

Table 1. Characteristics of the study participants ($N = 26$)

Characteristic	Value
Sex [f / m]	13 / 13
Age [years]	24.5 ± 3.1
Body height [cm]	177.9 ± 8.6
Body mass [kg]	73.3 ± 13.4
Body mass index [kg/m^2]	23.0 ± 2.9
Leg length [cm]	93.8 ± 5.5
Dominant leg [l / r]	4 / 22

Data are group mean values \pm standard deviations. f = female; l = left; m = male; r = right

Table 2. Balance performance during free compared to restricted arm movement conditions

Test	Free	Restricted	<i>p</i> -value
<i>OLS test</i>			
EO, FI [s]	60.0 ± 0.1	59.6 ± 2.2	.327
EO, FO [s]	60.0 ± 0.1	57.9 ± 7.3	.151
EC, FI [s]	40.5 ± 21.9	36.6 ± 22.4	.491
EC, FO [s]	9.7 ± 7.6	9.1 ± 6.6	.730
<i>3-m beam walk test</i>			
6.0-cm width [steps]	7.8 ± 0.7	7.4 ± 1.3	.101
4.5-cm width [steps]	7.7 ± 1.1	6.3 ± 2.2	<.001
3.0-cm width [steps]	6.3 ± 1.8	4.4 ± 1.9	<.001
<i>YBT-LQ test</i>			
AT reach [% LL]	71.5 ± 7.1	68.4 ± 6.1	.004
PM reach [% LL]	120.3 ± 9.5	113.3 ± 7.0	<.001
PL reach [% LL]	116.3 ± 7.3	110.1 ± 6.5	<.001

Data are group mean values \pm standard deviations. AT = anterior reach direction; EC = eyes closed; EO = eyes opened; FI = firm ground; FO = foam ground; LL = leg length; OLS = one-legged stance; PL = posterolateral reach direction; PM = posteromedial reach direction; YBT-LQ = Lower Quarter Y Balance test

Table 3. Joint kinematics for the Lower Quarter Y Balance test per reach direction during free compared to restricted arm movement conditions

	Anterior		Posteromedial		Posterolateral	
Joint	Free	Restricted	Free	Restricted	Free	Restricted
<i>Trunk</i>						
Extension (+) / flexion (-)	-19.8 \pm 16.4	-18.1 \pm 17.1	-47.0 \pm 8.6	-47.4 \pm 8.8	-49.3 \pm 12.7	-51.2 \pm 9.0
Right (+) / left (-) bending	5.2 \pm 9.1	2.8 \pm 9.1	19.6 \pm 27.1	22.4 \pm 27.5	-12.7 \pm 36.6	-14.2 \pm 26.1
<i>Shoulder</i>						
Anteversion (+) / retroversion (-)	23.3 \pm 30.3	-11.1 \pm 29.5*	51.3 \pm 26.6	-6.5 \pm 24.8*	50.9 \pm 30.9	-9.6 \pm 29.7*

Abduktion (+) / adduktion (-)	45.6 ± 28.6	41.1 ± 22.3	63.2 ± 24.8	40.4 ± 17.5*	66.5 ± 33.0	43.4 ± 18.1*
External (+) / internal (-) rotation	-26.9 ± 18.6	-51.2 ± 29.0*	-28.7 ± 19.9	-50.7 ± 41.6*	-34.1 ± 24.6	-55.5 ± 16.5*
<i>Elbow</i>						
Flexion (+) / extension (-)	13.6 ± 16.9	54.4 ± 22.0*	11.7 ± 19.9	58.6 ± 16.3*	17.3 ± 13.7	66.1 ± 17.4*
<i>Pelvis</i>						
Anterior (+) / posterior (-) tilt	7.4 ± 8.3	7.5 ± 12.1	30.8 ± 9.6	32.2 ± 8.6	33.0 ± 12.6	35.4 ± 9.8
Upward (+) / downward (-) obliquity	-2.49 ± 4.0	-1.6 ± 4.6	-7.6 ± 8.6	-8.0 ± 7.1	16.3 ± 12.5	17.4 ± 10.2
Internal (+) / external (-) rotation	-0.06 ± 0.1	-0.05 ± 0.1	-0.1 ± 0.2	-0.1 ± 0.2	0.7 ± 3.3	0.1 ± 0.2
<i>Hip</i>						
Flexion (+) / extension (-)	38.4 ± 24.4	36.9 ± 24.5	63.6 ± 19.6	64.4 ± 13.7	67.8 ± 26.1	68.6 ± 19.2
Abduktion (+) / adduktion (-)	-7.0 ± 10.3	-8.5 ± 9.9	-1.7 ± 10.2	-2.0 ± 11.0	-6.7 ± 8.0	-8.8 ± 8.0
External (+) / internal (-) rotation	0.1 ± 29.4	-0.5 ± 14.9	-1.5 ± 25.2	-1.5 ± 24.5	8.5 ± 34.1	8.4 ± 25.6
<i>Knee</i>						
Flexion (+) / extension (-)	54.8 ± 19.3	51.4 ± 19.9	52.1 ± 12.0	49.6 ± 10.3	45.2 ± 13.3	43.0 ± 9.9
Valgus (+) / varus (-)	-3.0 ± 6.5	-2.2 ± 7.3	-4.0 ± 6.5	-4.4 ± 7.7	-15.2 ± 8.2	-15.0 ± 7.1
External (+) / internal (-) rotation	0.3 ± 15.6	-0.7 ± 18.6	1.4 ± 18.6	7.1 ± 20.2	15.2 ± 14.5	18.8 ± 16.2
<i>Ankle</i>						
Dorsi (+) / plantarflexion (-)	19.4 ± 6.5	18.8 ± 5.1	16.9 ± 7.8	17.2 ± 5.8	14.9 ± 8.5	17.3 ± 4.1
External (+) / internal (-) rotation	10.6 ± 20.2	6.5 ± 15.9	12.1 ± 19.7	10.3 ± 21.6	11.2 ± 17.0	15.3 ± 12.1
Inversion (+) / eversion (-)	-6.1 ± 6.9	-6.5 ± 6.7	-6.4 ± 8.9	-6.9 ± 7.0	-7.5 ± 9.0	-7.8 ± 7.3

Data are group mean values ± standard deviations. Values refer to the maximal reach distance achieved per reach direction. *Represents a significant ($p < .05$) difference to the free arm movement condition.

Table 4. Joint kinematics for the 3-m beam walking backward test per beam width during free compared to restricted arm movement conditions

	6.0 cm width		4.5 cm width		3.0 cm width	
Joint	Free	Restricted	Free	Restricted	Free	Restricted
<i>Trunk</i>						
Extension (+) / flexion (-)	-13.5 ± 10.6	-15.3 ± 8.1	-15.0 ± 11.1	-16.9 ± 9.5	-20.6 ± 10.3	-20.9 ± 8.6
Right (+) / left (-) bending	0.3 ± 5.7	-0.6 ± 4.1	2.8 ± 17.6	0.1 ± 6.0	0.3 ± 19.1	2.0 ± 7.4
<i>Shoulder</i>						
Anteversion (+) / retroversion (-)	19.1 ± 21.5	-22.6 ± 8.5*	25.6 ± 20.8	-21.1 ± 9.6*	33.5 ± 21.4	-15.5 ± 13.9*
Abduktion (+) / adduktion (-)	44.6 ± 16.3	33.6 ± 7.4*	47.8 ± 17.5	35.9 ± 5.7*	50.1 ± 17.6	36.5 ± 6.2*
External (+) / internal (-) rotation	-13.5 ± 15.1	-49.3 ± 12.3*	-12.9 ± 11.4	-51.6 ± 11.1*	-16.8 ± 16.1	-58.5 ± 18.8*
<i>Elbow</i>						
Flexion (+) / extension (-)	22.6 ± 19.3	60.9 ± 12.1*	19.4 ± 15.6	61.9 ± 11.6*	17.9 ± 15.0	60.5 ± 13.1*
<i>Pelvis</i>						
Anterior (+) / posterior (-) tilt	9.2 ± 8.6	7.7 ± 9.9	9.3 ± 8.4	9.1 ± 9.0	11.9 ± 8.9	11.8 ± 7.4
Upward (+) / downward (-) obliquity	-0.3 ± 2.2	-0.7 ± 2.5	-0.3 ± 2.4	0.4 ± 6.0	-1.6 ± 3.5	-0.7 ± 4.5
Internal (+) / external (-) rotation	0.01 ± 0.2	-0.1 ± 0.1	0.1 ± 0.4	-0.3 ± 1.8	-0.1 ± 0.3	0.1 ± 0.4
<i>Hip</i>						
Flexion (+) / extension (-)	16.9 ± 11.3	13.8 ± 13.1	17.2 ± 11.6	17.2 ± 12.8	22.4 ± 13.6	22.1 ± 11.6
Abduktion (+) / adduktion (-)	-6.7 ± 7.3	-5.6 ± 6.4	-7.2 ± 7.4	-6.8 ± 9.1	-5.1 ± 7.9	-5.5 ± 7.4
External (+) / internal (-) rotation	-6.6 ± 21.2	-1.1 ± 9.5	-7.2 ± 18.7	-2.6 ± 15.7	-6.4 ± 21.4	-7.1 ± 15.6
<i>Knee</i>						
Flexion (+) / extension (-)	16.8 ± 9.8	13.8 ± 8.0	18.0 ± 10.3	15.0 ± 7.9*	21.6 ± 9.8	19.0 ± 10.8
Valgus (+) / varus (-)	0.9 ± 7.5	1.4 ± 6.2	1.4 ± 6.9	2.4 ± 7.2	2.5 ± 6.7	1.2 ± 7.0
External (+) / internal (-) rotation	4.4 ± 19.5	-0.2 ± 13.9	2.4 ± 17.8	-1.0 ± 15.1	-0.7 ± 20.8	4.9 ± 20.5
<i>Ankle</i>						
Dorsi (+) / plantarflexion (-)	1.2 ± 7.2	1.5 ± 8.5	2.2 ± 5.8	0.6 ± 6.5	4.5 ± 10.4	-1.4 ± 15.7

External (+) / internal (-) rotation	5.3 ± 19.0	17.0 ± 19.7*	2.8 ± 21.3	7.6 ± 16.8	3.6 ± 26.6	1.9 ± 15.8
Inversion (+) / eversion (-)	1.1 ± 6.8	2.9 ± 8.9	0.3 ± 6.2	2.3 ± 7.1	-1.2 ± 13.3	-0.9 ± 16.4

Data are group mean values ± standard deviations. Values refer to the mean of the two trials achieved per beam width. *Represents a significant ($p < .05$) difference to the free arm movement condition.

Table 5. Joint kinematics for the one-legged stance test per sensory manipulation during free compared to restricted arm movement conditions

	EO, FI		EO, FO		EC, FI		EC, FO	
Joint	Free	Restrict ed	Free	Restrict ed	Free	Restrict ed	Free	Restrict ed
<i>Trunk</i>								
Extension (+) / flexion (-)	-1.4 ± 5.2	-4.0 ± 4.8*	-2.5 ± 6.9	-7.6 ± 7.5*	-7.7 ± 10.7	-8.6 ± 6.3	-16.1 ± 8.4	-14.1 ± 9.3
Right (+) / left (-) bending	3.4 ± 5.1	3.3 ± 6.4	4.5 ± 7.0	4.8 ± 7.2	2.2 ± 6.6	4.4 ± 6.6*	-0.3 ± 12.6	3.8 ± 8.6
<i>Shoulder</i>								
Anteversion (+) / retroversion (-)	3.0 ± 11.0	-19.1 ± 10.9*	6.9 ± 21.9	-15.9 ± 13.7*	17.6 ± 32.6	-15.6 ± 10.2*	33.5 ± 33.4	-15.6 ± 14.3*
Abduktion (+) / adduktion (-)	17.8 ± 21.0	35.4 ± 6.3*	29.5 ± 20.6	35.2 ± 7.6	39.6 ± 23.8	35.1 ± 7.7	50.9 ± 20.3	36.2 ± 7.2*
External (+) / internal (-) rotation	-24.6 ± 29.9	-54.3 ± 10.6*	-16.7 ± 26.0	-56.1 ± 15.1*	-11.5 ± 30.7	-56.4 ± 13.1*	-13.5 ± 12.8	-55.8 ± 16.4*
<i>Elbow</i>								
Flexion (+) / extension (-)	6.7 ± 26.8	59.7 ± 9.2*	13.4 ± 23.6	58.7 ± 11.9*	13.2 ± 25.1	56.5 ± 11.9*	19.1 ± 14.7	60.3 ± 12.0*
<i>Pelvis</i>								
Anterior (+) / posterior (-) tilt	-6.4 ± 10.0	-2.9 ± 8.3*	-4.2 ± 11.2	0.1 ± 9.4*	1.2 ± 11.4	2.4 ± 9.6	8.2 ± 11.5	7.0 ± 9.9
Upward (+) / downward (-) obliquity	-2.0 ± 4.0	-1.5 ± 4.1	-3.2 ± 4.4	-2.4 ± 5.0	-3.8 ± 4.3	-3.6 ± 4.7	-5.3 ± 8.4	-3.3 ± 7.7
Internal (+) / external (-) rotation	0.1 ± 0.1	-0.1 ± 0.2	0.1 ± 0.1	0.1 ± 0.4	-0.1 ± 0.4	0.1 ± 0.2	0.3 ± 1.0	-0.1 ± 0.2
<i>Hip</i>								
Flexion (+) / extension (-)	-6.0 ± 12.5	-2.0 ± 10.7*	-2.1 ± 14.4	5.0 ± 14.5*	7.0 ± 15.0	9.6 ± 14.8	21.5 ± 17.6	18.0 ± 16.7*
Abduktion (+) / adduktion (-)	-4.1 ± 7.1	-5.7 ± 6.8	-3.2 ± 6.7	-4.4 ± 6.7	-2.6 ± 7.3	-3.9 ± 6.5	-0.7 ± 6.9	-2.3 ± 9.2
External (+) / internal (-) rotation	2.2 ± 17.8	0.9 ± 11.0	-3.5 ± 24.7	-0.4 ± 27.5	-0.1 ± 18.2	-4.3 ± 15.0	0.3 ± 10.9	-0.9 ± 33.7
<i>Knee</i>								
Flexion (+) / extension (-)	1.4 ± 8.9	1.8 ± 8.9	3.9 ± 9.9	7.0 ± 10.1*	9.3 ± 10.8	12.1 ± 11.9	19.6 ± 9.9	16.0 ± 10.2

Valgus (+) / varus (-)	-1.0 ± 4.6	-0.1 ± 5.0	-0.7 ± 5.3	0.6 ± 6.1	-1.0 ± 5.3	0.7 ± 6.3*	-0.2 ± 6.8	0.3 ± 6.5
External (+) / internal (-) rotation	3.0 ± 14.3	3.2 ± 14.7	7.9 ± 16.1	3.3 ± 24.1	5.4 ± 15.2	5.1 ± 13.8	7.9 ± 17.6	4.0 ± 21.6
<i>Ankle</i>								
Dorsi (+) / plantarflexion (-)	2.9 ± 4.4	4.2 ± 5.8	4.8 ± 5.1	5.7 ± 5.8	4.6 ± 5.4	5.3 ± 4.7	7.1 ± 6.3	6.9 ± 6.2
External (+) / internal (-) rotation	15.7 ± 17.6	17.8 ± 24.3	14.7 ± 17.1	12.8 ± 17.0	16.4 ± 16.2	13.1 ± 16.4	19.1 ± 20.1	16.0 ± 15.2
Inversion (+) / eversion (-)	-6.3 ± 6.3	-8.1 ± 6.7	-2.5 ± 6.9	-3.7 ± 7.2	-5.4 ± 7.8	-5.4 ± 7.3	-3.5 ± 8.7	-4.1 ± 7.2

Data are group mean values ± standard deviations. Values refer to the stance duration (max. 60 s) per sensory condition. *Represents a significant ($p < .05$) difference to the free arm movement condition.

EO = eyes opened; EC = eyes closed; FI = firm ground; FO = foam ground