CHAPTER 3
THE IMPORTANCE OF NEUROPLASTICITY IN AQUATIC EDUCATION

Juan Antonio Moreno Murcia and Adolfo Aracil Marco

How to cite this publication:
Moreno-Murcia, J. A., & Aracil, A. (2026). The importance of neuroplasticity in aquatic education. In R. Fonseca-Pinto, A. Albarracín, A. Ortiz, F. Yázigi, & J. A. Moreno-Murcia (Eds.), *Integral aquatic education: foundations, practices, and evidence* (pp. 25- 32). Sb editorial.

THE IMPORTANCE OF NEUROPLASTICITY IN AQUATIC EDUCATION

Juan Antonio Moreno Murcia and Adolfo Aracil Marco

Neuroplasticity allows the brain to adapt and improve skills in the aquatic environment through progressive and varied practice. Daily advances and positive reinforcement are essential for consolidating confidence and aquatic competence. To do so, it is necessary to adapt the education to individual rhythms and to promote motivation. Thus, brain plasticity enables an efficient and lasting aquatic learning.

Introduction

Learning is a dynamic process that involves the brain's ability to adapt and change in response to new experiences. This characteristic of the brain, known as neuroplasticity, is fundamental to aquatic education, where the repetition of movements and progressive exposure to the aquatic environment enable improvement in coordination, confidence, and ultimately, aquatic competence. Through an approach based on gradual learning and progressive skill consolidation, you can optimise the motor and cognitive learning in the aquatic environment, ensuring a safe and efficient adaptation.

In this document, we will explore how neuroplasticity influences aquatic education and how the application of progressive methods favours learning and adaptation to water.

Brain plasticity and its impact on aquatic learning

Neuroplasticity, also known as brain, neuronal or synaptic plasticity, refers to the brain's ability to change and reorganise according to experience and the surroundings (Gazerani, 2025). This phenomenon is key in the learning process, especially in contexts where the development of new motor and cognitive skills is required, such as in aquatic education (Masabeu, 2022).

Even though not all brains present a similar brain structure, the way in which their neural circuits are organised varies significantly from one person to another. These differences are not exclusively determined by genes, but they depend on the constant interaction between the person and their surroundings (Pascual-Leone et al., 2005). In the context of aquatic education, each experience in the water can potentially modify the brain and improve the learner's skills through repetition and conscious practice.

One of the clearest and best-documented examples of brain plasticity is observed during memory consolidation. In this process, neural circuits in the hippocampus and prefrontal cortex coordinate their oscillations to stabilize newly acquired information. These changes allow memories to shift from being dependent on the hippocampus to being durably stored in cortical regions, which facilitates more efficient retrieval (Gazerani, 2025).

Need to learn progressively in the aquatic environment

The studies about neuroplasticity and behavioural psychology have proven that small and consistent changes can provoke great transformations (Schlaug, 2015). This is especially relevant in education in the aquatic environment, in which the adaptation to the water and the development of abilities have to be performed progressively and structurally.

Swimming and other aquatic activities require a complex combination of motor and cognitive abilities. From flotation to the coordination of movement with legs and arms, each action involves activation and reorganisation of specific neural circuits. Brain plasticity plays a fundamental role in this process, enabling the formation of new synaptic connections that promote learning and the automatization of movements (Kleim & Jones, 2008).

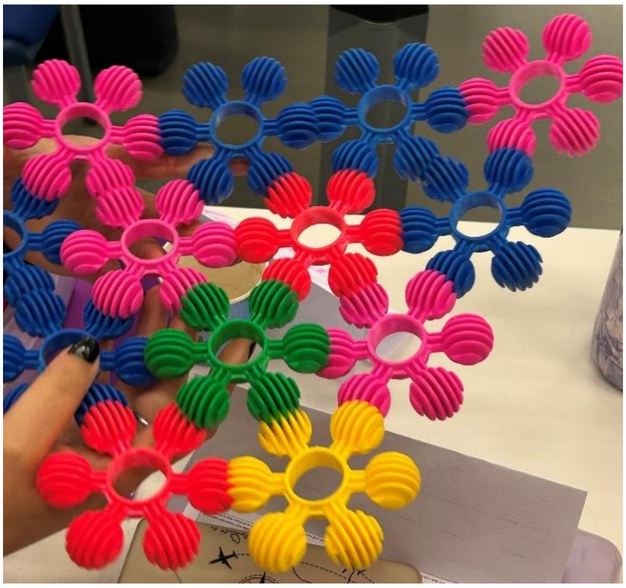
At a neural level, when a group of neurons is frequently activated simultaneously, their connections are strengthened (Hebb, 1949). In practice in the aquatic environment, this principle is evident when a person repeats a stroke pattern or a breathing technique until they turn into a natural and efficient movement. The systematic repetition of these exercises reinforces the involved neural circuits, making the execution of the activity more fluid and precise over time.

Variety in repetition: a key element for motivation and effective learning

Albeit repetition is essential to consolidate abilities and strengthen neural connections, how you do it is determinant to avoid demotivation and stagnation in learning and to improve the transfer of knowledge to different contexts (Ranganathan & Newell, 2013).

The motor learning theory indicates that varying the exercises, the environments and the conditions under which an ability is practised helps to consolidate a more solid and acceptable learning (Dhawale et al., 2017). In the case of aquatic education, this can be applied by changing the speed of the exercises, modifying breathing patterns, incorporating aquatic games or alternating the conditions of training, such as practising in different depths or with different floating implements.

From the perspective of motivation, the lack of variety in practice generates boredom and decreases the learner's disposition to continue improving (Deci & Ryan, 1985). Incorporating diverse strategies in aquatic education, such as including games in training, progressive challenges or dynamic positive reinforcements, can increase the student's commitment and facilitate more effective learning.



Moreover, educational neuroscience suggests that variability in repetition activates different areas of the brain and improves synaptic plasticity, easing the generalisation of the acquired knowledge (Wulf & Shea, 2002). Therefore, in aquatic education, promoting varied learning not only strengthens the learner's technique and confidence, but also optimises long-term retention and their ability to adapt to new challenges in the water.

Step-by-step learning in aquatic education

The importance of completing small daily advances in the learning process in the aquatic environment. Like in molecular processes, in which precision, repetition and optimisation are essential, the acquisition of the aquatic competence has to be structured in gradual steps. The system theory (Bertalanffy, 1976) shows us that progressive changes enable a better adaptation and a more effective consolidation of learning.

This methodological approach is based on:

- Undertaking small daily actions. Practising simple tasks such as progressive immersion or flotation before moving on to more complex techniques.
- Positive reinforcement. Celebrating advances and accomplishments in each step of the learning process strengthens motivation and trust in the water (Moreno-Murcia, 2025a).

- Continuous improvement. Evaluating and adjusting teaching according to individual progress, allowing each person to adapt at their own pace.

The impact of neuroplasticity in the adaptation to the aquatic environment

Neuroplasticity not only allows us to learn to swim but also enables the emotional and psychological adaptation to the aquatic environment. Many people experience fear or insecurity when entering the water for the first time (Moreno-Murcia, 2025b). Nevertheless, through progressive exposition and the repetition of positive experiences, the brain reconfigures its connections to generate a more relaxed and efficient response to this environment (Gezerani, 2025), as, if a person learns something incorrectly or has bad learning experiences, plasticity can turn against them.

In order for neuroplasticity to have a greater impact on aquatic education, we propose the following phases:

Phase 1. Strengthening and reorganisation of neural connections through exposure to the aquatic environment and sensorial integration. For example, with games in which facial immersion is undertaken voluntarily (proposing that the participants blow soap bubbles in a bucket and then, in the water, these bubbles that emerge from the bucket can touch the child's hand or body).

Phase 2. Developing basic motor patterns through repetition and movement variability. For example, with aquatic circuits (organising stations with different tasks: jumping inside of the water, picking up objects from the bottom at different depths, etc., or completing displacements with support in different materials or positions, generating varied ways of displacement).

Phase 3. Consolidating aquatic motor abilities through automation and reinforcement of efficient patterns. For instance, following an achievement diary (encouraging participants and families to register their daily advances in a notebook or a group mural, celebrating each small progress).

Phase 4. Refining motor patterns and improving the efficiency of aquatic competence. For instance, in games for scared participants, introducing relaxation activities and games on the edge of the pool (beach zone), using the necessary adapted material.

Phase 5. Integrating aquatic competence in varied contexts for better flexibility and adaptability in the aquatic environment. For example, experimenting in different contexts or scenarios, deep area, shallow area, water temperature or natural environments.

Phase 6. Undertaking an evaluation to check the importance of real competence perception, including families. For instance, doing a simple and visual evaluation with a visual rubric (designing a table in which you can mark the autonomy level in fundamental skills with coloured faces).

In this sense, adopting a gradual approach in aquatic education enables the optimisation of learning and minimisation of anxiety. Similarly to any other habit, the repetition of small actions generates lasting changes in the brain, consolidating essential motor and emotional skills for security and confidence in the water (Dweck, 2006). Moreover, it is key to consider the relationship between variability, repetition, teaching progression and objectives. The first experience with an ability has to be positive and awaken the participant's interest and from there, the proposals have to be approached in a way that

progressively challenge them inside of the same complexity level (horizontal progression) and, moving forward, maintain the same objective with increasing levels of difficulty /vertical progression). This does not entail constantly changing exercises nor introducing something in each session, but to ensure that every learning opportunity generates a noticeable change in the student's conduct, either in the motor, cognitive or emotional spheres, within the developing ability.

Conclusion

Neuroplasticity is a constant process that is subjacent to every kind of learning, including aquatic education. Regular practice in the aquatic environment strengthens neural connections responsible for motor coordination, emotional regulation and sensory adaptation. Moreover, an essential feature of swimming education is that it initiates in an artificial, controlled and professionally supervised environment, specifically to enable the student to operate confidently in a natural, dynamic and unpredictable environment. Applying progressive methods based on small and consistent changes allows for optimised aquatic learning, ensuing a more efficient and less stressful process.

Understanding how the brain is modified through experience and repetition allows us to design more effective teaching strategies, guaranteeing that each person, regardless of their initial level, manages to develop their aquatic competence step by step, integrating doing with thinking and feeling.

References

Bertalanffy, L. V. (1976). *Teoría general de los sistemas*. Editorial Fondo de Cultura Económica.Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media. https://doi.org/10.1007/978-1-4899-2271-7

Dhawale, A. K., Smith, M. A., & Ölveczky, B. P. (2017). The Role of Variability in Motor Learning. *Annual Review of Neuroscience*, *40*, 479–498. https://doi.org/10.1146/annurev-neuro-072116-031548

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House.

Gazerani, P. (2025). The neuroplastic brain: Current breakthroughs and emerging frontiers. *Brain Research*, *1858*, 149643. https://doi.org/10.1016/j.brainres.2025.149643

Hebb, D. O. (1949). *The Organization of Behavior: A Neuropsychological Theory*. Wiley.

Kleim, J. A., & Jones, T. A. (2008). Principles of experience-dependent neural plasticity: Implications for rehabilitation after brain damage. *Journal of Speech, Language, and Hearing Research*, *51*(1), S225-S239. https://doi.org/10.1044/1092-4388(2008/018)

Masabeu, E. J. (2022). Aspectos nerocientíficos aplicados a las situaciones de

enseñanza aprendizaje en el medio acuático. En Alejandro E. Ruiz, Robert A. Strauss, Marcelo C. Ruiz y Emilio J. Masabeu (Eds.), *Vivir el agua* (pp. 193-228). Editorial Autores de Argentina.
Moreno-Murcia, J. A. (2025a). ¿Funcionan los castigos para enseñar a nadar? En R. Fonseca-Pinto, A. Albarracín Pérez, A. Ortiz Olivar, F. Yázigi, & J. A. Moreno-Murcia (Eds.), *Nuevos horizontes en las actividades acuáticas. Ciencia, innovación y práctica* (pp. 47-56). Sb editorial.
Moreno-Murcia, J. A. (2025b). *Enseñar a nadar sin miedo*. Sb Editorial.
Pascual-Leone, A., Amedi, A., Fregni, F., & Merabet, L. B. (2005). The plastic human brain cortex. *Annual Review of Neuroscience*, *28*, 377-401. https://doi.org/10.1146/annurev.neuro.27.070203.144216
Ranganathan, R., & Newell, K. M. (2013). Changing up the routine: intervention-induced variability in motor learning. *Exercise and Sport Sciences Reviews*, *41*(1), 64–70. https://doi.org/10.1097/JES.0b013e318259beb5
Schlaug, G. (2015). Musicians and music making as a model for the study of brain plasticity. *Progress in Brain Research*, *217*, 37-55. https://doi.org/10.1016/bs.pbr.2014.11.020
Wulf, G., & Shea, C. H. (2002). Principles derived from the study of simple motor skills do not generalize to complex skill learning. *Psychonomic Bulletin & Review*, *9*(2), 185-211. https://doi.org/10.3758/BF03196276