psychology, University of California, Santa Barbara, 2002-2005

Research Fellow, Dept. of Surgery, University of California, San Francisco, 2000-2002

Professional Affiliations

Human Factors and Ergonomics Society, 2023-Present

American Medical Extended Reality Association, 2023-Present

Publications

Keehner M, Arslan B, Lindner MA. Cognition-centered design principles for digital assessment tasks and items. In RJ Tierney, F Rizvi, K Ercikan (Eds.), International encyclopedia of education: Quantitative research/ educational measurement 2023 (4th ed., pp. 171–184). Elsevier.

Araneda S, Lee D, Lewis J, Sireci SG., Moon JA, Lehman B, Keehner M. Exploring relationships among test takers' behaviors and performance using response Process Data. Education Sciences 2023; 12: 104.

Moon JA, Lindner MA, Arslan B, Keehner M. Investigating the split-attention effect in computer-based assessment: Spatial integration and interactive signaling approaches. Educational Measurement: Issues and Practice 2023.

Arslan B, Jiang Y, Keehner M, Gong T, Katz IR, Yan F. The effect of drag-and-drop item features on test-taker performance and response strategies. Educational Measurement: Issues and Practice 2020; 39: 96-106.

Moon JA, Keehner M, Katz IR. Test takers' response tendencies in alternative item formats: A cognitive science approach. Educational Assessment 2020; 25: 236-250.

Moon JA, Sinharay S, Keehner M, Katz IR. Investigating technology-enhanced item formats using cognitive and item response theory approaches. International Journal of Testing 2020; 20: 122-145.

Moon JA, Keehner M, Katz IR. Affordances of item formats and their effects on test-taker cognition under uncertainty. Educational Measurement: Issues and Practice 2019.

Keehner M, Gorin JS, Feng G, Katz IR. Developing and validating cognitive models in assessment. In AA Rupp, JP Leighton (Eds.), The handbook of cognition and assessment: Frameworks, methodologies, and applications 2017 (pp. 75-101). Oxford, UK: Wiley Blackwell.

Ockey GJ, Gu L, Keehner M. Web-based virtual environments for facilitating assessment of L2 oral communication ability. Language Assessment Quarterly 2017; 14: 346-359.

Oranje A, Keehner M, Persky H, Cayton-Hodges GA, Feng, G. The use of cognition in the design, development, and reporting of educational survey assessments. In AA Rupp, JP Leighton (Eds.), The handbook of cognition and assessment: Frameworks, methodologies, and applications 2017 (pp. 75-101). Oxford, UK: Wiley Blackwell.

Moon J, LaMar M, Forsyth CM, Keehner M. The impact of interactivity on simulation-based science inquiry with variable-setting controls. In A Papafragou, D Grodner, D Mirman, J Trueswell (Eds.), Proceedings of the 38th Annual Meeting of the Cognitive Science Society 2016 (pp. 824-829). Austin, TX: Cognitive Science Society.

Sheikh AY, Keehner M, Walker A, Chang PA, Burdon TA, Fann JI. Individual differences in field independence influence the ability to determine accurate needle angles. The Journal of Thoracic and Cardiovascular Surgery 2014; 148: 1804-1810.

Cayton-Hodges GA, Marquez E, van Rijn P, Keehner M, Laitusis C, Zapata-Rivera D, Bauer M, Hakkinen M. Technology enhanced assessments in mathematics and beyond. Invitational Research Symposium on Technology Enhanced Assessments, April 2012, Washington, DC.

Keehner M, Fischer MH. Unusual bodies, uncommon behaviors: Individual and group differences in embodied cognition in spatial tasks. Spatial Cognition & Computation 2012; 12: 71-82.

Keehner M, Fischer MH. Naïve realism in the public understanding of neuroscience. Nature Reviews Neuroscience 2011; 12: 118.

Keehner M, Mayberry L, Fischer MH. Different clues from different views: The role of image format in public perceptions of neuroimaging results. Psychonomic Bulletin & Review 2011; 18: 422-428.

Keehner M. Spatial cognition through the keyhole: How studying a real-world domain can inform basic science – and vice versa. Topics in Cognitive Science 2011; 3: 632-647.

Keehner M, Lowe RK. Seeing with the hands and with the eyes: The contributions of haptic cues to anatomical shape recognition in surgery. In Barkowski et al. (Eds.), Cognitive Shape Processing 2010 (pp. 8-14). Menlo Park: AAAI Press.

Hegarty M, Keehner M, Khooshabeh P, Montello DR. How spatial abilities enhance, and are enhanced by, dental education. Learning and Individual Differences 2009; 19: 61-70.

Keehner M, Khooshabeh P, Hegarty M. Interactive visualizations and individual differences among users. Lead chapter in F Dong, G Ghinea, SY Chen (Eds.), User centered design for medical visualization 2008 (pp. 1-24). Hershey, PA: Idea Group Inc.

Khooshabeh P, Hegarty M, Keehner M, Cohen C. Benefits of constrained interactivity in using a three-dimensional diagram. In G Stapleton, J Howse, J Lee (Eds.), Diagrammatic representation and interface, 5th International Conference, Diagrams 2008 (Lecture Notes in Artificial Intelligence, vol. 5223, pp. 385–387). Berlin, Germany: Springer.

Hegarty M, Keehner M, Cohen CA, Montello DR, Lippa Y. The role of spatial cognition in medicine: Applications for selecting and training professionals. In G Allen (Ed.), Applied spatial cognition: From research to cognitive technology 2007 (pp. 285-315). Mahwah, NJ: Lawrence Erlbaum.

Keehner M, Lippa Y, Hegarty M, Montello DR, Tendick F. Learning a spatial skill for surgery: How contributions of abilities change with practice. Applied Cognitive Psychology 2006; 20: 487-503.

Keehner M, Tendick F, Meng MV, Anwar HP, Hegarty M, Stoller ML, Duh QY. Spatial ability, experience, and skill in laparoscopic surgery. American Journal of Surgery 2004; 188: 71-75.

Keehner M. Conflicting cues from vision and touch can impair spatial task performance. In C Freksa, NS Newcombe, P Gardenfors, S. Wolfl (Eds.), Spatial Cognition VI – Learning, Reasoning, and Talking About Space. Lecture Notes in Computer Science, vol. 5248 2008 (pp. 189-201). Berlin, Germany: Springer.

Keehner M, Hegarty M, Cohen C, Khooshabeh P, Montello DR. Spatial reasoning with external visualizations: What matters is what you see. Cognitive Science 2008; 32: 1099-1132.

Keehner M, Gathercole SE. Cognitive adaptations arising from sign language experience in hearing adults. Memory & Cognition 2007; 35: 752-761.

Keehner M, Guerin SA, Turk DJ, Miller MB, Hegarty M. Modulation of neural activity by angle of rotation during imagined spatial transformations. NeuroImage 2006; 33: 391-398.

Keehner M, Atkinson J. Working memory and deafness: Implications for cognitive development. In SJ Pickering (Ed.), Working memory and education 2006 (pp. 189 -219). San Diego, CA: Elsevier.

Hegarty M, Mayer S, Kriz S, Keehner M. The role of gestures in mental animation. Spatial Cognition and Computation 2005; 5: 333-356.

Keehner M, Khooshabeh P. Computerized representations of 3D structure: How spatial comprehension and patterns of interactivity differ among learners. In Barkowski et al. (Eds.), Reasoning with Mental and External Diagrams 2005 (pp. 12-17). Menlo Park: AAAI Press.

Keehner M, Wong D, Tendick F. Effects of viewing angle, spatial ability, and sight of own hand on accuracy of movements performed under simulated laparoscopic conditions. In Proceedings of the human factors and ergonomics society 48th Annual Meeting 2004 (pp. 1695-1699).

Feygin D, Keehner M, Tendick F. Haptic guidance: Experimental evaluation of a haptic training method for a perceptual motor skill. In Proceedings of the 10th Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems 2002 (pp. 40-47). Washington, DC: IEEE Computer Society.

Presentations

Keehner, M. (2023, September). XR Technologies as a Cognitive Prosthetic: Insights from Cognitive and Learning Science. Paper presented at Shift Medical 2023, Heidelberg, Germany.

Keehner, M., Wixson, K. K., Saldivia, L., & Hill, R. (2018, June). Operational Research in Assessment Programs as a Window into Task and Item Design Principles: Examples from NAEP. In CCSSO 2018 National Conference on Student Assessment. CCSSO.

Keehner, M., Moon, J. A., & McCoy, M. (2018, June). What Cognitive Science Can Tell Us about Technology-Enhanced Item Design: Foundational Principles and Empirical Findings. In CCSSO 2018 National Conference on Student Assessment. CCSSO.

Keehner, M., & Cayton-Hodges, G. A. (2016, April). Interactive simulations as a window into cognition: Theory-driven characterizations of process data. Symposium session presented at the AERA Annual Meeting, Philadelphia, PA.

Keehner, M., Cayton-Hodges, G. A., & Katz, I. R. (2015, December). Adapting interactive simulations for assessment. Paper presented at the CERA Annual Conference, Anaheim, CA.

Keehner, M., & Smith, L. (2013, April). Connecting actions, cognitions, and measurement: The role of cognitive science in NAEP TEL task development. Paper presented at NCME Annual Meeting, San Francisco, CA.

Keehner, M. (2008, September). Conflicting cues from vision and touch can impair spatial task performance: Speculations on the role of spatial ability in reconciling frames of reference. Paper presented at the Spatial Cognition Annual Conference, Freiburg, Germany. *Runner up, Best Paper of Conference award.

Keehner, M. (2007, February). Effects of congruent and conflicting kinesthetic and visual cues on skilled performance in indirect viewing conditions. Paper presented at the 8th Motor Control and Human Skill Conference, Fremantle, Western Australia.

Keehner, M. (2006, November). Evidence for a possible motor representation of spatial movements among hearing non-native signers. Paper presented at the HCSNet Workshop on Perception and Action, Sydney, Australia.

Keehner, M., & Hegarty, M. (2005, November). Viewer rotation is not always easier than object rotation. Poster presented at the 46th Annual Meeting of the Psychonomics Society, Toronto, Canada.

Keehner, M., & Cohen, C. A., Montello, D. R., Khooshabeh, P., & Hegarty, M. (2005, November). Is active control better than passive viewing? It depends on what you see. Poster presented at the 46th Annual Meeting of the Psychonomics Society, Toronto, Canada.

Keehner, M., & Kooshabeh, P. (2005, March). Computerized representations of 3D structure: How patterns of interactivity differ among learners. Paper presented at the AAAI Spring Symposium, Stanford University, CA.

Keehner, M., Lippa, Y., Hegarty, M., Montello, D. R., & Tendick, F. (2005, January). Learning to use a simulated angled laparoscope: How practice moderates individual differences. Paper presented at the Medicine Meets Virtual Reality conference, Long Beach, CA.

Keehner, M., Wong, D., & Tendick, F. (2004, September). Effects of viewing angle, spatial ability, and sight of own hand on accuracy of movements performed under simulated laparoscopic conditions. Paper presented at the Human Factors and Ergonomics Society 48th Annual Meeting, New Orleans, LA.

Keehner, M., Montello, D. R., Hegarty, M., & Cohen, C. (2004, August). Effects of interactivity and spatial ability on the comprehension of spatial relations in a 3D computer visualization. Paper presented at the Cognitive Science Society Annual Conference, Chicago, IL.

Keehner, M., Cohen, C., Hegarty, M., & Montello, D. R. (2004, January). Cognitive factors and interactivity: Implications for the design and implementation of 3D computer visualizations for medical education. Poster session presented at Medicine Meets Virtual Reality, Newport Beach, CA. *Winner, Best Poster of Conference award.

Keehner, M., Tendick, F., Meng, M. V., & Stoller, M. L. (2002, May). Assessment of cognitive functions and laparoscopic skills. Paper presented at the 97th Annual Meeting of the American Urologic Association, Orlando, FL.

Wu, S. L., Keehner, M., Hwang, J., Wong, D., & Tendick, F. (2002, January). Spatial ability and laparoscopic pointing movements. Poster presented at Medicine Meets Virtual Reality, Long Beach, CA.

Keehner, M., & Gathercole, S. E. (2000, September). Evidence for enhanced motor mapping in hearing signers. Paper presented at the British Psychological Society Annual Conference, Colchester, UK.

Project Experience

Dr. Keehner uses her expertise in human cognition and human-centric research methods to help clients who need actionable insights about users. Examples of her work include:

• Exploring user expectations when using a new technology for the first time and, using responsive semi-structured interviewing, helping them to project their likely use cases and experiences with the technology, to support future-focused product decisions

• Developing valid survey items, by conducting in-depth interviews to establish the validity of the data captured by questions, and helping to reduce any potential misunderstandings that arise from users' interpretation of what they are asked and how they respond to those questions

• Characterizing global users of written content and methods that clients can use to evaluate the readability of their content in different languages, through research on reading comprehension skills and readability metrics in different global regions, countries, and languages

• Helping clients to develop and deploy surveys and online activities to gather data about users' fluency with their technology products and the interactive affordances they offer

• Planning and conducting controlled laboratory experiments to examine the effects of variables on the behavior and cognitive processes of end users, ranging from the effects of pricing when it differs from user expectations to the effects of medical devices repurposed for performance enhancement in the general population

Peer Reviews

American Educational Research Association; Applied Cognitive Psychology; Cognition; Cognition and Instruction; Cognitive Science Society; CHI; Human Factors & Ergonomics; SIGCHI; European Journal of Cognitive Psychology; Interacting with Computers; Journal of Experimental Psychology: Applied; Learning & Individual Differences; Psychonomic Bulletin & Review; Spatial Cognition and Computation; Teaching and Learning in Medicine; Topics in Cognitive Science.