

REFERENCES

- [1] R. Mayer and R. E. Mayer, *The Cambridge handbook of multimedia learning*. Cambridge university press, 2005.
- [2] B. Faghih, D. Azadehfar, M. Reza, P. Katebi *et al.*, “User interface design for e-learning software,” *arXiv preprint arXiv:1401.6365*, 2014.
- [3] E. Alemdag and K. Cagiltay, “A systematic review of eye tracking research on multimedia learning,” *Computers & Education*, vol. 125, pp. 413–428, 2018.
- [4] M. Desjarlais, “The use of eye-gaze to understand multimedia learning,” in *Eye-tracking technology applications in educational research*. IGI Global, 2017, pp. 122–142.
- [5] T. J. Mehigan, M. Barry, A. Kehoe, and I. Pitt, “Using eye tracking technology to identify visual and verbal learners,” in *2011 IEEE International Conference on Multimedia and Expo*. IEEE, 2011, pp. 1–6.
- [6] A. Paivio, *Mental representations: A dual coding approach*. Oxford University Press, 1990, vol. 9.
- [7] A. D. Baddeley, *Essentials of human memory*. Psychology Press, 1999.
- [8] J. Sweller, “Instructional design in technical areas. camberwell,” *Victoria: ACER Press*, 1999.
- [9] R. E. Mayer and L. J. Massa, “Three facets of visual and verbal learners: Cognitive ability, cognitive style, and learning preference.” *Journal of educational psychology*, vol. 95, no. 4, p. 833, 2003.
- [10] J. Oughton and W. Reed, “The influence of learner differences on the construction of hypermedia concepts: a case study,” *Computers in Human Behavior*, vol. 15, no. 1, pp. 11–50, 1999.
- [11] A. Mezei, “Imagery and verbal processes by allan paivio,” *Leonardo*, vol. 5, no. 4, pp. 359–360, 1972.
- [12] M. Koć-Januchta, T. Höffler, G.-B. Thoma, H. Prechtel, and D. Leutner, “Visualizers versus verbalizers: Effects of cognitive style on learning with texts and pictures—an eye-tracking study,” *Computers in Human Behavior*, vol. 68, pp. 170–179, 2017.
- [13] A. Richardson, “Verbalizer-visualizer: A cognitive style dimension.” *Journal of mental imagery*, 1977.

- [14] J. R. Kirby, P. J. Moore, and N. J. Schofield, "Verbal and visual learning styles," *Contemporary educational psychology*, vol. 13, no. 2, pp. 169–184, 1988.
- [15] J. L. Plass, D. M. Chun, R. E. Mayer, and D. Leutner, "Supporting visual and verbal learning preferences in a second-language multimedia learning environment." *Journal of educational psychology*, vol. 90, no. 1, p. 25, 1998.
- [16] M. A. E. Alhathli, J. F. M. Masthoff, and N. A. Beacham, "The effects of learners' verbal and visual cognitive styles on instruction selection," in *Proceedings of Intelligent Mentoring Systems Workshop Associated with the 19th International Conference on Artificial Intelligence in Education, AIED 2018*, 2018.
- [17] A. Paivio, *Mind and its evolution: A dual coding theoretical approach*. Psychology Press, 2014.
- [18] M. Sadoski and A. Paivio, *Imagery and text: A dual coding theory of reading and writing*. Routledge, 2013.
- [19] J. M. Clark and J. I. Campbell, "Integrated versus modular theories of number skills and acalculia," *Brain and Cognition*, vol. 17, no. 2, pp. 204–239, 1991.
- [20] A. L. Mendelson and E. Thorson, "How verbalizers and visualizers process the newspaper environment," *Journal of Communication*, vol. 54, no. 3, pp. 474–491, 2004.
- [21] L.-H. Chen, "Web-based learning programs: Use by learners with various cognitive styles," *Computers & Education*, vol. 54, no. 4, pp. 1028–1035, 2010.
- [22] E. S. Paik and G. Schraw, "Learning with animation and illusions of understanding." *Journal of Educational Psychology*, vol. 105, no. 2, p. 278, 2013.
- [23] R. E. Mayer, M. Hegarty, S. Mayer, and J. Campbell, "When static media promote active learning: Annotated illustrations versus narrated animations in multimedia instruction." *Journal of Experimental Psychology: Applied*, vol. 11, no. 4, p. 256, 2005.
- [24] P. Rodrigues and P. J. Rosa, "Eye-tracking as a research methodology in educational context: a spanning framework," in *Eye-tracking technology applications in educational research*. IGI Global, 2017, pp. 1–26.
- [25] R. E. Mayer, "Using multimedia for e-learning," *Journal of Computer Assisted Learning*, vol. 33, no. 5, pp. 403–423, 2017.
- [26] H. K. Tabbers, R. L. Martens, and J. J. Van Merriënboer, "Multimedia instructions and cognitive load theory: Effects of modality and cueing," *British journal of educational psychology*, vol. 74, no. 1, pp. 71–81, 2004.

- [27] T. Ujbanyi, J. Katona, G. Sziladi, and A. Kovari, "Eye-tracking analysis of computer networks exam question besides different skilled groups," in *2016 7th IEEE International Conference on Cognitive Infocommunications (CogInfoCom)*. IEEE, 2016, pp. 000 277–000 282.
- [28] P. V. Yulianandra, S. Wibirama, and P. I. Santosa, "Examining the effect of website complexity and task complexity in web-based learning management system," in *2017 1st International Conference on Informatics and Computational Sciences (ICICoS)*. IEEE, 2017, pp. 119–124.
- [29] H.-C. Liu, "Investigating the impact of cognitive style on multimedia learners' understanding and visual search patterns: an eye-tracking approach," *Journal of Educational Computing Research*, vol. 55, no. 8, pp. 1053–1068, 2018.
- [30] N. Tsianos, P. Germanakos, Z. Lekkas, C. Mourlas, and G. Samaras, "Eye-tracking users' behavior in relation to cognitive style within an e-learning environment," in *2009 Ninth IEEE International Conference on Advanced Learning Technologies*. IEEE, 2009, pp. 329–333.
- [31] D. Lagun, C. Manzanares, S. M. Zola, E. A. Buffalo, and E. Agichtein, "Detecting cognitive impairment by eye movement analysis using automatic classification algorithms," *Journal of neuroscience methods*, vol. 201, no. 1, pp. 196–203, 2011.
- [32] M. Shojaeizadeh, S. Djamasbi, R. C. Paffenroth, and A. C. Trapp, "Detecting task demand via an eye tracking machine learning system," *Decision Support Systems*, vol. 116, pp. 91–101, 2019.
- [33] S. Eivazi and R. Bednarik, "Predicting problem-solving behavior and performance levels from visual attention data," in *Proc. Workshop on Eye Gaze in Intelligent Human Machine Interaction at IUI*, 2011, pp. 9–16.
- [34] Y. Lou, Y. Liu, J. K. Kaakinen, and X. Li, "Using support vector machines to identify literacy skills: Evidence from eye movements," *Behavior research methods*, vol. 49, no. 3, pp. 887–895, 2017.
- [35] M. Borys, S. Barakate, K. Hachmoud, M. Plechawska-Wójcik, P. Krukow, and M. Kamiński, "Classification of user performance in the ruff figural fluency test based on eye-tracking features," in *ITM Web of Conferences*, vol. 15. EDP Sciences, 2017, p. 02002.
- [36] Y. Yin, C. Juan, J. Chakraborty, and M. P. McGuire, "Classification of eye tracking data using a convolutional neural network," in *2018 17th IEEE International Conference on Machine Learning and Applications (ICMLA)*. IEEE, 2018, pp. 530–535.

- [37] X. Wu, V. Kumar, J. R. Quinlan, J. Ghosh, Q. Yang, H. Motoda, G. J. McLachlan, A. Ng, B. Liu, S. Y. Philip *et al.*, “Top 10 algorithms in data mining,” *Knowledge and information systems*, vol. 14, no. 1, pp. 1–37, 2008.
- [38] A. Muller and S. Guido, *Introduction to Machine Learning with Python and Scikit-Learn*. O’reilly, 2015.
- [39] E. T. Al-Shammari, A. Keivani, S. Shamshirband, A. Mostafaeipour, L. Yee, D. Petković, and S. Ch, “Prediction of heat load in district heating systems by support vector machine with firefly searching algorithm,” *Energy*, vol. 95, pp. 266–273, 2016.
- [40] H.-C. Liu and H.-H. Chuang, “An examination of cognitive processing of multimedia information based on viewers’ eye movements,” *Interactive Learning Environments*, vol. 19, no. 5, pp. 503–517, 2011.
- [41] J. Hyönä, “The use of eye movements in the study of multimedia learning,” *Learning and Instruction*, vol. 20, no. 2, pp. 172–176, 2010.
- [42] P. Ramakrisnan, A. Jaafar, F. H. A. Razak, and D. A. Ramba, “Evaluation of user interface design for leaning management system (lms): Investigating student’s eye tracking pattern and experiences,” *Procedia-Social and Behavioral Sciences*, vol. 67, pp. 527–537, 2012.
- [43] S. Zander, S. Wetzel, T. Kühn, and S. Bertel, “Underlying processes of an inverted personalization effect in multimedia learning—an eye-tracking study,” *Frontiers in Psychology*, vol. 8, p. 2202, 2017.
- [44] A. I. Molina, Ó. Navarro, M. Ortega, and M. Lacruz, “Evaluating multimedia learning materials in primary education using eye tracking,” *Computer Standards & Interfaces*, vol. 59, pp. 45–60, 2018.
- [45] F. Mawad, M. Trías, A. Giménez, A. Maiche, and G. Ares, “Influence of cognitive style on information processing and selection of yogurt labels: Insights from an eye-tracking study,” *Food Research International*, vol. 74, pp. 1–9, 2015.
- [46] A. Goswami, G. Walia, M. McCourt, and G. Padmanabhan, “Using eye tracking to investigate reading patterns and learning styles of software requirement inspectors to enhance inspection team outcome,” in *Proceedings of the 10th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement*, 2016, pp. 1–10.
- [47] G. E. Raptis, C. Katsini, M. Belk, C. Fidas, G. Samaras, and N. Avouris, “Using eye gaze data and visual activities to infer human cognitive styles: method and feasibility studies,” in *Proceedings of the 25th Conference on User Modeling, Adaptation and Personalization*, 2017, pp. 164–173.

- [48] R. Zemblys, "Eye-movement event detection meets machine learning," *BIOMEDICAL ENGINEERING* 2016, vol. 20, no. 1, 2016.
- [49] M. Faber, R. Bixler, and S. K. D'Mello, "An automated behavioral measure of mind wandering during computerized reading," *Behavior Research Methods*, vol. 50, no. 1, pp. 134–150, 2018.
- [50] R. E. Mayer, *Cognitive Theory of Multimedia Learning*, 2nd ed., ser. Cambridge Handbooks in Psychology. Cambridge University Press, 2014, p. 43–71.
- [51] R. E. Mayer and R. Moreno, "Nine ways to reduce cognitive load in multimedia learning," *Educational psychologist*, vol. 38, no. 1, pp. 43–52, 2003.
- [52] S. Mousavi, F. Radmehr, and H. Alamolhodaei, "The role of mathematical homework and prior knowledge on the relationship between students' mathematical performance, cognitive style and working memory capacity," 2012.
- [53] R. E. Mayer, "Cognitive theory of multimedia learning," *The Cambridge handbook of multimedia learning*, vol. 41, pp. 31–48, 2005.
- [54] K. Scheiter and A. Eitel, "The use of eye tracking as a research and instructional tool in multimedia learning," in *Eye-tracking technology applications in educational research*. IGI Global, 2017, pp. 143–164.
- [55] M. T. McKay, I. Fischler, and B. R. Dunn, "Cognitive style and recall of text: An eeg analysis," *Learning and individual differences*, vol. 14, no. 1, pp. 1–21, 2003.
- [56] R. Riding and I. Cheema, "Cognitive styles—an overview and integration," *Educational psychology*, vol. 11, no. 3-4, pp. 193–215, 1991.
- [57] E. Sadler-Smith and R. Riding, "Cognitive style and instructional preferences," *Instructional science*, vol. 27, no. 5, pp. 355–371, 1999.
- [58] D. Jonassen and B. Grabowski, "Handbook of individual differences learning and instruction lawrence erlbaum associates, publishers," *New Jersey: London*, 1993.
- [59] M. Kozhevnikov, "Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style," *Psychological bulletin*, vol. 133, no. 3, p. 464, 2007.
- [60] R. M. Felder, L. K. Silverman *et al.*, "Learning and teaching styles in engineering education," *Engineering education*, vol. 78, no. 7, pp. 674–681, 1988.
- [61] J. Kuljis and F. Liu, "A comparison of learning style theories on the suitability for elearning," *Web Technologies, Applications, and Services*, vol. 2005, pp. 191–197, 2005.

- [62] S. Graf, T.-C. Liu, N.-S. Chen, S. J. Yang *et al.*, “Learning styles and cognitive traits—their relationship and its benefits in web-based educational systems,” *Computers in Human Behavior*, vol. 25, no. 6, pp. 1280–1289, 2009.
- [63] R. Felder and B. n. Soloman. Learning styles and strategies. [Online]. Available: <https://www.engr.ncsu.edu/wp-content/uploads/drive/1WPAfj3j5o5OuJMiHorJ-lv6fON1C8kCN/styles.pdf>
- [64] B. Ciloglulil, “Adaptivity based on felder-silverman learning styles model in e-learning systems,” in *4th International Symposium on Innovative Technologies in Engineering and Science (ISITES2016) 3-5 Nov 2016 Alanya/Antalya-Turkey*, 2016.
- [65] R. M. Felder and J. Spurlin, “Applications, reliability and validity of the index of learning styles,” *International journal of engineering education*, vol. 21, no. 1, pp. 103–112, 2005.
- [66] R. K. Sungkur, M. A. Antoaroo, and A. Beeharry, “Eye tracking system for enhanced learning experiences,” *Education and Information Technologies*, vol. 21, no. 6, pp. 1785–1806, 2016.
- [67] G. Nishimura and A. Faisal, “Déjà vu: Classification of memory using eye movements,” 2015.
- [68] Z. Sharafi, T. Shaffer, B. Sharif, and Y.-G. Guéhéneuc, “Eye-tracking metrics in software engineering,” in *2015 Asia-Pacific Software Engineering Conference (APSEC)*. IEEE, 2015, pp. 96–103.
- [69] M. A. Just and P. A. Carpenter, “A theory of reading: From eye fixations to comprehension.” *Psychological review*, vol. 87, no. 4, p. 329, 1980.
- [70] K. Holmqvist, M. Nyström, R. Andersson, R. Dewhurst, H. Jarodzka, and J. Van de Weijer, *Eye tracking: A comprehensive guide to methods and measures*. OUP Oxford, 2011.
- [71] E. Megaw and J. Richardson, “Eye movements and industrial inspection,” *Applied Ergonomics*, vol. 10, no. 3, pp. 145–154, 1979.
- [72] Z. Xu, I. King, M. R.-T. Lyu, and R. Jin, “Discriminative semi-supervised feature selection via manifold regularization,” *IEEE Transactions on Neural networks*, vol. 21, no. 7, pp. 1033–1047, 2010.
- [73] X. Zhou, X. Gao, J. Wang, H. Yu, Z. Wang, and Z. Chi, “Eye tracking data guided feature selection for image classification,” *Pattern Recognition*, vol. 63, pp. 56–70, 2017.
- [74] I. Guyon, J. Weston, S. Barnhill, and V. Vapnik, “Gene selection for cancer classification using support vector machines,” *Machine learning*, vol. 46, no. 1-3, pp. 389–422, 2002.

- [75] P.-H. Tseng, I. G. Cameron, G. Pari, J. N. Reynolds, D. P. Munoz, and L. Itti, "High-throughput classification of clinical populations from natural viewing eye movements," *Journal of neurology*, vol. 260, no. 1, pp. 275–284, 2013.
- [76] M. Čertický, M. Čertický, P. Sinčák, G. Magyar, J. Vaščák, and F. Cavallo, "Psychophysiological indicators for modeling user experience in interactive digital entertainment," *Sensors*, vol. 19, no. 5, p. 989, 2019.
- [77] C. Cortes and V. Vapnik, "Support vector machine," *Machine learning*, vol. 20, no. 3, pp. 273–297, 1995.
- [78] A. Ng, "Cs229 lecture notes," *CS229 Lecture notes*, vol. 1, no. 1, pp. 1–3, 2000.
- [79] S. Parikh and H. Kalva, "Eye gaze feature classification for predicting levels of learning," in *InProceedings of the 8th Workshop on Personalization Approaches in Learning Environments (PALE 2018)*, 2018.
- [80] F. Pedregosa, G. Varoquaux, A. Gramfort, V. Michel, B. Thirion, O. Grisel, M. Blondel, P. Prettenhofer, R. Weiss, V. Dubourg, J. Vanderplas, A. Passos, D. Cournapeau, M. Brucher, M. Perrot, and E. Duchesnay, "Scikit-learn: Machine learning in Python," *Journal of Machine Learning Research*, vol. 12, pp. 2825–2830, 2011.
- [81] D. M. Powers, "Evaluation: from precision, recall and f-measure to roc, informedness, markedness and correlation," 2011.
- [82] G. Jurman, S. Riccadonna, and C. Furlanello, "A comparison of mcc and cen error measures in multi-class prediction," *PloS one*, vol. 7, no. 8, p. e41882, 2012.
- [83] D. Chicco, "Ten quick tips for machine learning in computational biology," *BioData mining*, vol. 10, no. 1, p. 35, 2017.
- [84] D. Chicco and G. Jurman, "The advantages of the matthews correlation coefficient (mcc) over f1 score and accuracy in binary classification evaluation," *BMC genomics*, vol. 21, no. 1, p. 6, 2020.
- [85] J. L. Turner, *Using statistics in small-scale language education research: Focus on non-parametric data*. Routledge, 2014.
- [86] G. W. Corder and D. I. Foreman, "Nonparametric statistics for non-statisticians," 2011.
- [87] Danielle, David, and T. J., *Learning Statistics with JASP: A Tutorial for Psychology Students and Other Beginners*. [Online]. Available: <https://jasp-stats.org/2019/09/17/introducing-a-new-jasp-fueled-textbook-learning-statistics-with-jasp/>

- [88] R. Felder and B. n. Soloman. (1997) Index of learning styles. [Online]. Available: <https://www.webtools.ncsu.edu/learningstyles/>
- [89] L. Rello and M. Ballesteros, "Detecting readers with dyslexia using machine learning with eye tracking measures," in *Proceedings of the 12th Web for All Conference*, 2015, pp. 1–8.
- [90] S. Berkovsky, R. Taib, I. Koprinska, E. Wang, Y. Zeng, J. Li, and S. Kleitman, "Detecting personality traits using eye-tracking data," in *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 2019, pp. 1–12.
- [91] T. Asvestopoulou, V. Manousaki, A. Psistakis, I. Smyrnakis, V. Andreadakis, I. M. Aslanides, and M. Papadopoulou, "Dyslexml: Screening tool for dyslexia using machine learning," *arXiv preprint arXiv:1903.06274*, 2019.
- [92] C. K. Prantner, "The evaluation of the results of an eye tracking based usability tests of the so called instructor's portal framework (<http://tanitlap.ektf.hu/csernaiz>)," in *2015 6th IEEE International Conference on Cognitive Communications (CogInfoCom)*. IEEE, 2015, pp. 459–465.
- [93] J. Holsanova, N. Holmberg, and K. Holmqvist, "Reading information graphics: The role of spatial contiguity and dual attentional guidance," *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, vol. 23, no. 9, pp. 1215–1226, 2009.
- [94] L. Mason, M. C. Tornatora, and P. Pluchino, "Do fourth graders integrate text and picture in processing and learning from an illustrated science text? evidence from eye-movement patterns," *Computers & Education*, vol. 60, no. 1, pp. 95–109, 2013.
- [95] L. Mason, P. Pluchino, M. C. Tornatora, and N. Ariasi, "An eye-tracking study of learning from science text with concrete and abstract illustrations," *The Journal of Experimental Education*, vol. 81, no. 3, pp. 356–384, 2013.
- [96] N. V. Chawla, K. W. Bowyer, L. O. Hall, and W. P. Kegelmeyer, "Smote: synthetic minority over-sampling technique," *Journal of artificial intelligence research*, vol. 16, pp. 321–357, 2002.
- [97] R. M. French and J.-P. Thibaut, "Using eye-tracking to predict children's success or failure on analogy tasks," in *Proceedings of the Annual Meeting of the Cognitive Science Society*, vol. 36, no. 36, 2014.
- [98] B. Park, A. Korbach, and R. Brünken, "Do learner characteristics moderate the seductive-details-effect? a cognitive-load-study using eye-tracking," *Journal of Educational Technology & Society*, vol. 18, no. 4, pp. 24–36, 2015.

- [99] T. van Marlen, M. van Wermeskerken, H. Jarodzka, and T. van Gog, “Showing a model’s eye movements in examples does not improve learning of problem-solving tasks,” *Computers in Human Behavior*, vol. 65, pp. 448–459, 2016.
- [100] R. Johansson and M. Johansson, “Look here, eye movements play a functional role in memory retrieval,” *Psychological science*, vol. 25, no. 1, pp. 236–242, 2014.
- [101] A. L. Wantz, C. S. Martarelli, and F. W. Mast, “When looking back to nothing goes back to nothing,” *Cognitive processing*, vol. 17, no. 1, pp. 105–114, 2016.
- [102] T. N. Höffler, M. Koć-Januchta, and D. Leutner, “More evidence for three types of cognitive style: Validating the object-spatial imagery and verbal questionnaire using eye tracking when learning with texts and pictures,” *Applied Cognitive Psychology*, vol. 31, no. 1, pp. 109–115, 2017.
- [103] N. Borgers and J. Hox, “Reliability of responses in questionnaire research with children,” in *fifth international conference on logic and methodology, Cologne, Germany*, 2000.
- [104] Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, *Learning from data*. AMLBook New York, NY, USA:, 2012, vol. 4.