

2.1 Motor transfer

| | |
|-----------------|---|
| Author | [Arupinum] |
| Editor | [Nickol Udovičič, Marko Bolha] |
| Version status | [V1.0] |
| Issue date | [19/12/2025] |
| Submission date | [] |
| Project number | [101184066] |
| Acronym | [KeYs] |
| Project title | [Keeping our young generations in sports] |

Deliverable Factsheet



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Table of contents

| | |
|---|----|
| Abstract..... | 3 |
| Introduction to motor transfer | 4 |
| Aquatic sports | 7 |
| Sports with ball | 12 |
| Other land-based sports | 17 |
| Take home messages for coaches and athletes | 22 |
| Conclusion..... | 23 |
| References | 24 |



**Co-funded by
the European Union**

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Abstract

This document provides a structured theoretical and practical overview of motor transfer and its relevance for rowing development (flat and coastal rowing). Motor transfer is addressed as a key educational and performance-related mechanism through which physical, technical, cognitive, and behavioural competences acquired in one sport can be transferred to another. The document reflects Erasmus+ Sport priorities by promoting innovation in training approaches, cross-sectoral learning, and holistic athlete development. The content is organised into three thematic sections: aquatic sports, sports with a ball, and other land-based sports. Within each section, five sports were selected based on the expert evaluation of the KEYS Technical Commission as those demonstrating the highest potential for positive motor transfer to rowing. The selection criteria consider movement similarities, physiological demands, coordination and decision-making requirements, and relevance to flat and beach sprint rowing contexts.

Each sport is analysed using a unified and replicable framework. This includes a brief description of sport-specific characteristics and development needs, identification of motor transfer to rowing, and assessment of reciprocal transfer from rowing to the selected sport. To support transparency and transferability of results, each sport is evaluated using a 1–10 relevance scale, where 1 indicates no motor transfer and 10 indicates a very strong motor transfer. Separate scores are assigned for transfer into rowing and for transfer from rowing into the selected sport. Furthermore, practical implementation guidelines demonstrate how sport-specific elements can be integrated into rowing training programmes, with particular emphasis on adaptability, inclusion, injury prevention performance. Overall, the document serves as an applied knowledge resource for coaches, educators, and sport organisations. It supports the development of innovative, evidence-informed training models, encourages interdisciplinary cooperation, and contributes to the long-term sustainability and quality of rowing education in line with Erasmus+ Sport objectives.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Introduction to motor transfer

Motor transfer is a fundamental concept in movement science, motor learning, and kinesiology (Schmidt & Lee, 2019; Magill & Anderson, 2021). It refers to the phenomenon whereby learning, practice, or performance of one motor task influences the acquisition or execution of another motor task. This influence can be positive, negative, or neutral, and its magnitude depends on the similarity of movement structures, perceptual–cognitive demands, and the underlying neurophysiological mechanisms involved in motor learning. Motor transfer should not be understood merely as the transfer of a specific movement technique. Contemporary perspectives emphasize that transfer also encompasses the adaptation of motor control strategies, perceptual processes, decision-making, timing, balance, and the ability to regulate movement under varying environmental constraints (Newell, 1986; Krakauer et al., 2019). From this viewpoint, motor transfer represents a key mechanism through which humans build adaptable and transferable movement competence across different contexts. Motor transfer emerges as a consequence of how the central nervous system acquires, stores, and reorganizes movement-related information. During motor learning, repeated practice induces functional and structural changes in the brain, a process commonly referred to as experience-dependent neuroplasticity (Krakauer et al., 2019). These changes do not remain confined to a single motor task but can influence a broader network of motor representations.

At the cortical level, motor learning involves the primary motor cortex, premotor cortex, supplementary motor area, and parietal regions responsible for sensorimotor integration (Krakauer et al., 2019; Schmidt & Lee, 2019). Practice leads to the formation and refinement of neural motor programs and internal models that link motor commands with predicted sensory consequences. When a new task shares common coordination patterns, force–time characteristics, or perceptual demands with a previously learned task, these internal models can be partially reused or adapted, facilitating transfer. Subcortical structures also play a crucial role (Doyon et al., 2009; Krakauer et al., 2019). The cerebellum contributes to error detection, movement timing, and predictive control, allowing learned corrections to generalize to similar tasks. The basal ganglia are involved in movement selection, automatization, and habit formation, which explains why highly automated motor patterns may either support or interfere with new learning depending on task compatibility. From a learning perspective, motor transfer is closely related to the abstraction of invariant features of movement, such as relative timing, coordination between body segments, and control of degrees of freedom (Schmidt, 1975; Schmidt & Lee, 2019). Rather than storing isolated movements, the brain encodes generalized motor solutions that can be scaled and adapted to new situations. This process is further influenced by attentional focus, feedback, variability of practice, and the interaction between cognitive and motor processes.

Positive motor transfer occurs when prior learning or experience in one motor task enhances performance or accelerates learning in another task (Magill & Anderson, 2021). This typically arises when tasks share similar biomechanical structures, coordination patterns, perceptual cues, or control strategies. For example, well-developed trunk stability and rhythmical force production may positively transfer from one cyclic sport to another. Positive transfer is particularly evident when practice promotes adaptable motor solutions rather than rigid



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

movement patterns. Variable practice conditions, exposure to multiple task constraints, and emphasis on movement principles rather than exact technique tend to strengthen positive transfer effects.

Negative motor transfer refers to situations in which previously learned motor patterns interfere with the acquisition or execution of a new task (Schmidt & Lee, 2019). This often occurs when tasks appear superficially similar but require different coordination strategies, timing, or force application. Highly automated motor habits may be difficult to inhibit, leading to persistent errors in the new task. Negative transfer highlights the importance of task analysis and coaching strategies that deliberately disrupt inappropriate movement automatisms and promote the development of new control solutions.

Near transfer describes the transfer of learning between tasks that are highly similar in terms of movement structure, environmental context, or performance demands, whereas far transfer reflects deeper generalization across structurally different tasks (Barnett & Ceci, 2002; Magill & Anderson, 2021). Far transfer, in contrast, occurs between tasks that are structurally different but share deeper commonalities, such as decision-making under time pressure, balance control, or perceptual anticipation. While near transfer is more commonly observed and easier to induce, far transfer is of particular interest in long-term athlete development, as it reflects the acquisition of generalizable motor and cognitive capacities rather than sport-specific techniques alone.

In kinesiology, motor transfer provides a theoretical foundation for understanding how movement competence develops across the lifespan and across different physical activities (Newell, 1986; Schmidt & Lee, 2019). It underpins training design, physical education curricula, rehabilitation protocols, and talent development models. From a conceptual standpoint, kinesiology views motor learning as a dynamic interaction between the individual, the task, and the environment. Motor transfer emerges when this interaction fosters adaptable movement solutions that can be reorganized under new constraints. Consequently, effective training does not aim solely at optimizing performance in a single task, but at enriching the learner's movement repertoire and capacity for adaptation. This logic is particularly relevant in youth development, injury prevention, and interdisciplinary training approaches, where the goal is to build resilient, versatile movers rather than early specialization in narrow skill sets.

In practical training settings, motor transfer can be deliberately facilitated through thoughtful task selection and training structure. Coaches and practitioners can enhance positive transfer by:

- incorporating movement variability and constraint-based tasks,
- training underlying movement qualities such as balance, coordination, rhythm, and force control,
- using drills that challenge perception–action coupling rather than isolated muscle function,
- using different sports to enrich motor knowledge.





A growing body of practice integrates dual-task training, in which motor tasks are combined with cognitive demands such as decision-making, reaction to stimuli, or problem-solving (Pellecchia, 2005; Wulf, 2013). Dual-task conditions promote the integration of motor and cognitive processes, supporting transfer not only between physical tasks but also to so-called soft skills, including attention control, stress management, communication, and teamwork. By embedding cognitive challenges within movement tasks, training more closely reflects real-world and sport-specific environments, where performance rarely depends on motor execution alone.

Rowing, and particularly coastal rowing, provides a rich context for the application of motor transfer principles. Traditional rowing emphasizes cyclic force production, rhythm, intermuscular coordination, and precise timing, all of which can transfer to and from other endurance and power-based sports. Coastal rowing further amplifies the importance of adaptability, balance, perceptual awareness, and decision-making due to variable environmental conditions such as waves, wind, and changing race dynamics (Baudouin & Hawkins, 2004; Secher, 2007). As a result, training approaches that leverage motor transfer from other sports—or that deliberately design drills to promote far transfer—may be especially valuable. Understanding motor transfer allows coaches to justify cross-training strategies, integrate non-rowing activities into preparation phases, and design learning environments that support both performance and long-term athlete development. This chapter serves as a theoretical and practical foundation for the subsequent analysis of motor transfer between different sports and rowing, and vice versa. By clarifying the mechanisms, types, and applications of motor transfer, it provides a conceptual framework for examining how diverse movement experiences can enhance rowing performance, particularly in the evolving discipline of coastal rowing.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Aquatic sports

Water sports, such as kayaking, swimming, and stand-up paddleboarding, provide a valuable foundation for rowing due to their shared emphasis on balance, core stability, and upper body coordination. Engaging in diverse aquatic activities enhances proprioception, movement adaptability, and rhythmic force application, all of which are transferable to rowing strokes. Additionally, these sports cultivate cardiovascular endurance and muscular strength in movement patterns analogous to rowing, supporting positive motor transfer. From a cognitive perspective, navigating variable water conditions develops anticipatory skills, decision-making under dynamic constraints, and attention control, which are critical for coastal rowing performance. Cross-training in water sports not only reduces overuse injury risk by distributing load across different muscle groups but also promotes skill diversification and resilience in athletes. Therefore, incorporating a variety of water-based disciplines within training programs can effectively augment rowing-specific performance while fostering broader movement competence.

In the following chapter we selected 5 aquatic sports.

| Sport: Kayak | |
|--|---|
| <i>Sport characteristics and development needs:</i> Kayaking is a water-based sport requiring a combination of physical endurance, technical skill, and environmental awareness. Effective performance depends on stroke efficiency, balance, manoeuvrability, and the ability to adapt to changing water conditions. Strength, power, and cardiovascular endurance are essential for long-distance paddling, while safety and navigation skills, including water safety and rescue techniques, are crucial for both performance and risk management. | |
| <i>Identified needs/possible motor transfer to rowing:</i> Kayaking can positively contribute to rowing by enhancing stroke efficiency, dynamic balance, and overall manoeuvrability. Targeted strength and conditioning exercises develop endurance and power in muscle groups shared with rowing, particularly the core, shoulders, arms, and posterior chain. Furthermore, kayaking fosters environmental awareness and coordination, which can support decision-making and adaptability during coastal or open-water rowing sessions. | |
| Relevance of the motor transfer (scale 1-10) | 8 |
| <i>Motor transfer of rowing into selected sport:</i> Rowing provides substantial transfer to kayaking through developed strength, stroke rhythm, and coordination. Rowers transitioning to kayaking benefit from enhanced torso rotation, trunk stabilization, and upper-limb endurance. Practicing controlled, shorter strokes and stability exercises such as single-leg squats or dynamic core workouts further improves kayak control and adaptability in variable water conditions. | |
| Relevance of the motor transfer (scale 1-10) | 9 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> Kayaking can be effectively used as a cross-training tool to complement rowing programs, particularly for improving endurance, stroke efficiency, and water awareness. Strength training exercises targeting the core, shoulders, and arms, such as pull-ups, seated rows, and latissimus pulldowns, should be included to enhance both rowing and kayaking performance. Kettlebell swings and dumbbell squats can improve power and muscular endurance. Incorporating paddling sessions with varied stroke lengths and frequencies promotes adaptability and neuromuscular coordination. Interval training on the water supports cardiovascular fitness and high-intensity performance. Practicing kayaking in diverse environments, including rivers, lakes, and open water, can further enhance adaptability and tactical decision-making relevant for rowing competitions. Periodization and individualized progression are essential to maximize positive motor transfer while minimizing risk of overuse or injury. | |

| Sport: Sailing | |
|---|---|
| <i>Sport characteristics and development needs:</i> | |
| Sailing is a dynamic, skill-intensive water sport that requires a combination of physical endurance, technical expertise, and strategic decision-making. Performance relies on effective core engagement, balance, precise timing, coordination, and the ability to adapt to changing environmental conditions. Sailing also demands hand and forearm strength for rope and line handling, as well as mental resilience to maintain focus over extended periods and under challenging conditions. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| Sailing develops core strength and rotational power through handling lines and manoeuvring around the boat, which directly supports powerful and sustainable rowing strokes. Maintaining body awareness and upright posture in varying conditions enhances postural control, stability, and efficient force application in rowing. "Reading the water" fosters anticipatory skills and environmental adaptation, which can improve tactical decision-making in rowing. Endurance requirements in longer sailing sessions contribute to cardiovascular conditioning, while hand and forearm strength support a secure grip on the oars. The coordinated movements of sailing, combining upper- and lower-body actions with precise timing, reinforce neuromuscular control applicable to complex rowing movements. | |
| Relevance of the motor transfer (scale 1-10) | 7 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing provides benefits for sailing by enhancing cardiovascular endurance, core stability, balance, upper-body strength, and adaptability to diverse water conditions. The development of sustained stroke rhythm and postural control in rowing can improve efficiency and control in sailing manoeuvres. | |
| Relevance of the motor transfer (scale 1-10) | 8 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Training for rowing can incorporate principles from sailing to improve core engagement, posture, and rhythmic movement. Balance exercises, including single-leg squats and stability ball workouts, support postural control and stability. Additionally, training drills that simulate decision-making and reaction to variable conditions can strengthen mental resilience and anticipatory skills relevant for both rowing and sailing. Integrating these exercises in a periodized and progressive manner maximizes positive motor transfer while minimizing the risk of negative transfer or injury. | |



Sport: Swimming

Sport characteristics and development needs:

Swimming is a technically demanding and physically intensive water sport that requires a combination of aerobic endurance, muscular strength, and precise motor skill execution. Successful swimming performance relies on full-body engagement, controlled breathing, stroke mechanics, coordination, and mental focus, as well as the ability to sustain effort over variable distances and intensities.

Identified needs/possible motor transfer to rowing

Swimming supports rowing by developing strong core musculature, improving body positioning, and enhancing postural control in the water. Swimmers' emphasis on smooth, rhythmic strokes mirrors rowing's need for coordinated and efficient oar propulsion. Controlled breathing patterns and aerobic conditioning in swimming translate into improved oxygen regulation and endurance for rowers. Furthermore, swimming promotes upper-body and back strength, which supports rowing stroke power and technical stability.

Relevance of the motor transfer (scale 1-10)

7

Motor transfer of rowing into selected sport

Rowing contributes to swimming performance by enhancing cardiovascular endurance, trunk stabilization, and leg strength. The repetitive, cyclic movement patterns in rowing improve neuromuscular coordination, which can be applied to swimming strokes and efficient water displacement.

Relevance of the motor transfer (scale 1-10)

7

Suggestions: how to implement sport specific training into rowing? – recommendations

Steady-state swimming sessions can be integrated to build aerobic endurance for long rowing distances. Swimming engages the core, shoulders, and back muscles, complementing rowing-specific strength development. Dryland exercises such as pull-ups, latissimus pulldowns, and resistance band routines should be included to reinforce rowing muscles. Breath-hold and controlled-breathing drills can improve lung capacity and endurance. Emphasis on stroke timing, efficiency, and smooth, rhythmic movements in swimming can enhance neuromuscular coordination, translating to improved rowing stroke mechanics. Periodization should ensure that swimming sessions complement rowing training without excessive fatigue or interference with on-water performance.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

| Sport: Stand-Up Paddleboarding (SUP) | |
|---|---|
| <i>Sport characteristics and development needs:</i> Stand-Up Paddleboarding (SUP) is a versatile water sport combining elements of surfing and paddling. It requires balance, core engagement, and coordination between the upper and lower body, with particular emphasis on arm, shoulder, and back strength. Environmental awareness and adaptability are also essential, as paddlers must adjust to varying water conditions, currents, and wind. | |
| <i>Identified needs/possible motor transfer to rowing</i> SUP enhances balance and core stability, engages the legs, core, arms, and shoulders, and promotes environmental awareness. These capabilities transfer to rowing by supporting stability in the boat, improving trunk and shoulder engagement during strokes, and reinforcing coordination across multiple muscle groups. SUP can also be performed on lakes, rivers, and oceans, offering varied training conditions that contribute to neuromuscular adaptability. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Motor transfer of rowing into selected sport</i> Rowing develops strong core and upper-body strength, which is essential for SUP balance and effective paddle propulsion. Rowers' experience with long, powerful strokes can be adapted to SUP through controlled, shorter paddling movements. The stamina and understanding of water currents, wind, and navigation developed in rowing directly benefit SUP performance. | |
| Relevance of the motor transfer (scale 1-10) | 8 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> SUP training can be incorporated into rowing programs to improve core engagement and stability, particularly in dynamic or rough-water conditions. Exercises such as lunges, squats, planks, and balance drills can enhance strength and proprioception, directly supporting rowing technique. SUP paddling emphasizes proper stroke mechanics, which reinforces controlled and efficient rowing movements. Alternating between rowing and SUP sessions allows for training variety, reduces the risk of repetitive strain injuries, and contributes to overall endurance and neuromuscular coordination. Periodization and progressive intensity should ensure optimal positive motor transfer while minimizing fatigue or negative interference with rowing performance. | |

Sport: Water polo

Sport characteristics and development needs:

Water polo is a physically demanding team sport that requires a combination of upper- and lower-body strength, cardiovascular endurance, agility, tactical awareness, and rapid decision-making. Athletes must execute explosive movements, maintain balance while treading water, and coordinate complex actions under dynamic conditions.

Identified needs/possible motor transfer to rowing

Water polo emphasizes upper-body strength, lower-body endurance, rapid changes in direction, spatial awareness, and quick decision-making. These physical and cognitive skills can transfer to rowing by enhancing muscular endurance, neuromuscular coordination, and adaptability under varying conditions. The combination of explosive and sustained movements in water polo complements rowing's power-endurance demands.

Relevance of the motor transfer (scale 1-10)

7

Motor transfer of rowing into selected sport

Rowing develops powerful back, shoulder, and arm muscles, which can improve water polo passing, shooting, and defensive actions. Core engagement and trunk stabilization gained from rowing enhance balance and stability while treading water. The endurance and high-intensity bursts in rowing translate well to the demands of water polo matches. Rowers' precise timing and coordination can also benefit passing accuracy and tactical positioning in water polo.

Relevance of the motor transfer (scale 1-10)

8

Suggestions: how to implement sport specific training into rowing? – recommendations

Rowers can incorporate treading-water drills or resistance-based leg exercises to enhance lower-body endurance. High-intensity interval training (HIIT) and plyometric exercises support the development of explosive power. Medicine ball throws, rotational core exercises, and dynamic stability drills reinforce trunk strength and neuromuscular coordination. Swimming-based endurance sessions maintain cardiovascular fitness, while exercises mimicking water polo movements—such as overhead presses, quick directional changes, and reaction-based drills—can enhance adaptability and decision-making under physical stress. Periodized integration of these drills ensures safe progression and maximizes positive motor transfer to rowing.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Sports with ball

Ball sports, such as basketball, soccer, and handball, offer significant benefits for rowing by developing coordination, spatial awareness, and dynamic balance under variable conditions. These sports enhance reaction time, decision-making, and team communication skills, which are directly transferable to crew-based rowing environments. Engaging in ball sports also promotes agility, quick changes of direction, and multi-planar movement control, supporting positive motor transfer to rowing strokes that require adaptive timing and force modulation. Cognitive demands inherent in team ball sports foster attentional focus, anticipatory skills, and strategic thinking, complementing the mental requirements of both on-water and coastal rowing. Additionally, ball sports diversify physical load patterns and reduce the risk of overuse injuries by engaging different muscle groups, while simultaneously enhancing cardiovascular fitness and general movement competence. Therefore, integrating ball sports into rowing training programs can effectively strengthen both physical and cognitive aspects of rowing performance.

In the following chapter we selected 5 sports with the ball.

| Sport: Basketball | |
|--|---|
| <i>Sport characteristics and development needs:</i> | |
| Basketball is a high-intensity, team-based sport requiring a combination of aerobic and anaerobic endurance, explosive power, agility, coordination, and strategic decision-making. Players must perform repeated sprints, jumps, rapid changes of direction, and precise ball-handling skills under dynamic conditions. Mental focus, spatial awareness, and anticipatory skills are essential for both offensive and defensive performance. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| Basketball develops lower-body strength (quadriceps, hamstrings, glutes) and explosive power through jumps and sprints, which can enhance leg drive in rowing. Upper-body strength, trunk stability, and coordination developed during passing, shooting, and defensive movements support rowing stroke efficiency and posture. Agility and quick decision-making in basketball can enhance cognitive flexibility and reaction speed in rowing, particularly in crew coordination and adapting to variable water conditions. | |
| Relevance of the motor transfer (scale 1-10) | 7 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing contributes to basketball performance by improving cardiovascular endurance, trunk and core stability, and muscular strength in the back, shoulders, and arms. These adaptations can enhance postural control, balance, and power in jumps, sprints, and ball-handling. Repetitive rowing movements reinforce neuromuscular coordination and rhythm, supporting efficient movement patterns in basketball. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Basketball contributes to beach sprint performance through its emphasis on explosive leg power, rapid acceleration and deceleration, and agility during changes of direction. Jumping, sprinting, and lateral movements in basketball develop lower-body strength and neuromuscular coordination that directly support powerful push-offs and quick footwork on sand. Additionally, basketball's cognitive demands—such as spatial awareness, anticipatory skills, and fast decision-making—enhance the athlete's ability to adapt to variable beach terrain and environmental conditions. Upper-body strength and trunk stability gained through shooting, passing, and defensive movements further support balance and efficient energy transfer during the rowing start and sprint phases. Integrating basketball-based drills into beach sprint preparation can therefore improve overall speed, agility, power, and adaptive motor control. | |



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Sport: Beach volleyball

Sport characteristics and development needs:

Beach volleyball is a high-intensity team sport performed on unstable sand surfaces, requiring a combination of explosive power, agility, balance, coordination, and tactical awareness. The sport places significant demands on lower-limb strength, core stability, and neuromuscular control due to frequent jumping, sprinting, rapid directional changes, and landing on unstable terrain. In addition, beach volleyball requires quick decision-making, spatial awareness, and effective communication between teammates under physically demanding conditions.

Identified needs/possible motor transfer to rowing

Beach volleyball develops explosive lower-body power, particularly in the quadriceps, hamstrings, and gluteal muscles, which are essential for effective leg drive in rowing. The unstable sand surface enhances proprioception, balance, and core activation, supporting postural control and force transfer during the rowing stroke. Upper-body strength and coordination developed through spiking, blocking, and defensive actions contribute to shoulder stability and trunk control. Furthermore, the cognitive demands of beach volleyball—anticipation, reaction speed, and teamwork—can positively influence crew coordination and adaptability in rowing.

Relevance of the motor transfer (scale 1-10) 7

Motor transfer of rowing into selected sport

Rowing contributes to beach volleyball performance by enhancing cardiovascular endurance, core stability, and upper-body strength. The sustained trunk engagement and postural control developed in rowing support balance during dynamic movements and landing tasks. Additionally, rowing improves force coordination and muscular endurance, which can help athletes maintain performance levels during extended rallies and matches.

Relevance of the motor transfer (scale 1-10) 6

Suggestions: how to implement sport specific training into rowing? – recommendations

Beach volleyball-inspired exercises can be effectively integrated into rowing training to enhance explosive power, balance, and neuromuscular coordination. Plyometric drills, such as jump squats, bounding, and lateral hops on sand or unstable surfaces, can improve leg drive and force production relevant to the rowing stroke. Core stabilization exercises emphasizing anti-rotation and dynamic balance support efficient force transfer in both classic rowing and coastal rowing disciplines. From a beach sprint perspective, beach volleyball is particularly valuable due to its emphasis on rapid acceleration, deceleration, and directional changes on sand. These movement demands closely resemble the running phase of beach sprint racing, where athletes must accelerate quickly from the shoreline, maintain balance on unstable terrain, and transition efficiently into the boat. Incorporating beach volleyball drills enhances lower-limb power, ankle and knee stability, reaction speed, and decision-making under fatigue, all of which are critical for optimal beach sprint performance. Periodized integration ensures positive motor transfer while minimizing the risk of overload or negative transfer.



**Co-funded by
the European Union**

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

| Sport: Rugby | |
|---|---|
| <i>Sport characteristics and development needs:</i> | |
| Rugby is a high-intensity, collision-based team sport that requires exceptional levels of strength, power, speed, endurance, and tactical awareness. The sport is characterized by repeated bouts of sprinting, rapid accelerations and decelerations, changes of direction, and frequent physical contact. Rugby places high demands on lower-body strength, trunk stability, upper-body power, and neuromuscular coordination, as well as mental toughness and decision-making under physical and cognitive stress. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| Rugby develops powerful lower-limb musculature and explosive strength, particularly in the hips, quadriceps, and hamstrings, which directly support leg drive and force production in rowing. High demands on trunk and core stability during contact situations enhance the ability to transfer force efficiently from the lower to the upper body. Upper-body strength and shoulder stability developed through tackling and ball-carrying contribute to injury resilience and postural control relevant for rowing. Additionally, rugby's emphasis on sprinting, agility, and repeated high-intensity efforts can support anaerobic capacity and fatigue resistance in rowing. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing contributes to rugby performance by improving cardiovascular endurance, trunk stability, and muscular strength in the back, shoulders, and arms. The sustained force application and coordination developed in rowing support postural control and power transmission during scrums, tackles, and ball-handling actions. Furthermore, rowing enhances mental resilience and the ability to sustain high effort levels, which are critical during prolonged phases of rugby competition. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Rugby-inspired training elements can be integrated into rowing preparation to enhance strength, power, and contact stability. Strength exercises such as heavy squats, deadlifts, sled pushes, and resisted sprint drills can improve leg drive and force production relevant to the rowing stroke. Core stabilization and anti-rotation exercises support efficient force transfer and trunk control in both classic rowing and coastal rowing. From a Beach Sprint perspective, rugby is particularly valuable due to its emphasis on explosive acceleration, short-distance sprinting, and the ability to maintain stability under external perturbations. These qualities closely resemble the demands of the beach run, rapid boat entry, and powerful start phases in beach sprint rowing. Rugby-based agility drills, contact-preparation exercises, and high-intensity interval efforts can enhance lower-body power, joint stability, and decision-making under fatigue, supporting optimal performance in dynamic coastal racing environments. Periodized integration ensures positive motor transfer while minimizing injury risk. | |

Sport: Dodgeball

Sport characteristics and development needs:

Dodgeball is a fast-paced team sport characterized by repeated short sprints, rapid changes of direction, throwing and catching actions, and continuous perceptual–cognitive demands. The sport requires high levels of agility, reaction speed, hand–eye coordination, spatial awareness, and decision-making under time pressure. Upper-body power, shoulder mobility, and core stability are essential to perform repeated throwing actions efficiently while maintaining balance and body control.

Identified needs/possible motor transfer to rowing

Dodgeball contributes to the development of explosive movements, quick reactions, and dynamic balance, which support rowing performance, particularly in environments that require rapid adaptation. Repeated throwing actions enhance shoulder stability, coordination, and neuromuscular control, supporting injury prevention in the rowing shoulder complex. The requirement to accelerate, decelerate, and change direction improves lower-body coordination and proprioception, indirectly supporting movement efficiency during boat handling and dynamic phases of rowing, especially in coastal conditions.

Relevance of the motor transfer (scale 1-10)

6

Motor transfer of rowing into selected sport

Rowing supports dodgeball performance by improving general endurance, trunk stability, and upper-body strength. Core stability developed through rowing enhances postural control during throwing, dodging, and catching actions. The ability to sustain repeated high-intensity efforts and maintain technical consistency under fatigue, developed in rowing training, can improve overall performance and decision-making quality in dodgeball.

Relevance of the motor transfer (scale 1-10)

5

Suggestions: how to implement sport specific training into rowing? – recommendations

Dodgeball-based activities can be integrated into rowing training as a playful yet effective method for developing reaction speed, coordination, and decision-making under pressure. Short dodgeball games or throwing–catching drills can be used during warm-ups or recovery sessions to stimulate neuromuscular activation and cognitive engagement. Medicine ball throwing, reactive catching drills, and partner-based evasion exercises can further enhance upper-body coordination and trunk control.

From a Beach Sprint perspective, dodgeball is particularly valuable due to its emphasis on rapid reactions, spatial awareness, and quick decision-making in unpredictable environments. These skills closely resemble the demands of beach starts, boat handling in crowded conditions, and tactical positioning around turns and finishes. Integrating dodgeball-inspired drills can enhance athletes’ ability to react quickly, maintain balance under perturbations, and adapt movement strategies in high-pressure coastal racing situations.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Sport: Floorball

Sport characteristics and development needs:

Floorball is a high-intensity indoor team sport characterized by frequent accelerations and decelerations, rapid changes of direction, and continuous stick handling in a low body position. The sport places high demands on lower-limb strength and agility, trunk rotation, hand–eye coordination, and perceptual–cognitive skills. Players must maintain dynamic balance while performing asymmetrical movements, requiring strong core stabilization and efficient force transfer between the lower and upper body.

Identified needs/possible motor transfer to rowing

Floorball contributes to the development of lower-body explosiveness, coordination, and trunk rotation, which are essential for effective force transfer during the rowing stroke. The low playing posture and repeated transitions between upright and flexed positions enhance hip mobility and postural control, supporting efficient rowing biomechanics. The sport’s emphasis on rotational movements improves transverse-plane strength and neuromuscular control, which are important for stabilizing the trunk during high-power rowing and for injury prevention, particularly in the lower back and hips.

Relevance of the motor transfer (scale 1-10)

6

Motor transfer of rowing into selected sport

Rowing supports floorball performance by developing aerobic and anaerobic endurance, trunk stability, and coordinated force production through the kinetic chain. Improved core endurance helps maintain a stable posture during prolonged defensive and offensive actions, while enhanced leg strength supports repeated sprint efforts. The ability to sustain high-intensity work under fatigue, developed in rowing training, can positively influence movement efficiency and decision-making in floorball.

Relevance of the motor transfer (scale 1-10)

6

Suggestions: how to implement sport specific training into rowing? – recommendations

Floorball-inspired drills can be used in rowing training to develop agility, rotational strength, and perceptual–cognitive skills. Short-sided floorball games or modified stick-and-ball drills can be incorporated into warm-ups or coordination sessions to stimulate rapid decision-making and reactive movement. Off-water training may include rotational medicine ball throws, lateral lunges, and change-of-direction drills to replicate floorball movement patterns. From a beach sprint perspective, floorball is particularly valuable due to its demands on rapid acceleration, sharp directional changes, spatial awareness, and decision-making under pressure. These skills closely align with beach starts, sprint running on sand, quick boat entry, and tactical manoeuvring around buoys. Training elements derived from floorball can therefore enhance athletes’ ability to adapt quickly to dynamic race situations and maintain movement efficiency in unpredictable coastal environments.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Other land-based sports

Other sports, including gymnastics, track and field, cycling, and climbing, provide complementary benefits for rowing by enhancing general motor skills, strength, flexibility, and coordination. These activities foster balance, postural control, and proprioceptive awareness, which are essential for maintaining optimal body alignment and force application in rowing. Sports such as gymnastics and climbing improve core stability and joint mobility, facilitating efficient stroke mechanics and injury prevention. Track and field and cycling contribute to cardiovascular endurance and lower body power, which are crucial for overall rowing performance. Engaging in a variety of land-based sports also promotes adaptability in motor control, multi-planar movement competence, and cognitive skills such as focus, anticipation, and decision-making under dynamic conditions. Integrating these diverse physical activities into rowing training can thus support holistic athletic development, enhance rowing-specific capabilities, and reinforce positive motor transfer.

In the following chapter we selected 5 sports on land without ball.

| Sport: Olympic weightlifting | |
|---|--|
| <i>Sport characteristics and development needs:</i> | |
| Olympic weightlifting is a competitive strength sport characterized by the requirement for high levels of maximal and explosive strength combined with excellent joint mobility, flexibility, and neuromuscular stabilization. The sport consists of two primary lifts: the snatch and the clean and jerk. Successful performance depends on rapid force production, precise intermuscular coordination, efficient force transmission through the kinetic chain, and high postural control under external load. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| The fundamental physical and coordinative demands of Olympic weightlifting show strong similarities to those of rowing, particularly in terms of explosive strength, mobility, and stabilization. These functional capacities can positively influence rowing technique and biomechanics, contributing to a more effective and efficient rowing stroke. In addition to performance enhancement, improved strength, mobility, and trunk stabilization derived from weightlifting can play a significant role in injury prevention. Both Olympic lifts promote coordinated force transfer from the lower extremities through the trunk to the upper extremities, which closely aligns with the kinetic sequencing required during the rowing stroke. | |
| Relevance of the motor transfer (scale 1-10) | 8 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing demonstrates a more limited motor transfer to Olympic weightlifting. However, it may contribute to the reinforcement of general muscle coordination and power development along the kinetic chain from the feet toward the upper limbs. Due to its cyclic and rhythmical nature, rowing may also support concentration, proprioceptive awareness, and kinesthetic sensitivity, which can indirectly benefit Olympic weightlifting athletes, particularly during technical refinement and load management. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Weightlifting-derived auxiliary exercises should be used to develop whole-body strength and explosive power in rowers. Training programs should systematically include mobility, stability, and flexibility exercises to support safe and efficient force production. More experienced athletes may incorporate selected Olympic lifts (snatch or clean and jerk) into their strength training routines; however, this should only be done after proper technical instruction and gradual progression to minimize injury risk and ensure effective motor learning. In practice, emphasis should be placed on weightlifting derivatives and partial lifts (e.g., power cleans, hang snatches, clean pulls, squats) that closely align with rowing-specific force application and kinetic sequencing. Training should prioritize low repetitions with high technical quality rather than maximal loads, particularly during the competitive season. Olympic weightlifting exercises are best integrated within a periodized strength program and combined with rowing-specific drills to maximize positive transfer. Continuous technical feedback, appropriate recovery strategies, and individualized load management are | |
|  <p>Co-funded by the European Union</p> | <p>“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”</p> |

essential to ensure that gains in strength and power are effectively translated into improved rowing performance.

| Sport: Roller skating /Ice skating | |
|---|---|
| <i>Sport characteristics and development needs:</i> | |
| Roller skating and ice skating require high levels of lower-limb strength and muscular endurance, particularly in the quadriceps, hamstrings, and gluteal muscles. Both sports are characterized by cyclic gliding movements that demand coordinated action between the upper and lower extremities, as well as precise balance control. The alternating engagement of contralateral arms and legs places significant demands on core muscle activation to ensure trunk stabilization while maintaining dynamic balance during propulsion and directional changes. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| Skating contributes to the development of lower-limb strength, especially in the gluteal muscles, hamstrings, and quadriceps, which are essential for effective force generation during the rowing stroke. The emphasis on hip extension and lateral force application supports improved force transfer from the legs to the trunk, with increased activation of the posterior chain. Enhanced hamstring strength and neuromuscular control may also contribute to knee joint stability and injury prevention, which is particularly relevant in rowing populations exposed to repetitive loading. Additionally, the gliding nature of skating promotes rhythmic movement patterns and efficient force application, which align well with rowing biomechanics. | |
| Relevance of the motor transfer (scale 1-10) | 7 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing, as an endurance-based cyclic sport, can positively contribute to skating performance by improving aerobic capacity, lower-limb strength, and coordinated force transfer from the legs through the trunk to the upper body. The sustained core activation required in rowing may enhance trunk stability during skating movements. Furthermore, rowing training can support the development of explosive leg strength, which is beneficial for acceleration and speed changes in both roller skating and ice skating. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Skating can be effectively used as a complementary training modality for low-intensity endurance sessions, allowing athletes to increase overall training volume when on-water rowing is not feasible. It can also be employed for interval-based training while reducing cumulative mechanical load on the lumbar spine, which is often highly stressed during rowing. In addition, skating may be particularly beneficial for beach sprint preparation, as improved gluteal strength and neuromuscular control contribute to enhanced ankle and knee stability during running on unstable surfaces. From a practical perspective, skating sessions should emphasize technical quality, controlled gliding, and symmetrical force application to reinforce efficient movement patterns. Training formats may include prolonged steady-state skating for aerobic development, tempo intervals to improve force sustainability, and short acceleration drills to target explosive lower-limb power. When integrated into rowing programs, skating should be periodized according to the training phase and combined with rowing-specific technical and strength exercises to ensure that lateral movement patterns support, rather than interfere with, sagittal-plane rowing mechanics. Continuous monitoring of fatigue, balance asymmetries, and individual adaptation is recommended to maximize positive motor transfer while minimizing the risk of negative transfer. | |



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Sport: Cycling

Sport characteristics and development needs:

Cycling is an endurance-based cyclic sport that requires a high level of aerobic capacity and sustained force production, primarily engaging the muscles of the lower extremities and the posterior chain, including the gluteal muscles and spinal extensors. Similar to rowing, cycling places strong demands on mental resilience and the ability to tolerate prolonged discomfort during continuous or high-intensity efforts. Due to its accessibility and widespread use, cycling is commonly incorporated into training programs as both a primary and supplementary conditioning modality.

Identified needs/possible motor transfer to rowing

Cycling is frequently used in rowing training due to its positive transfer effects on aerobic endurance, lower-limb strength endurance, and psychological robustness. It allows athletes to increase overall training volume while reducing mechanical stress on the upper body, spine, and shoulder girdle compared to on-water rowing. The cyclic nature of pedalling supports rhythmic force production and reinforces sustained leg drive, which aligns well with the propulsion demands of the rowing stroke.

Relevance of the motor transfer (scale 1-10) 8

Motor transfer of rowing into selected sport

Rowing can contribute to cycling performance through improved neuromuscular coordination, enhanced force transmission from the legs through the trunk, and increased trunk and upper-body muscle activation. The postural control and core stability developed in rowing may support improved cycling posture and efficiency, particularly during prolonged efforts or high-power outputs.

Relevance of the motor transfer (scale 1-10) 6

Suggestions: how to implement sport specific training into rowing? – recommendations

Cycling can be effectively integrated into rowing training programs as a low-impact endurance modality to increase overall training volume when environmental or logistical conditions limit on-water rowing. Its high relevance for rowing stems primarily from shared physiological and mechanical characteristics, including cyclic lower-limb force production, sustained aerobic energy demands, and the requirement for mental resilience during prolonged efforts. These shared demands explain the relatively high degree of positive motor transfer between cycling and rowing, particularly with respect to endurance development and leg-driven propulsion. Cycling is also well suited for interval-based sessions, allowing athletes to target aerobic and anaerobic energy systems while reducing cumulative mechanical loading on the lumbar spine, shoulder girdle, and upper extremities. Importantly, cycling represents a valuable training modality during rehabilitation or modified training phases. It is commonly used in cases of lower back pain, rib stress fractures, or upper-body overuse injuries, as it enables the maintenance of cardiovascular fitness and lower-limb conditioning under controlled and reduced mechanical stress conditions.



**Co-funded by
the European Union**

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

| Sport: Cross country skiing | |
|---|---|
| <i>Sport characteristics and development needs:</i> | |
| Cross country skiing, similar to skating, engages a large number of lower-limb muscles and requires substantial core stabilization and dynamic balance. Unlike skating, cross-country skiing also involves coordinated force production from the upper torso and arms to propel the athlete forward. The sport places significant demands on aerobic endurance, neuromuscular coordination, and mental resilience, requiring athletes to tolerate prolonged discomfort and maintain technical precision over extended durations. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| Cross country skiing can serve as a complementary training modality to increase training volume at easy to moderate intensity. It is particularly useful during the winter preparation period, providing high training volume with minimal impact on joints and muscles. Additionally, cross country skiing can be effectively employed for interval-based sessions, allowing athletes to develop aerobic capacity, muscular endurance, and rhythmic coordination without excessive spinal or upper-limb loading. | |
| Relevance of the motor transfer (scale 1-10) | 8 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing can positively influence cross country skiing performance, particularly during the summer preparation period. It enhances muscle coordination, power development, and core stability, supporting efficient force transfer from the lower to the upper body. Furthermore, rowing improves aerobic endurance and upper-limb and trunk strength, which are directly relevant for effective propulsion in cross country skiing. | |
| Relevance of the motor transfer (scale 1-10) | 6 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| Cross country skiing can be strategically integrated as a complementary endurance modality, particularly during winter or off-water periods, to maintain aerobic conditioning with minimal impact on joints and upper-body structures. Interval-based skiing sessions can target both aerobic and anaerobic energy systems while reducing cumulative mechanical loading on the lumbar spine, shoulders, and arms. Additionally, skiing promotes coordinated force application between the lower and upper body, enhancing neuromuscular transfer to rowing strokes. Skiing drills emphasizing poling technique, rhythm, and balance can reinforce trunk stabilization and upper-limb endurance. Periodization should ensure that skiing complements rowing technical and strength sessions, and session intensity, duration, and recovery should be individually adjusted to optimize positive transfer and minimize the risk of negative or non-specific transfer. Finally, cross country skiing can also be used to enhance mental resilience and pacing strategies, which are critical for both long-distance rowing and coastal sprint performance. | |

| Sport: CrossFit | |
|---|---|
| <i>Sport characteristics and development needs:</i> | |
| CrossFit is a high-intensity functional fitness regime that incorporates a wide variety of exercises, including Olympic weightlifting, plyometrics, powerlifting, gymnastics, calisthenics, and high-intensity interval training. It emphasizes functional movements performed under controlled conditions, promoting general physical preparedness, muscular coordination, and cardiovascular endurance. However, performing CrossFit exercises without sufficient technique or body control can increase the risk of injury, highlighting the importance of structured coaching and progressive load management. | |
| <i>Identified needs/possible motor transfer to rowing</i> | |
| CrossFit can serve as a complementary training tool during rowing preparation periods by adding diversity to training sessions. Its varied movements contribute to enhanced motor learning, improved overall fitness, greater muscular coordination, and the ability to adapt rapidly to changing physical demands and environments. The multi-planar, high-intensity exercises can enhance neuromuscular adaptability and facilitate the development of rapid force production, which can support rowing performance in both endurance and sprint contexts. | |
| Relevance of the motor transfer (scale 1-10) | 7 |
| <i>Motor transfer of rowing into selected sport</i> | |
| Rowing, particularly on rowing ergometers, is sometimes included in CrossFit routines. Proper rowing technique increases efficiency, improves aerobic and muscular endurance, and reduces the risk of injury. As such, rowing can reinforce trunk stabilization, coordination, and strength development relevant to various CrossFit movements. | |
| Relevance of the motor transfer (scale 1-10) | 5 |
| <i>Suggestions: how to implement sport specific training into rowing? – recommendations</i> | |
| CrossFit can be integrated into rowing programs to enhance high-intensity interval training sessions, strengthen core stability, and develop explosive power. Its diversity can be leveraged to improve intermuscular coordination, rapid force production, and adaptability to dynamically changing environments, supporting dual-task training approaches relevant for coastal rowing and beach sprints. Specific CrossFit movements should be selected and periodized to complement rowing-specific strength and endurance exercises, with a focus on technique, recovery, and progressive intensity to maximize positive motor transfer while minimizing the risk of injury or negative transfer. | |





Take home messages for coaches and athletes

- Motor transfer is trainable and intentional: Cross-training should be planned strategically, not used randomly, to target specific rowing and Beach Sprint demands.
- Match the sport to the rowing discipline: Sports with a ball are particularly effective for developing beach sprint-specific skills, while cyclical, swimming, skating sports better support flat rowing performance.
- Use variability to build robustness: Exposure to different movement patterns enhances adaptability, coordination, and resilience to fatigue and environmental stressors.
- Support injury prevention through diversity: Complementary sports allow high training volumes while reducing repetitive strain on rowing-specific structures.
- Develop soft skills alongside physical capacities: Decision-making, spatial awareness, stress management, and teamwork can be effectively trained through selected non-rowing sports.
- Integrate, don't replace: Complementary sports should enrich rowing training, especially during preparation, transition, and rehabilitation phases.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

Conclusion

This document has provided a structured overview of motor transfer and its practical application in rowing, with a particular focus on flat rowing and beach sprint. By integrating theoretical foundations with applied examples from multiple sport domains, the document highlights motor transfer as a valuable tool for enhancing performance, supporting injury prevention, and fostering holistic athlete development. The systematic analysis across aquatic sports, sports with a ball, and other land-based sports demonstrates how diversified movement experiences can positively influence rowing-specific physical, technical, and cognitive capacities.

One of the key findings of this analysis is that sports with a ball show a stronger and more direct motor transfer to beach sprint disciplines. Their emphasis on agility, rapid changes of direction, explosive acceleration, spatial awareness, and decision-making under pressure closely aligns with the demands of beach starts, sprint running on sand, boat entry, and tactical manoeuvring in dynamic coastal environments. These sports therefore represent an effective training resource for developing adaptability, reactivity, and soft skills in Beach Sprint athletes.

In contrast, cyclical sports such as kayaking, cycling, skating, and cross-country skiing demonstrate a stronger transfer to flat rowing. Their repetitive movement patterns, endurance demands, and emphasis on continuous force production and rhythm closely correspond to the biomechanical and physiological requirements of classical rowing. These sports are particularly valuable for building aerobic capacity, technical efficiency, and sustainable power output while managing cumulative training load. Overall, the findings support the strategic integration of selected complementary sports into rowing training programmes. Such an approach enhances performance, increases training diversity, and aligns with contemporary principles of long-term athlete development and Erasmus+ Sport objectives.



Co-funded by
the European Union

“Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EACEA]. Neither the European Union nor the granting authority can be held responsible for them.”

References

- Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin*, 128(4), 612–637. <https://doi.org/10.1037/0033-2909.128.4.612>
- Baudouin, A., & Hawkins, D. (2004). A biomechanical review of factors affecting rowing performance. *British Journal of Sports Medicine*, 38(4), 396–402. <https://doi.org/10.1136/bjism.2002.003954>
- Doyon, J., Bellec, P., Amsel, R., Penhune, V., Monchi, O., Carrier, J., ... Benali, H. (2009). Contributions of the basal ganglia and functionally related brain structures to motor learning. *Behavioural Brain Research*, 199(1), 61–75. <https://doi.org/10.1016/j.bbr.2008.11.012>
- Krakauer, J. W., Hadjiosif, A. M., Xu, J., Wong, A. L., & Haith, A. M. (2019). Motor learning. *Comprehensive Physiology*, 9(2), 613–663. <https://doi.org/10.1002/cphy.c170043>
- Magill, R. A., & Anderson, D. I. (2021). *Motor learning and control: Concepts and applications* (12th ed.). McGraw-Hill Education.
- Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), *Motor development in children: Aspects of coordination and control* (pp. 341–360). Martinus Nijhoff.
- Pellecchia, G. L. (2005). Dual-task training reduces impact of cognitive task on postural sway. *Journal of Motor Behavior*, 37(3), 239–246. <https://doi.org/10.3200/JMBR.37.3.239-246>
- Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review*, 82(4), 225–260. <https://doi.org/10.1037/h0076770>
- Schmidt, R. A., & Lee, T. D. (2019). *Motor learning and performance: From principles to application* (6th ed.). Human Kinetics.
- Secher, N. H. (2007). Rowing. In J. G. Garrett & D. T. Kirkendall (Eds.), *Exercise and sport science* (pp. 837–843). Lippincott Williams & Wilkins.
- Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. *International Review of Sport and Exercise Psychology*, 6(1), 77–104. <https://doi.org/10.1080/1750984X.2012.723728>

