Journal of Motor Learning and Development, 2026, 14, 1-5
https://doi.org/10.1123/jmld.2025-0133

Human Kinetics
COMMENTARY

Diversity, Individualization, and Enhancement in Motor Learning: Current Challenges and Future Directions From the First Theoretical and Applied Advances in Motor Learning Conference

Russell W. Chan,[1] Elger Abrahamse,[2] Klaus Blischke,[3] Raoul M. Bongers,[4] Arnaud Boutin,[5] Friedhelm C. Hummel,[6,7,8] Maarten A. Immink,[9] Katja Kornysheva,[10] Rob H.J. van der Lubbe,[1] Pablo Maceira,[11] Stefan Panzer,[3] Marit F.L. Ruitenberg,[12,13] Andreea I. Sburlea,[14] Rachael Seidler,[15,16,17] Jordan A. Taylor,[18,19] David L. Wright,[20] and Willem B. Verwey[1]

[1]Section Cognition, Data and Education, Faculty of Behavioural Management and Social Sciences, University of Twente, Enschede, The Netherlands; [2]Department of Communication and Cognition, Tilburg University, Tilburg, The Netherlands; [3]Institute of Sport Science, Saarland University, Saarbrücken, Germany; [4]Department of Human Movement Sciences, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands; [5]Université Paris-Saclay, INRIA, CIAMS, Gif-sur-Yvette, France; [6]Neuro-X Institute (INX), École Polytechnique Fédérale de Lausanne (EPFL), Geneva, Switzerland; [7]Neuro-X Institute (INX), EPFL Valais, Clinique Romande de Réadaptation, Sion, Switzerland; [8]Clinical Neuroscience, Medical School, University of Geneva, Geneva, Switzerland; [9]Flinders University, Adelaide, SA, Australia; [10]Centre for Human Brain Health, School of Psychology, University of Birmingham, Birmingham, United Kingdom; [11]Wyss Center for Bio and Neuroengineering, Geneva, Switzerland; [12]Health, Medical and Neuropsychology Unit, Institute of Psychology, Leiden University, Leiden, The Netherlands; [13]Leiden Institute for Brain and Cognition, Leiden, The Netherlands; [14]Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, Cognitive Modelling Group, University of Groningen, Groningen, The Netherlands; [15]Department of Applied Physiology and Kinesiology, University of Florida, Gainesville, FL, USA; [16]Norman Fixel Institute for Neurological Diseases, University of Florida, Gainesville, FL, USA; [17]McKnight Brain Institute, University of Florida, Gainesville, FL, USA; [18]Department of Psychology, Princeton University, Princeton, NJ, USA; [19]Princeton Neuroscience Institute, Princeton University, Princeton, NJ, USA; [20]Department of Kinesiology and Sport Management Perception-action Dynamics Laboratory, Texas A&M University, College Station, TX, USA

The field of motor learning faces a critical gap between foundational theory and real-world application. This editorial synthesizes expert discussions from the First Theoretical and Applied Advances in Motor Learning Conference to address key issues impeding further progress. We are hampered by the science of "averages," characterized by an overreliance on data from homogenous, Western, educated, industrialized, rich, and democratic populations and a flawed assumption of cognitive uniformity. This approach masks critical individual differences, limiting the translational potential of our science and leading to one-size-fits-all enhancement strategies. We propose a multitiered roadmap for the maturation of our field. The foundational priorities are structural: embracing co-creation with diverse communities; moving beyond Western, Educated, Industrialized, Rich, and Democratic science; and implementing structured mentorship and active sponsorship to empower a new generation of scholars. Building on this, we advocate for technology-driven individualization like using advanced Mobile Brain/Body Imaging techniques for the development of neurophenotypes, to fulfill the potential of Brain–Computer Interfaces. Finally, we call for a precision-enhancement framework, shifting from "learning boosters" to a diagnostic-to-prescriptive model that targets specific, identified bottlenecks. This roadmap allows our field to build upon its foundational principles to create a more effective, accessible, and equitable motor learning science for all.

Keywords: neurophenotyping, co-creation, precision rehabilitation, ecological validity, brain-computer interface

The field of motor learning and development has reached a critical juncture. While foundational principles have been established through decades of rigorous laboratory research, there is a growing consensus that progress is being hampered by a persistent gap between theory and real-world application. Key challenges such as the limited diversity of study populations, the inefficiencies of one-size-fits-all interventions, and the complex ethics of emerging technologies require a concerted, forward-thinking effort from the research community. To address this bottleneck, the First Theoretical and Applied Advances in Motor Learning Conference was held on November 2–4, 2022, at the University of Twente Campus in Enschede, The Netherlands. Funded by the European Union's Horizon 2020 research and innovation program under a Marie Skłodowska-Curie Fellowship awarded to Russell W Chan (No. 898286), the conference program focused on current and future motor learning research directions around the themes of diversity, individualization, and enhancement. In addition to keynote lectures and plenary talks, the program included round table discussions

Chan https://orcid.org/0000-0002-3512-2337
Abrahamse https://orcid.org/0000-0002-9361-2916
Bongers https://orcid.org/0000-0002-3518-7464
Boutin https://orcid.org/0000-0002-5696-2626
Hummel https://orcid.org/0000-0002-4746-4633
Immink https://orcid.org/0000-0002-4652-0090
Kornysheva https://orcid.org/0000-0002-1562-7880
van der Lubbe https://orcid.org/0000-0003-3658-0345
Maceira https://orcid.org/0000-0001-9861-5246
Panzer https://orcid.org/0000-0002-7301-2374
Ruitenberg https://orcid.org/0000-0001-7435-3229
Sburlea https://orcid.org/0000-0001-6766-3464
Seidler https://orcid.org/0000-0003-2452-9024
Taylor https://orcid.org/0000-0001-9300-1229
Wright https://orcid.org/0000-0002-3090-5375
Verwey https://orcid.org/0000-0003-3994-8854
Chan (r.w.chan@utwente.nl) is corresponding author.

designed to allow the 25 delegates from eight countries around the globe to define challenges and outline future directions related to the three conference themes. The purpose of this editorial is to synthesize these expert discussions and communicate to the wider motor learning researcher and practitioner community a roadmap for future research and practice regarding three key themes: (a) diversity in our research populations and scholars, (b) the resulting need for individualization in our methods, and (c) the precise application of enhancement strategies.

The Foundational Challenge: A Science of Averages, Not Individuals

A significant challenge limiting the generalizability of motor learning principles is our field's narrow demographic scope. The vast majority of research in our field relies on participants from Western, educated, industrialized, rich, and democratic (WEIRD) societies, a concern that echoes across the behavioral sciences (Keyes et al., 2024). Whether it is a scientific choice for the study of mechanisms or a choice of convenience, it raises critical questions about the applicability of our findings as motor actions are deeply influenced by cultural norms, educational practices, and physical environments that vary widely across global populations (Karasik et al., 2010). Consequently, the field risks developing theoretical models and interventions that are not universally effective (Valentini et al., 2022).

This reliance on homogenous samples directly causes our inability to account for *individual differences*. Our field tends to treat the immense variability between individuals not as a core feature of learning, but as an obstacle to our models of motor control and learning mechanisms. While our models explain group averages, they are still unable to clearly outline why one person learns faster, develops a different strategy, or responds better to a specific intervention than another (Abrahamse et al., 2013; Anderson et al., 2021; Seidler & Carson, 2017; Verwey, 2024). This is not only a minor theoretical detail but one of the primary reasons for there being a gap of effectively translating benefits of motor learning to the diverse general population. Furthermore, even in specialized contexts like clinical research and elite sports, our field's reliance on group averages often masks the fact that successful interventions may not work or may even be detrimental for some individuals. Our field is now poised to move beyond the "average" human and embrace the full spectrum of individual learners. We must dedicate our efforts to understanding the rich diversity and unique needs of developing children with different needs, aging adults that aim to impede motor skill decline, patients that want effective personalized rehabilitation, and high-performance athletes striving for their next medal. This outward-facing challenge of participant diversity is mirrored by an inward-facing one: a scholarly community that also lacks diversity, particularly from the Global South. This, combined with insufficient platforms for early-career researchers (ECRs), makes our science remain locked in an echo chamber of established ideas.

The Way Forward: Embracing Human Variability—From WEIRD Science to Personalized Profiles

We affirm that the issues of diversity and individualization are inseparable: to solve one, we must solve the other. Therefore, we propose a three-step approach for a decisive shift away from WEIRD science and toward a unified framework. The first step lies in adopting a *co-creation and global collaboration* model, partnering directly with diverse communities to design and implement culturally relevant research (Real & Schmittinger, 2022). This requires funders and scientific review panels to become active agents in dismantling WEIRD bias and actively support international, multilab collaborations, like the Global SUNRISE study (Kariippanon et al., 2022) or the European WEAVE-Program (WEAVE, 2025). The building of representative data sets starts today, and with each successful initiative, we further empower scholarship that works at a global level. At the local level, this also means treating participants not as passive subjects, but as active co-designers who are empowered to drive the direction of future research themes, as exemplified by the Dutch Research Agenda (Nationale Wetenschapsagenda [NWA]), The Netherlands Organisation for Health Research and Development (ZonMW), and Horizon-Europe projects. We can take a cue from successful clinical research funding in that requirements from patients are clearly elicited before interventions start so that their needs are tailored into these programs and each iteration provides feedback for increased personalization. If we take inspiration from this approach and inbuild it not as an afterthought but as a core design principle of our experiments, the diversity of participants and their needs at each stage of research can be enlightening for our community and target populations (Smits et al., 2020).

The second step is to commit to *technology-driven personalization*. We must leverage technology to move from group averages to individual profiles. The immediate future lies in the cutting-edge implementation of multimodal data from Mobile Brain/Body Imaging techniques (Barnstaple et al., 2021; Chan et al., 2025), for the establishment of neurophenotypes that can unravel biologically grounded classifications of learner types based on computational psychophysiology (Bigdely-Shamlo et al., 2020; Emish & Young, 2024). By feeding these high-dimensional profiles into machine learning models (Adans-Dester et al., 2020; Zabolotniy et al., 2025), we can begin to predict individual learning trajectories and identify specific bottlenecks that are contextually driven. The end-goal application of this lies in closed-loop Brain–Computer Interfaces, which can deliver truly personalized, real-time interventions (Müller-Putz et al., 2022). Systems like g.tec's RECOVERIX (Irimia et al., 2016) are not just theoretical, they are proof that using an individual's own neural signals to guide therapy can become the norm of effective rehabilitation in the near future.

The third final step in this challenge is the implementation of *structured mentorship and active sponsorship to empower future scientific generations and ECRs* (particularly those from underrepresented backgrounds). This mentorship cannot be ad-hoc; it must provide explicit guidance on the core competencies of a successful scientific career, including the dissemination of high-impact research, designing robust experiments with impact in mind, navigating peer review, securing seed grant funding, and translating scientific work into societal benefit. The Marie Skłodowska-Curie Action Doctoral Training Networks of the Horizon Europe is one such funding structure that provides excellent opportunities for the training of young talented researchers of the future with this research attitude. Beyond this guidance, we also call upon senior peers to act as sponsors: meaning to proactively advocate for ECRs, use their influence to nominate them for awards and speaking roles, and create pathways for them to lead and progress in their careers. We also advocate our peers organizing future conferences in our field to dedicate seed funding mechanisms for ECRs and specific programs to link mentors with mentees, aimed at infusing the field

with the new ideas and perspectives essential for the vitality of pushing the next generation of scientists.

The Enhancement Challenge: Beyond the Assumption of Cognitive Uniformity and Blind Enhancement

A critical yet often unstated challenge in motor learning research is the implicit assumption that all participants possess equivalent cognitive capacity to benefit from learning programs and interventions. We design experiments and test as if executive functions like attentional control and working memory are uniform across individuals. This flawed assumption, while already problematic in our typical young adult student-based convenience sampled experiments, becomes invalid when studying clinical populations, which are sampled from the whole, highly variable population. This assumption directly contradicts the core themes of diversity and individualization; if we accept that individuals are different, we must also accept that their cognitive readiness to learn is also different. The contentious evidence and replication failures for many "brain games" (Flores-Gallegos & Mayer, 2022) and noninvasive brain stimulation (NIBS) techniques (Das et al., 2016) are direct symptoms of this problematic, one-size-fits-all approach, which provides solutions without first isolating the problem.

The search for universal "learning boosters" has led to a field with often contentious and contradictory findings. For example, the evidence from meta-analyses for NIBS as a general cognitive or motor enhancer remains equivocal, concluding that NIBS offers, at best, small-to-moderate, context-dependent effects with significant heterogeneity across studies (Harris et al., 2025; Tao et al., 2024). The field has mainly focused on the question, "Does NIBS work?," but this framing is misdirected. The controversy surrounding NIBS should be reframed as the strongest possible evidence for a precision approach. The correct and more fruitful and contextually rich question is "*For whom, for what specific bottleneck, and under what conditions* does a given enhancement strategy work?" Answering this requires a fundamental change in our experimental and clinical paradigm.

The Way Forward: A Precision-Enhancement Framework

Our recommendation involves a two-step approach to tackle the enhancement challenge. The first step is to adopt a *diagnostic-to-prescriptive* approach, meaning that, before applying any intervention, we should first identify an individual's specific cognitive-motor profile and needs. This is a direct application and further development of the neurophenotyping concept discussed earlier and is achieved by using multimodal data to identifying specific bottlenecks for a learner. For example, is an individual's slow progress due to a deficit in sustained attention, limitations in the ability to maintain information in working memory, or high levels of performance anxiety? By targeting the specific limiting factor, we can move away from a one-size-fits-all approach and select *targeted, evidence-based interventions*.

Once a specific bottleneck is identified, targeted evidence-based interventions can be applied with greater precision. This is where NIBS' cognitive and contemplative strategies offer significant, targeted value. For a learner diagnosed with *poor attentional control* or high susceptibility to *cognitive interference*, brief sessions of focused-attention meditation may be a potent intervention, priming the brain for more efficient motor encoding by modulating frontal cortical activity (Chan et al., 2020; Immink et al., 2017). Similarly, for an individual showing poor long-term memory retention, the focus should be on sleep hygiene as a primary intervention. Leveraging sleep as a targeted tool to enhance memory consolidation (Boutin et al., 2024), particularly through postlearning naps for older adults (King et al., 2016), treats the approach not just as a general recommendation but as prescribed therapy for an identified consolidation deficit. Mental/motor imagery for those who are physically injured not only engages domain-specific neural networks but also contributes to the development of expert-like performance by optimizing neurocognitive resources and enhancing plasticity (De Kleine & Van der Lubbe, 2011; Debarnot et al., 2014; Sobierajewicz et al., 2017). For individuals who show significant performance decrements when performing a motor task concurrently with a cognitive task, dual-task training shows systematic learning benefit leading to improved performance and retention (Li et al., 2025; Surkar et al., 2025).

This precision framework also forces a reevaluation of NIBS, in that its future use likely lies not in its use as a blunt instrument to globally enhance learning, but as a highly targeted tool. If a diagnostic approach identifies a specific hypoactive neural circuit underlying a cognitive bottleneck, then targeted NIBS (e.g., anodal Transcranial Direct Current Stimulation) could be used as a precision tool to modulate that circuit's excitability in synergy with a relevant behavioral practice (Hummel, 2025; Maceira-Elvira et al., 2024). This integrated, diagnostic-to-prescriptive model represents the most promising path forward, ensuring that enhancement strategies are used not just because they exist, but because they become the right solution for the right individual at the right time.

Conclusion: An Actionable Blueprint for the Next Decade

The path forward for motor learning science, as highlighted by our expert panel and conference, requires a multitiered approach that is immediately actionable and technologically ambitious. As immediate and foundational priorities, we advocate for structural and methodological shifts that can begin today: embracing *co-creation* with community stakeholders to ensure that our research is relevant, implementing structured research to move away from WEIRD science, and implementing structured mentorship and active sponsorship to empower a more diverse generation of scholars. This will enable future scholars to tackle the frontiers of *neurophenotyping* toward *precision-driven* enhancement systems.

This shift does not mean abandoning the pursuit of mechanisms from the investigation of averages, which are also valuable and necessary steps in establishing the general principles and foundational cognitive-biological models of our field. Rather, it represents a maturation of our science. We have now reached a point at which new statistical and technological advances allow us to build upon that foundation, integrate complexity, and progress to a new, individual-based science. By building upon these principles and embracing the complexity of individuals, we have an outlook on closing the persistent gap between theory and practice. This is not just a recommendation; it is a mandate for the future of our field to ensure impact on the general as well as the clinical populations. By committing to both the foundational and frontier aspects of this roadmap, our field can move beyond generalized principles to unlock the full spectrum of human potential, ensuring that the benefits of our science are effective, accessible, and equitable for all.

Acknowledgments

We dedicate this editorial to the late Professor Klaus Blischke, who attended the symposium and contributed to the ideas put forth. He was an inspiring figure to all who attended. **Declaration of generative AI and AI-assisted technologies in the writing process**: During the preparation of this work, the author(s) used Google's Gemini 2.5 Pro for textual content primarily to refine paragraph structure and organize thoughts without influencing intellectual direction of the manuscript. This approach underscores a judicious application of AI tools to augment the research process, maintaining the integrity and originality of the work. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

References

Abrahamse, E.L., Ruitenberg, M.F., de Kleine, E., & Verwey, W.B. (2013). Control of automated behavior: Insights from the discrete sequence production task. *Frontiers in Human Neuroscience, 7*, Article 82. https://doi.org/10.3389/fnhum.2013.00082

Adans-Dester, C., Hankov, N., O'Brien, A., Vergara-Diaz, G., Black-Schaffer, R., Zafonte, R., Dy, J., Lee, S.I., & Bonato, P. (2020). Enabling precision rehabilitation interventions using wearable sensors and machine learning to track motor recovery. *NPJ Digital Medicine, 3*(1), Article 121. https://doi.org/10.1038/s41746-020-00328-w

Anderson, D.I., Lohse, K.R., Lopes, T.C.V., & Williams, A.M. (2021). Individual differences in motor skill learning: Past, present and future. *Human Movement Science, 78*, Article 102818. https://doi.org/10.1016/j.humov.2021.102818

Barnstaple, R., Protzak, J., DeSouza, J.F.X., & Gramann, K. (2021). Mobile brain/body Imaging in dance: A dynamic transdisciplinary field for applied research. *European Journal of Neuroscience, 54*(12), 8355–8363. https://doi.org/10.1111/ejn.14866

Bigdely-Shamlo, N., Touryan, J., Ojeda, A., Kothe, C., Mullen, T., & Robbins, K. (2020). Automated EEG mega-analysis II: Cognitive aspects of event related features. *Neuroimage, 207*, Article 116054. https://doi.org/10.1016/j.neuroimage.2019.116054

Boutin, A., Gabitov, E., Pinsard, B., Boré, A., Carrier, J., & Doyon, J. (2024). Temporal cluster-based organization of sleep spindles underlies motor memory consolidation. *Proceedings of the Royal Society B: Biological Sciences, 291*(2014), Article 20231408. https://doi.org/doi:10.1098/rspb.2023.1408

Chan, R.W., Alday, P.M., Zou-Williams, L., Lushington, K., Schlesewsky, M., Bornkessel-Schlesewsky, I., & Immink, M.A. (2020). Focused-attention meditation increases cognitive control during motor sequence performance: Evidence from the N2 cortical evoked potential. *Behavioural Brain Research, 384*, Article 112536. https://doi.org/10.1016/j.bbr.2020.112536

Chan, R.W., Lakomski, V., Pannermayr, J.V.R., Wiechmann, E., van 't Klooster, J.-W.J.R., & Verwey, W.B. (2025). Multimodal mobile brain and body imaging for quantification of dance motor sequence learning. *MethodsX, 14*, Article 103324. https://doi.org/10.1016/j.mex.2025.103324

Das, S., Holland, P., Frens, M.A., & Donchin, O. (2016). Impact of Transcranial Direct Current Stimulation (tDCS) on neuronal functions. *Frontiers in Neuroscience, 10*, Article 550. https://doi.org/10.3389/fnins.2016.00550

De Kleine, E., & Van der Lubbe, R.H. (2011). Decreased load on general motor preparation and visual-working memory while preparing familiar as compared to unfamiliar movement sequences. *Brain and Cognition, 75*(2), 126–134. https://doi.org/10.1016/j.bandc.2010.10.013

Debarnot, U., Sperduti, M., Di Rienzo, F., & Guillot, A. (2014). Experts bodies, experts minds: How physical and mental training shape the brain. *Frontiers in Human Neuroscience, 8*, Article 280. https://doi.org/10.3389/fnhum.2014.00280

Emish, M., & Young, S.D. (2024). Remote wearable neuroimaging devices for health monitoring and neurophenotyping: A scoping review. *Biomimetics, 9*(4), Article 237. https://doi.org/10.3390/biomimetics9040237

Flores-Gallegos, R., & Mayer, R.E. (2022). Learning cognitive skills by playing video games at home: Testing the specific transfer of general skills theory. *Journal of Cognitive Enhancement, 6*(4), 485–495. https://doi.org/10.1007/s41465-022-00253-8

Harris, D.M., Latella, C., Tripodi, N., & O'Bryan, S.J. (2025). Exploring non-invasive brain stimulation effects on physical outcomes in people with Parkinson's disease: An umbrella evidence mapping review with meta-analyses. *Neurorehabilitation and Neural Repair, 39*(4), 321–340. https://doi.org/10.1177/15459683241310984

Hummel, F.C. (2025). Personalization of non-invasive brain stimulation to enhance the magnitude of recovery from stroke. *Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation, 18*(1), Article 291. https://doi.org/10.1016/j.brs.2024.12.232

Immink, M.A., Colzato, L.S., Stolte, M., & Hommel, B. (2017). Sequence learning enhancement following single-session meditation is dependent on metacontrol mode and experienced effort. *Journal of Cognitive Enhancement, 1*(2), 127–140. https://doi.org/10.1007/s41465-017-0019-2

Irimia, D., Sabathiel, N., Ortner, R., Poboroniuc, M., Coon, W., Allison, B.Z., & Guger, C. (2016). recoveriX: A new BCI-based technology for persons with stroke. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2016*, 1504–1507. https://doi.org/10.1109/embc.2016.7590995

Karasik, L.B., Adolph, K.E., Tamis-LeMonda, C.S., & Bornstein, M.H. (2010). WEIRD walking: Cross-cultural research on motor development. *Behavioral and Brain Sciences, 33*(2–3), 95–96. https://doi.org/10.1017/S0140525X10000117

Kariippanon, K.E., Chong, K.H., Janssen, X., Tomaz, S.A., Ribeiro, E.H.C., Munambah, N., Chan, C.H.S., Chathurangana, P.P., Draper, C.E., El Hamdouchi, A., Florindo, A.A., Guan, H., Ha, A.S., Hossain, M.S., Kim, D.H., VAN Kim, T., Koh, D.C.L., Löf, M., Pham, B.N., … Okely, A.D. (2022). Levels and correlates of objectively measured sedentary behavior in young children: SUNRISE study results from 19 Countries. *Med Sci Sports Exerc, 54*(7), 1123–1130. https://doi.org/10.1249/MSS.0000000000002886

Keyes, K.M., Pakserian, D., Rudolph, K.E., Salum, G., & Stuart, E.A. (2024). Population neuroscience: Understanding concepts of generalizability and transportability and their application to improving the public's health. In T. Paus, J.R. Brook, K. Keyes, & Z. Pausova (Eds.), *Principles and advances in population neuroscience* (pp. 37–51). Springer Nature Switzerland. https://doi.org/10.1007/7854_2024_465

King, B.R., Saucier, P., Albouy, G., Fogel, S.M., Rumpf, J.-J., Klann, J., Buccino, G., Binkofski, F., Classen, J., Karni, A., & Doyon, J. (2016). Cerebral activation during initial motor learning forecasts subsequent sleep-facilitated memory consolidation in older adults. *Cerebral Cortex, 27*(2), 1588–1601. https://doi.org/10.1093/cercor/bhv347

Li, Y., Liu, Y., Leung, A.Y., & Montayre, J. (2025). Technology-assisted motor-cognitive training among older adults: Rapid systematic review of randomized controlled trials. *JMIR Serious Games, 13*, Article e67250. https://doi.org/10.2196/67250

Maceira-Elvira, P., Popa, T., Schmid, A.-C., Cadic-Melchior, A., Müller, H., Schaer, R., Cohen, L.G., & Hummel, F.C. (2024). Native learning ability and not age determines the effects of brain stimulation. *NPJ Science of Learning, 9*(1), Article 69. https://doi.org/10.1038/s41539-024-00278-y

Müller-Putz, G.R., Kobler, R.J., Pereira, J., Lopes-Dias, C., Hehenberger, L., Mondini, V., Martínez-Cagigal, V., Srisrisawang, N., Pulferer, H., Batistić, L., & Sburlea, A.I. (2022). Feel your reach: An EEG-based framework to continuously detect goal-directed movements and error processing to gate kinesthetic feedback informed artificial arm control. *Frontiers in Human Neuroscience, 16*, Article 841312. https://doi.org/10.3389/fnhum.2022.841312

Real, M., & Schmittinger, F. (2022). A framework for experimenting co-creation in real-life contexts. In A. Deserti, M. Real, & F. Schmittinger (Eds.), *Co-creation for responsible research and innovation: Experimenting with design methods and tools* (pp. 11–24). Springer International Publishing. https://doi.org/10.1007/978-3-030-78733-2_2

Seidler, R.D., & Carson, R.G. (2017). Sensorimotor learning: Neurocognitive mechanisms and individual differences. *Journal of NeuroEngineering and Rehabilitation, 14*(1), Article 74. https://doi.org/10.1186/s12984-017-0279-1

Smits, D.-W., van Meeteren, K., Klem, M., Alsem, M., & Ketelaar, M. (2020). Designing a tool to support patient and public involvement in research projects: The involvement matrix. *Research Involvement and Engagement, 6*(1), Article 30. https://doi.org/10.1186/s40900-020-00188-4

Sobierajewicz, J., Przekoracka-Krawczyk, A., Jaśkowski, W., & van der Lubbe, R.H.J. (2017). How effector-specific is the effect of sequence learning by motor execution and motor imagery? *Experimental Brain Research, 235*(12), 3757–3769. https://doi.org/10.1007/s00221-017-5096-z

Surkar, S.M., Lin, C.-C., Trotter, B., Phinizy, T., & Sylcott, B. (2025). Effects of dual-task training on cognitive-motor learning and cortical activation: A non-randomized clinical trial in healthy young adults. *PLoS One, 20*(5), Article e0322036. https://doi.org/10.1371/journal.pone.0322036

Tao, Y., Liang, Q., Zhang, F., Guo, S., Fan, L., & Zhao, F. (2024). Efficacy of non-invasive brain stimulation combined with antidepressant medications for depression: A systematic review and meta-analysis of randomized controlled trials. *Systematic Reviews, 13*(1), Article 92. https://doi.org/10.1186/s13643-024-02480-w

Valentini, N.C., Nobre, G.C., & Gonçalves Duarte, M. (2022). Gross motor skills trajectory variation between WEIRD and LMIC countries: A cross-cultural study. *PLoS One, 17*(5), Article e0267665. https://doi.org/10.1371/journal.pone.0267665

Verwey, W.B. (2024). C-SMB 2.0: Integrating over 25 years of motor sequencing research with the discrete sequence production task. *Psychonomic Bulletin & Review, 31*(3), 931–978. https://doi.org/10.3758/s13423-023-02377-0

WEAVE. (2025). *Research funding without borders*. https://weave-research.net/

Zabolotniy, A., Chan, R.W., Moiseeva, V., & Fedele, T. (2025). Convolutional neural networks decode finger movements in motor sequence learning from MEG data. *Frontiers in Neuroscience, 19*, Article 1623380. https://doi.org/10.3389/fnins.2025.1623380