

Manual for the land-based and water-based MAT (adapted from<sup>1</sup>)

## 1. Land-based MAT

<b>Standing balance</b>			<b>SB</b>
<i>Participants perform various exercises while standing.</i>			
Progression: BOS	Progression: Catching & Throwing	Progression: Tools	
Narrow BOS	Alone	Number of objects for throwing	
Semi-tandem stance	With partner	Kind of objects (small sacks, balls, ...)	
Tandem stance			
One leg stance (+movements of opposite leg)			
Half kneeling			
Sensory modification	Visual: closed eyes		
	Somatosensory: various unstable support surfaces		
	Vestibular: head turns (horizontal, vertical)		
Cognitive add-on	-		
<b>"Chaosball"</b>			<b>SB</b>
<i>An object (e.g. ball) is passed in a group in a certain sequence, participants follow the sequence and recall certain attributes of the group members.</i>			
Progression: Number of sequences/objects			
1 sequence (= 1 object)			
Switching: 2 sequences (= 2 objects)			
Simultaneously: 2 sequences (= 2 objects)			
Simultaneously: 3 sequences (= 3 objects)			
Sensory modification	Visual: -		
	Somatosensory: various unstable support surfaces		
	Vestibular: -		
Cognitive add-on (main focus)	Memory: Recall orders		
	Divided attention: more than one object		
<b>Balancing on lines</b>			<b>DB</b>
<i>Participants follow the lines on the gym floor.</i>			
Progression: BOS, DOM	Progression: Movement	Progression: Speed of movement	
Narrow gait	High knees	Slow swing phase (e.g., 3s)	
Tandem gait	Lunges		
Forwards, backwards			
Sensory modification	Visual: Perform several steps with eyes closed		
	Somatosensory: -		
	Vestibular: Upper body & head turns		
Cognitive add-on	Double-task: Pairs of two, trailing partner gives commands for stops or turns for leading partner		
	Double-task: Pairs of two, trailing partner has to move synchronously with leading partner		
<b>Stepping</b>			<b>DB</b>
<i>Participants perform various forms of steps.</i>			
Progression: DOM	Progression: Movement	Progression: Tools	
Forwards, backwards, sideways	High knees	Stepping out of hoop	
Combination of directions	Lunges		
	Floor "touches"		
Sensory modification	Visual: closed eyes		
	Somatosensory: Various unstable support surfaces		
	Vestibular: Head turns (horizontal, vertical, diagonal)		
Cognitive add-on	Memory: Each direction gets a number (e.g. front = 1)		
<b>"Transport chain"</b>			<b>DB</b>
<i>Over 5-10m each participant follows a line, but after each collective step an object is "transported" (e.g. thrown).</i>			
Progression: BOS, DOM	Progression: Movement	Progression: Tools	
Narrow gait	High knees	Number of tools to be thrown	
Tandem gait	Lunges	Kind of objects (small sacks, balls, ...)	
forwards, backwards			
Sensory modification	Visual: -		
	Somatosensory: -		
	Vestibular: Upper body & head turns (horizontal)		
Cognitive add-on	-		
<b>"Commander"</b>			<b>DB</b>
<i>Pairs of two: one participant has to react to the commands of the other. Commands are different combinations of a step and simultaneous catch.</i>			
Progression: Movement	Progression: Starting position	Progression: Number of commands	
Tasks for one side of body	On the floor	2 to 8	
Tasks for both sides of body (e.g. step left, catch right)	On the floor but inside a hoop		
	On unstable support surface		
	180° turn before step and catch		
Sensory modification	Visual: closed eyes (starting position)		
	Somatosensory: Various unstable support surfaces (starting position)		
	Vestibular: 180° turns before catch		
Cognitive add-on (main focus)	Memory: Recall pairs (movement+number / movement+color word / movement+number or color word)		
	Inhibition: command = stay in place		
	Reaction: commander minimizes time to react		

<b>"Movement memory"</b>		DB
<i>Participants move through the gym while performing gait variations coded with various commands given by therapist.</i>		
Progression: Movement	Progression: Number of pairs	
Tasks for one side of body	4 to 8	
Tasks for both sides of body (e.g. left knee up & right hand to left shoulder)		
Similarity of movements		
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on (main focus)	Memory: Recall pairs (movement+number / movement+color word / movement+number or color word) Inhibition: command = stop	

<b>"Remote control"</b>		DB
<i>Pairs of two: a participant is steered through the room with closed eyes via tactile cues of the partner.</i>		
Progression: number of cues	Progression: movement	
3 to 6	Tandem walk, high knees	
Sensory modification	Visual: closed eyes Somatosensory: - Vestibular: turning in place	
Cognitive add-on	Spatial orientation: report location in space to partner (closed eyes)	

<b>Walking with tasks</b>		AG
<i>Each participant performs various tasks (e.g. touch opposite knee while throwing an object left to right) while walking back and forth on a 20m lane.</i>		
Progression: DOM, speed	Progression: movement	Progression: tools
Forwards, backwards, sideways	Tasks for one side of body	Kind of objects (small sacks, balls, ...)
walking, jogging	Tasks for both sides of body (e.g. left knee, right hand)	
Sensory modification	Visual: - Somatosensory: - Vestibular: Head turns (horizontal)	
Cognitive add-on	-	

<b>Agility ladder</b>		AG
<i>Participants perform exercises in an agility ladder on the floor. Number and type of foot contacts in each field are varied.</i>		
Progression: DOM, speed	Progression: complexity	Progression: tools
Forwards, backwards, sideways	Easier sequences (2 / 3 touches)	Kind of objects (small sacks, balls, ...)
	Harder sequences (1,2,3,2,1 / 2 forwards 1 back / 2 in 1 out)	
Sensory modification	Visual: - Somatosensory: - Vestibular: Head turns	
Cognitive add-on	Divided attention: Participants have to call numbers shown by therapist Divided attention: Participants have to catch objects thrown by therapist	

<b>Cone tipping</b>		AG
<i>Pairs of two: one participant starts surrounded by an assemble of cones. The partner outside of the cones says which cones have to be touched.</i>		
Progression: speed, duration	Progression: number of cones	
Walking, jogging	4 to 8	
1 round = 30s		
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on	Spatial orientation & memory: directions are given by numbers, colors or alphabet	

<b>Slalom</b>		AG
<i>Participants move through a slalom parcours.</i>		
Progression: speed, duration	Progression: number of obstacles	Progression: competition
Walking, jogging	4 to 8	Hit a target with an object at the end of slalom
1 round = 60-90s		
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on	-	

<b>Soccer</b>		AG
<i>Participants move and pass a ball.</i>		
Progression: speed, duration	Progression: number of players	Progression: change of direction
Walking, jogging	1 to 4	Front - back
1 round = 60-90s		Front - back and sideways Random
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on	Attention: participants have to react to stop and change of direction signals by therapist	

<b>"Suicide runs"</b>			<b>AG</b>
<i>The length of the gym is split into 3 sections. Participants cover each section in different speeds, accelerating and decelerating</i>			
Progression: speed, duration	Progression: Stops at end of section	Progression: competition	
Walking, jogging 1 round = 45-90s	touch a cone circle a cone stop - 2 steps back - accelerate forwards	Hit a target with an object at the end	
Sensory modification	Visual: - Somatosensory: - Vestibular: -		
Cognitive add-on	-		

## 2. Water-based MAT

<b>Standing balance</b>			<b>SB</b>
<i>Participants perform various exercises while standing in the pool.</i>			
Progression: BOS	Progression: free leg	Progression: hands	
Narrow BOS	Floor "touches"	Inside water	
Semi-tandem stance	Leg swings	Outside water	
Tandem stance	Number, amplitude, direction of swings		
One leg stance (+movements of free leg)			
Sensory modification	Visual: closed eyes Somatosensory: standing on kickboard Vestibular: head turns (horizontal, vertical)		
Cognitive add-on	-		

<b>Gait and jump variations</b>			<b>DB</b>
<i>Participants perform gait and jump variations in a lane.</i>			
Progression: BOS, DOM	Progression: movement	Progression: hands	
Narrow gait	High knees	Inside water	
Tandem gait	Lunges	Outside water	
Forwards, backwards, sideways	Hot steps, skipping gait Single-leg, two-legged jumps, hold landing position 3s jumping jack		
Sensory modification	Visual: closed eyes Somatosensory: walking with feet on 1-2 kickboard(s) Vestibular: head turns (horizontal, vertical, diagonal)		
Cognitive add-on	Memory: 4 variations of jumping jack		

<b>"Movement memory"</b>			<b>DB</b>
<i>Participants move through the water while performing gait variations coded with various commands given by therapist.</i>			
Progression: movement	Progression: number of pairs		
Only legs/only arms	4 to 8		
Combination of arms + legs, one-side of body			
Combination of arms + legs, both sides of body			
Similarity of movements			
Sensory modification	Visual: - Somatosensory: - Vestibular: -		
Cognitive add-on (main focus)	Memory: recall pairs (movement+number / movement+color word / movement+number or color word) Inhibition: command = stop		

<b>"Commander"</b>			<b>DB</b>
<i>Pairs of two. One participant must respond to the commands of the partner. The commands consist of different combinations of a catch and step.</i>			
Progression: movement	Progression: starting position	Progression: number of commands	
Catch/step = same side of body	Floor	2 to 8	
Catch/step = diagonal	standing on kickboard 180° turns before catching		
Sensory modifications	Visual: starting position with closed eyes Somatosensory: kickboard (starting position) Vestibular: 180° turns (starting position)		
Cognitive add-on (main focus)	Memory: recall pairs (movement + number / movement + color / movement + number or color) Inhibition: command = stop Reaction: reduce response time		

<b>"Circuit Training"</b>			<b>DB</b>
<i>Participants complete a circuit as pairs, consisting of various functional leg strength exercises.</i>			
Progression: duration, speed			
45-60s per exercise, 2-3 rounds, 3-4 exercises per round			
Exercises include: running, swimming, jumping, step-ups			
Sensory modifications	Visual: - Somatosensory: - Vestibular: -		
Cognitive add-on	-		

<b>"Chaosball"</b>		SB/AG
<i>Participants stand in a circle and throw a ball to each other in a certain order. Various attributes of other participants must be remembered in the process.</i>		
Progression: number of orders / objects		
1 order (= 1 object)		
Change: 2 orders (= 2 objects)		
Simultaneously: 2 orders (= 2 objects)		
Simultaneously: 3 orders (= 3 objects)		
Sensory modifications	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on (main focus)	Memory: recall orders Divided attention: more than one object Spatial orientation: comply with order, while participants no longer stand in a circle, but walk/run around in the pool	

<b>"Waiter"</b>		AG
<i>Participants balance a ball on a kickboard and simultaneously perform different exercises.</i>		
Progression: DOM, speed	Progression: movement	
Walk, jog	Balance ball, throw & catch ball	
Forwards, backwards, turns	Change hands on kickboard Throw & catch ball while changing hands	
Sensory modification	Visual: Move eyes away from ball Somatosensory: - Vestibular: throw & catch with 180°/360° turns	
Cognitive add-on (main focus)	Dual-task: walk/jog & balance ball & react to commands from therapist Divided attention: balance ball while commands given by therapist include hand signs Memory: commands from therapist are given via numbers or via a mix of numbers, hand signs, and/or clapping Processing speed: react as fast as possible to commands given by therapist	

<b>"Compass"</b>		AG
<i>Participants move in the directions given by therapist.</i>		
Progression: speed, duration	Progression: number of directions	
Walking, jogging	4 to 8 (front, back, side, diagonal)	
1 round = 45-60s		
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on	Memory: recall pairs (direction+number / direction+color word) Inhibition: therapist gives false cues Processing speed: react as fast as possible to commands	

<b>"Mirror"</b>		AG
<i>Pairs of two. One participant leads, the other follows while always keeping the same distance.</i>		
Progression: speed, duration	Progression: fakes	
Walking, jogging, competition (shake off)	Leader fakes change of direction Leader changes speeds	
45-60sec.		
Sensory modification	Visual: - Somatosensory: - Vestibular: -	
Cognitive add-on	-	

<b>"Beachball"</b>		AG
<i>Participants play with a beachball.</i>		
Progression: number of players		
2 to whole group		
Sensory modification	Visual: - Somatosensory: standing on kickboard Vestibular: -	
Cognitive add-on	-	

MAT = multimodal agility-based exercise training; BOS = Base of support; DOM = Direction of movement

### Components

- SB = Standing balance
- DB = Dynamic balance & functional leg strength
- AG = Agility

Each bracket represents a module. Each module targets one of the three components.

1. Callesen J, Cattaneo D, Brincks J, et al. How do resistance training and balance and motor control training affect gait performance and fatigue impact in people with multiple sclerosis? A randomized controlled multi-center study. *Mult Scler* 2020;26(11):1420-32. doi: 10.1177/1352458519865740 [published Online First: 20190724]