The effect of dual tasking on foot kinematics in people with functional ankle instability

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Abstract

Background: Some cases of repeated inversion ankle sprains are thought to have a neurological basis and are termed functional ankle instability (FAI). In addition to factors local to the ankle, such as loss of proprioception, cognitive demands have the ability to influence motor control and may increase the risk of repetitive lateral sprains.

Objective: The purpose of this study was to investigate the effect of cognitive demand on foot kinematics in physically active people with functional ankle instability.

Methods: 21 physically active participants with FAI and 19 matched healthy controls completed trials of normal walking (single task) and normal walking while performing a cognitive task (dual task). Foot motion relative to the shank was recorded. Cognitive performance, ankle kinematics and movement variability in single and dual task conditions was characterized.

Results: During normal walking, the ankle joint was significantly more inverted in FAI compared to the control group pre and post initial contact. Under dual task conditions, there was a statistically significant increase in frontal plane foot movement variability during the period 200ms pre and post initial contact in people with FAI compared to the control group (p<0.05). Dual task also significantly increased plantar flexion and inversion during the period 200ms pre and post initial contact in the FAI group (p<0.05).

Conclusion: participants with FAI demonstrated different ankle movement patterns and increased movement variability during a dual task condition. Cognitive load may increase risk of ankle instability in these people.

Keywords: Ankle sprain; Gait; attention; cognition

1. Introduction

Lateral ankle sprains (LAS) are among the most common sport related injuries. Inversion of the rearfoot leads to disruption of the lateral ligament complex and up to 70% of cases experience recurrent sprains and chronic ankle instability (CAI) [1]. This may play a role in the development of ankle osteoarthritis [2].

Repeated inversion sprains are thought to have neuromotor origins if they occur when the normal mechanical constraints at the ankle are intact. This has been termed functional rather than mechanical ankle instability (FAI) [3,4]. Indeed, proprioceptive ability, postural control, strength of ankle muscles, and feedback (reflex-mediated) and feedforward (anticipatory) neural control have all been shown to be impaired in FAI [5–7]. This suggests that altered sensorimotor control is a contributory factor to the recurrent LAS [4–6]. Furthermore, it has been demonstrated that sagittal and frontal plane rearfoot movement variability is increased during single leg landing and stop jump maneuver in cases of FAI [8,9]. This is important because consistent movement patterns are related to greater automaticity of motor control [10] and greater movement variability have already been associated with risk of musculoskeletal injury and falling (e.g., in Parkinson's, Alzheimer's and older people) [11].

Movement patterns are also altered in cases of CAI. Increased rearfoot inversion has been reported before, at and immediately after initial contact (IC) during walking, throughout the gait cycle during walking and jogging, and in the pre landing phase of running [12–14]. People with CAI exhibit less dorsiflexion at the point of peak dorsiflexion during jogging [15]. Furthermore, people with FAI exhibit greater maximum ankle plantar flexion before IC compared to those with mechanical ankle instability [16]. Together the changes in movement pattern and movement variability may indicate sensorimotor deficits because the system connecting the central nervous system to muscles and nerves around ankle may be altered in FAI [4,17].

To compound the altered movement patterns, the cognitive load associated with integration of inputs from visual, vestibular, and somatosensory systems could further increase risk of LAS in FAI [18]. The capacity of the CNS is finite and simultaneous execution of two attention-demanding tasks may affect performance of one or both tasks [18]. The level of interference between the two tasks is influenced by individual differences in sensorimotor expertise, difficulty of the postural task, and level of cognitive load [19]. Reduced postural stability during dual tasking has previously been reported in people with FAI, suggesting that postural control may demand more attention in FAI [20]. The effects of the impaired feedback, feedforward and local sensorimotor deficits in FAI may therefore be compounded by the demands for cognitive attention during a movement task.

Inappropriate movement patterns in the ankle prior to and after initial foot contact (e.g. increased inversion), combined with local neurological impairments and greater central cognitive load, may therefore combine to increase the risk of re-spraining the ankle in cases of FAI. It was hypothesized that dual task conditions would result in inappropriate foot and ankle kinematics and increase movement variability in people with FAI compared to those without FAI. Therefore, the purpose of this study was to investigate the effect of cognitive demand on foot kinematics in physically active people with functional ankle instability.

2. Methods

2.1. Participants

Ethical approval was obtained from the institutional ethics committee. Initially, 65 participants with self-reported CAI were recruited. All reported a history of at least one significant unilateral inversion ankle sprain occurring more than 12 months ago. Each episode must have resulted in pain, swelling, limited weight bearing or full immobilization for a minimum of three days, a failure to return to pre injury function and repeated episodes of ankle spraining. All reported at least 2 episodes of the ankle 'giving way' in the past 1 year [3].

Within the 65 physically active individuals (sport activities => 3 times per week) with CAI, cases of FAI were identified using Functional Ankle Ability Measure (FAAM), and a questionnaire assessing the presence of experiences associated with FAI. An experienced physical therapist performed the anterior drawer and talar tilt test to assess mechanical instability (1-5 scale), and scores 1 (very hypomobile) or 4 and 5 (loose, very loose) excluded [21]. Participants were excluded if they scored >90% in the FAAM ADL score, or >80% in the FAAM sport score [3,22]. Participants were excluded if they had known vestibular, visual, auditory, cognitive, neurological, metabolic, musculoskeletal or other disorder, a history of lower limb fracture or surgery, or took any medication affecting cognition/motor performance. Participants were excluded if they were receiving ankle rehabilitation, or showed acute clinical signs and symptoms in the lower limb or a sprained ankle within the prior 3 months [3]. This screening identified 21 people with FAI.

As a control group 19 physically active individuals with no history of ankle sprain and a score 100 on both FAAM questionnaires were recruited from local sport centers. They were recruited to be age-matched with our FAI sample. They were excluded if they had the history of foot and ankle disorder, surgery or met any of the other exclusion criteria applied to the FAI group. All participants provided written consent to participate. Table 1 shows pathology and function-related information.

[Table 1 about here]

2.2. Instrumentations

A seven camera motion capture system (Qualysis, Sweden) was used to obtain three-dimensional kinematic data for the foot and leg (100Hz). Reflective markers were attached to the head of first, second and fifth metatarsals and the posterior calcaneus. Markers were attached to medial and lateral femur epicondyles and medial and lateral malleoli. A rigid cluster of four 14mm markers was positioned over the lateral aspect of the shank.

2.3. Data collection

All participants were acclimatized to the lab and protocol before testing. One relaxed standing trial was performed to define the 0º position. Participants completed three randomized conditions (five trials per condition): (1) normal walking on a 10m walkway, (2) normal walking while performing a cognitive task, (3) same cognitive task while sitting. Prior to testing, one practice trial of numerical task was performed while sitting and walking.

Participants walked barefoot at a self-selected speed while looking forward. During the dual task condition participants did the same whilst repeatedly subtracting seven from a randomly selected number between 200-250 (other than numbers ending with 7and 0) [23]. Participants were asked to perform the motor and cognitive tasks to the best of their ability, not to stop walking if they made mistake, and instructed to avoid prioritization of either task. The time required to walk the 10m and the number of subtractions during this time were recorded using a stopwatch (precision of 0.01 s) and tape recorder. At least 60s rest was allowed between each walking trial.

In the third condition participants sat and completed as many subtractions as possible within the same time that was needed to complete the walking distance over the practice trial.

2.4. Data processing

Evaluation of performance on the cognitive task included the total number of subtractions and the number of correct answers.

Kinematic data was exported to Visual 3d (C-motion, USA) and a 4th order Butterworth low-pass filter (cut off 6Hz) applied. Movement data was motion of the foot relative to the shank. The Calibrated Anatomical System Technique (CAST) was adopted to establish an anatomical model of the foot and shank [24].

The joint coordinate system was used to calculate joint rotations. 0º was relaxed standing. The foot velocity algorithm (FVA) was used to determine IC and toe off (TO) [25] and kinematic data normalized in the time domain. Transition between swing and stance phase is critical in cases of LAS because this is when most sprains occur. 200ms pre, 100ms pre, IC, 100ms post, 200ms post, and TO were therefore identified for all trials and ankle kinematic data for sagittal, frontal, and transverse planes of motion derived from these periods and averaged across at least five trials.

The coefficient of multiple correlations (CMC) and intraclass correlation (ICC) [26] were used to evaluate variability of foot-shank rotations time curves and specific shank-foot angles respectively (the latter 200 and 100ms pre and post IC, and at TO).

2.5. Statistical analysis

Analyses were conducted using SPSS 21.0. Mixed between-within subjects' ANOVA with Bonferroni corrections was used to compare the data for FAI and control between groups and conditions. All post hoc comparisons were performed with independent and paired t-test, respectively (data was normally distributed in Shapiro-wilk tests ($P > 0.05$)). All findings were considered statistically significant at $p \leq 0.05$.

3. Results

There was no significant differences in age (*p*=0.62), body mass (*p*=0.71), height (*p*=0.65), and physical activity (*p*=0.15) between control and FAI groups. Participants in both groups walked slower under dual task compared to single task (normal walking) conditions (control: 1.10 ± 0.17 m/s vs. 1.20 ± 0.11 m/s, *p*=0.02, ES=0.57 and FAI: 1.11 ± 0.21 m/s vs. 1.24 ± 0.17, *p*=0.01, ES=0.62). There were no statistically significant differences in stride velocity between the two groups during single and dual tasks ($p > 0.05$).

During sitting there was no significant difference in the number of correctly calculated figures between two groups ($p > 0.05$). However, during dual task walking, the FAI group calculated significantly fewer correct answers compared with the control group (12.16±3.35 vs. 14.89±4.44, *p*=0.04, ES=0.69). Participants in both groups enumerated significantly fewer correct figures during walking compared to the sitting task (control: 14.89±4.44 vs. 18.50±4.16, ES=1.15, FAI: 12.16±3.35 vs. 15.95±4.45, ES=1.01) ($p < 0.001$).

3.1. Kinematics

Figures 1 shows the ankle kinematic data (i.e. the foot relative to the shank) in the sagittal and frontal planes for the affected side of people with FAI and the matched sides of control participants during normal and dual task walking.

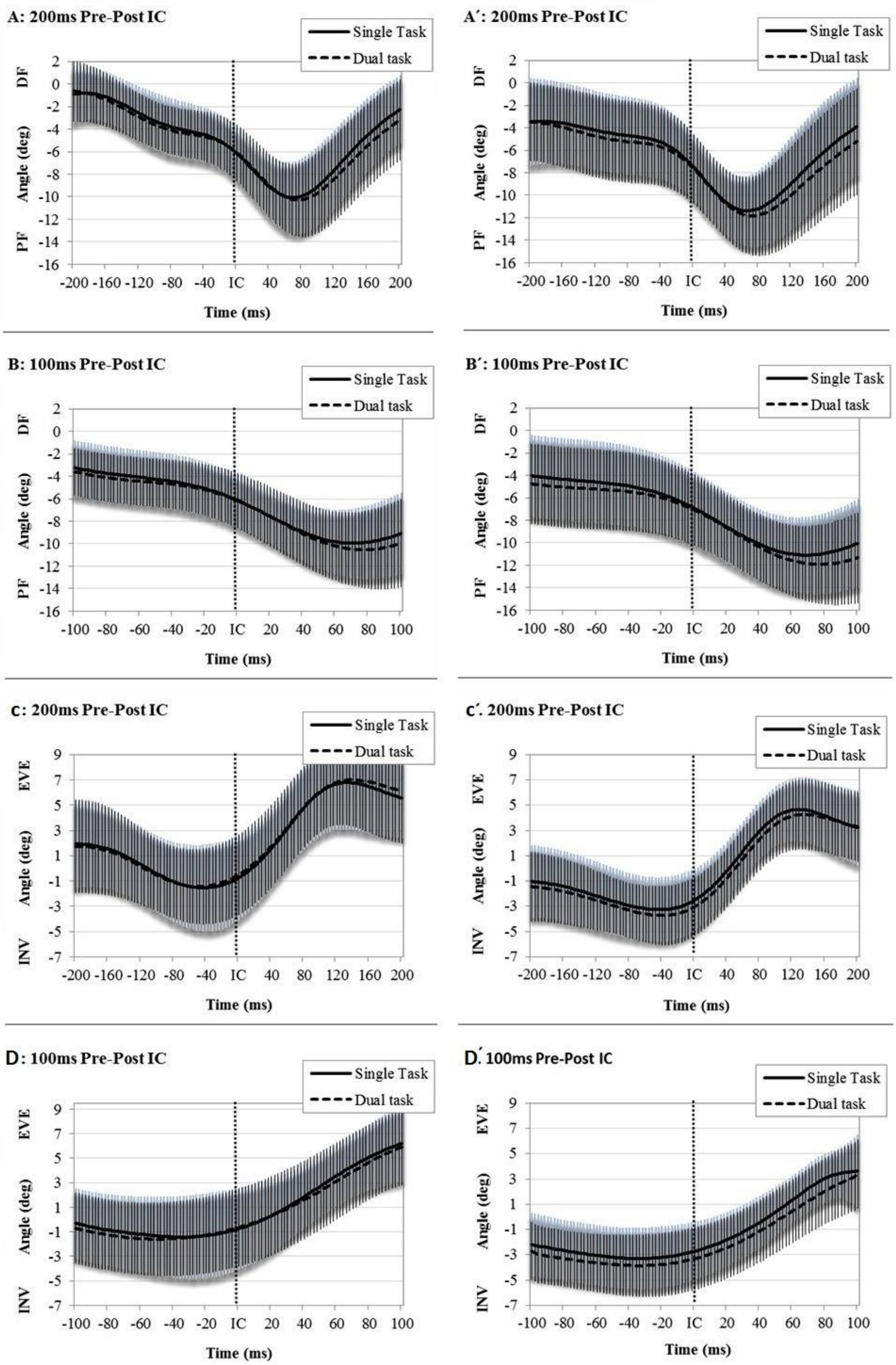
During normal walking, the ankle joint was significantly more inverted in FAI compared to the control group pre and post initial contact.

There were no statistically significant differences in kinematic data between single and dual task walking for the control group (p >0.05). However, in the FAI group, during dual task walking and compared with single task, the ankle was more inverted at IC and more plantar flexed 100ms pre and 200ms post IC (table 2).

During dual task walking and compared with the control group, the FAI group showed a significantly more inverted ankle at IC and 100ms and 200ms pre and post IC (Table 2). The ankle was also significantly more plantarflexed at 200ms pre IC in the FAI group (p=0.01).

The differences between control and FAI in frontal plane kinematics were apparent at the level of the group comparisons (that combines single and dual task data) in the ANOVA results. For the ANOVA analysis of sagittal plane data only the effect of task was apparent, except for a difference between FAI and control at 200ms pre IC, IC and TO. There were no significant differences in the transverse plane data between single and dual tasks for either FAI and control group, nor between control and FAI groups in the dual task condition

[Table 2 and Fig 1about here]



3.2. Variability

Table 3 details the CMC results for the affected side of those with FAI and the matched sides of control participants during the single and dual task conditions. Table 4 details the ICC for angles at IC and 200ms, 100ms pre and post IC.

There were no significant differences in CMC values between FAI and control group during normal walking (single task condition). However, ICC values were lower in the FAI group compared to the control group for 15 of the 18 data tested for the normal walking condition.

For the control group, the only statistically significant difference in CMC values during the dual task condition was an increase in CMC (i.e. less movement variability) in the transverse plane for the period 200ms pre and post IC. For the FAI group, the only statistically significant difference in CMC in the dual task condition values was a decrease (i.e. greater movement variability) in the frontal plane for the period 200ms pre and post IC. There were differences between FAI and control groups in the ANOVA analysis (i.e. when single and dual tasks were combined) of sagittal plane for the period 200ms pre and post IC and stance phase. There were no differences between single and dual tasks (i.e. when FAI and control data were combined).

There were reductions in ICC magnitudes (i.e. greater movement variability) in the dual-task condition compared to single task conditions for both control and FAI groups. However, these were more frequent for the control group (14/18 data tested) than the FAI group (10 of 18).

[Table 3 and 4 about here]

4. Discussion

This is the first study, to our knowledge, to investigate the effect of dual-tasking on foot kinematics during walking in physically active people with FAI. During dual tasking and compared to a control group, individuals with FAI demonstrated a more inverted ankle position and greater frontal plane movement variability from 200ms pre to 200ms post IC with effect sizes above 0.7, indicating medium to large effects due to FAI [27]. Similar to our findings, individuals with ankle instability have been shown to have increased rearfoot inversion before, at, and after ground contact during walking, single leg drop jump and lateral hop [7,12,28]. It is proposed that this exposes people with FAI to greater risk of repeated LAS. The increase in frontal plane movement variability during a dual task condition would further add to the risk of LAS because implementing an effective eversion recovery strategy might be more difficult.

Integration of visual, vestibular and somatosensory afferent information is necessary to produce an effective motor response, such as an eversion recovery strategy, and avoid LAS [18]. The central nervous system uses a preprogrammed feedforward mechanism of motor control to deal with any external perturbation and implement a response that would increase ankle stability [4]. However, individuals with FAI have demonstrated alterations in both feedback and feedforward mechanisms, and central processing requires some degree of attention to receive and integrate sensory information, and disregard irrelevant stimuli [6,7,18,19]. Our findings show that the performance of a backward counting task while walking, in both groups, significantly decreased the mean values of stride velocity, suggesting that walking requires attention. Al-Yahya et al's systematic review found that healthy participants showed slower gait speed under dual task conditions compared to single task [29]. Activation during cognitive tasks of areas of the brain concerned with motor processing may result in dual task costs [18]. Our observation of alternations in dual task related performance of walking and counting support the capacity interference approach [30]. Overload of the central resource capacity due to competing cognitive and walking tasks may lead to decreases in the performance of both tasks. In this study we assumed dual tasking increased cognitive load and the consequence was a more supinated ankle position and reduced consistency in frontal plane movement, even during a well-practiced and predictable task such as walking. During less predictable tasks, such as challenging sport situations that require rapid processing of complex information and simultaneous performance of complex cognitive and dynamic tasks, abnormal kinematics and variability might be greater still.

Our results show that the effects of dual tasking are almost unique to participants of FAI group which enables us to postulate a cause and effect link between FAI and ankle movement impairments during dual task conditions. Dual tasking altered frontal plane ankle position and increased frontal plane movement variability during the period when LAS occur. This was in the apparent absence of equivalent changes in the sagittal and transverse planes. The increased variability is unlikely, therefore, be the systematic effect of a cognitive task on movement variability and may instead indicate a plane specific reduction in motor control ability.

Rehabilitation of those with FAI typically involves restoring static and dynamic postural control. However, if cognitive load is a factor associated with risk of recurrent sprains in FAI then these interventions should seek to increase motor skills whilst reducing dependency on conscious information processing. Dual task and multi task training can increase the capability of people to overcome the limited CNS processing capacity [30]. Athletes are more at risk of ankle sprain during challenging activities such as landing from a jump [4]. Having demonstrated the principle that dual tasking and cognitive load appear relevant factors in FAI, future research should investigate the effect of more challenging cognitive tasks on ankle biomechanics in people with FAI.

The use of a single segment model of the foot is a potential limitation since it does not isolate ankle nor rearfoot kinematics specifically. However, making ground contact is a functional task for the whole foot and in the first instance this model was felt to be appropriate. However, use of a multi-segment foot model would certainly further illuminate the kinematic events within the foot pre and post ground contact. We recruited participants based on a series of clinical assessments that have subjective elements to them and self-reported clinical histories. This process is susceptible to errors but it reflects clinical practice and defines a FAI cohort in terms that could be repeated in a clinical setting. Finally, we tested physically active people under walking conditions, however, since walking is a well-practiced and more predictable process compared to athletic maneuvers, evidence of a dual task effect under walking conditions was felt to be a strong basis for more comprehensive testing of athletic situations thereafter. It also reduces the risk of LAS during experiments.

5. Conclusion

The ankle joint functioned around more supinated position and frontal plane foot movement variability increased pre and post initial contact while performing simultaneous cognitive task in physically active people with FAI. Cognitive load may contribute to increased risk of repeated lateral ankle sprains.

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Table 1

Subjects demographic information (Mean ± SD).

	CON (n=19)	**FAI** (n=21)
Gender (*M:F*)	11:8	11:10
Age (*y*)	24.95±3.12	25.57±4.77
Mass (*kg*)	67.00±13.61	67.33±15.33
Height (*m*)	1.74±0.09	1.72±0.12
FAAM- sport score (%)	100±0.0	63.42±16.86
FAAM- ADL score (%)	100±0.0	80.90±7.74
Hours of exercises (*h/w*)	7.05±3.85	9.24±5.52
Giving way and sprains (*n/yr*)	N/A	6.43±3.68

CON: control; FAI: functional ankle instability

Table 2

Ankle position in the sagittal, frontal, and transverse planes during different conditions (Mean ± SD˚).

Planes of motion	Variable (in˚)	CON		FAI		Mixed Model				CST vs. FST		CDT vs. FDT		CST vs. CDT		FST vs. FDT	
						Group		Task									
		ST	DT	ST	DT	F	*P*	F	*P*	*P*	E.S	*P*	E.S	*P*	E.S	*P*	E.S
Sagittal	200 pre	-0.89±2.53	-0.62±2.71	-3.14±4.04	-3.46±3.52	(1,35)=5.66	0.02	(1,35)=0.02	0.90	0.06	0.67	0.01	0.67	0.41	-0.21	0.31	0.33
	100 pre	-3.33±2.46	-3.60±2.09	-4.01±3.60	-4.90±3.62	(1,35)=1.08	0.30	(1,35)=10.80	0.002	0.46	0.25	0.20	0.43	0.16	0.37	0.01	0.71
	IC	-6.12±2.36	-6.01±2.43	-6.93±3.09	-7.05±3.14	(1,35)=1.06	0.31	(1,35)=0.00	0.99	0.38	0.29	0.28	0.32	0.75	-0.08	0.72	0.08
	100 post	-9.08±3.65	-9.95±3.91	-10.11±3.93	-11.25±4.01	(1,35)=0.93	0.34	(1,35)=5.35	0.03	0.42	0.27	0.33	0.33	0.19	0.34	0.07	0.43
	200 post	-2.24±3.00	-3.19±3.56	-3.49±4.34	-5.09±4.53	(1,35)=1.65	0.21	(1,35)=8.52	0.01	0.32	0.34	0.17	0.47	0.09	0.44	0.03	0.53
	TO	-16.73±5.08	-16.57±5.37	-18.49±7.23	-18.11±6.59	(1,35)=0.67	0.42	(1,35)=0.87	0.36	0.41	0.28	0.45	0.39	0.71	-0.09	0.34	-0.23
Frontal	200 pre	1.92±3.47	1.72±3.67	-0.95±3.00	-1.40±2.72	(1,34)=8.20	0.01	(1,34)=1.82	0.19	0.01	0.87	0.00	0.96	0.60	0.13	0.16	0.34
	100 pre	-0.31±2.84	-0.70±2.90	-2.24±2.50	-2.70±2.28	(1,34)=5.62	0.02	(1,34)=2.23	0.15	0.04	0.72	0.03	1.30	0.31	0.24	0.29	0.25
	IC	-0.64±3.44	-0.31±3.66	-2.74±2.46	-3.39±2.35	(1,34)=6.66	0.01	(1,34)=0.05	0.83	0.04	0.71	0.00	0.97	0.54	-0.15	0.03	0.78
	100 post	6.21±3.10	5.93±3.09	3.54±2.85	3.50±2.72	(1,34)=7.57	0.01	(1,34)=0.27	0.61	0.01	0.90	0.02	0.83	0.44	0.19	0.83	0.18
	200 post	5.55±3.16	6.09±4.08	3.21±2.95	3.26±2.72	(1,34)=6.11	0.02	(1,34)=1.04	0.32	0.03	0.76	0.02	0.81	0.27	-0.27	0.80	-0.03
	TO	-7.81±5.87	-7.97±5.61	-7.93±5.82	-8.25±6.26	(1,34)=0.01	0.92	(1,34)=0.30	0.59	0.95	0.02	0.89	0.05	0.81	0.06	0.61	0.12
Transverse	200 pre	1.06±3.88	0.65±4.03	-0.56±4.22	-0.24±4.44	(1,34)=0.88	0.36	(1,34)=0.02	0.90	0.24	0.21	0.53	0.21	0.48	0.17	0.51	-0.15
	100 pre	-0.76±4.06	-1.16±4.16	-1.67±4.81	-2.03±4.57	(1,34)=0.37	0.55	(1,34)=1.96	0.17	0.55	0.20	0.55	0.20	0.14	0.37	0.44	0.18
	IC	-1.45±4.12	-0.43±3.68	-2.83±4.41	-2.57±4.16	(1,34)=1.78	0.19	(1,34)=3.04	0.09	0.34	0.33	0.11	0.55	0.15	-0.37	0.47	-0.17
	100 post	2.21±2.77	1.54±4.12	0.70±3.81	0.29±3.72	(1,34)=1.46	0.24	(1,34)=1.57	0.22	0.19	0.45	0.35	0.32	0.31	0.21	0.37	0.21
	200 post	5.23±2.83	5.16±1.99	3.85±1.81	3.81±2.83	(1,34)=3.06	0.09	(1,34)=0.14	0.71	0.09	0.58	0.10	0.55	0.67	0.12	0.87	0.04
	TO	4.06±4.32	4.29±4.10	3.96±5.50	3.94±5.89	(1,34)=0.02	0.90	(1,34)=0.28	0.60	0.90	0.02	0.84	0.07	0.39	0.21	0.91	0.03

ST: single task; DT: dual task; CST (DT): control single (dual) task; FST (DT): FAI single (dual) task; 100 (200) pre indicates 100 (200) milliseconds pre initial contact (IC); 100 (200) post, 100 (200) milliseconds post IC. Toe off (TO); Sagittal: plantar flexion, - ; dorsiflexion, +; Frontal: inversion, - ; eversion, +; Transverse: adduction, - ; abduction, +; E.S: effect size; (p<0.05).

Table 3

Mean CMC during different conditions (Mean ± SD).

Planes of motion	Variable	CON ST	CON DT	FAI ST	FAI DT	Mixed Model Group F	Group *P*	Task F	Task *P*	CST vs. FST *P*	CST vs. FST E.S	CDT vs. FDT *P*	CDT vs. FDT E.S	CST vs. CDT *P*	CST vs. CDT E.S	FST vs. FDT *P*	FST vs. FDT E.S
Sagittal	200 pre-post IC	0.968±0.019	0.966±0.026	0.951±0.042	0.937±0.046	(1,37)=5.55	0.02	(1,37)=1.73	0.20	0.11	0.53	0.04	0.70	0.61	0.12	0.22	0.28
	IC-TO	0.992±0.005	0.990±0.005	0.984±0.019	0.983±0.022	(1,37)=4.39	0.04	(1,37)=0.24	0.63	0.13	0.56	0.13	0.45	0.39	0.20	0.77	0.06
Frontal	200 pre-post IC	0.951±0.031	0.956±0.036	0.953±0.029	0.927±0.044	(1,36)=2.02	0.16	(1,36)=2.96	0.09	0.98	0.04	0.03	0.72	0.56	-0.14	0.01	0.61
	IC-TO	0.953±0.038	0.953±0.046	0.940±0.042	0.912±0.092	(1,34)=3.52	0.07	(1,34)=1.05	0.31	0.32	0.34	0.06	0.58	0.96	0.01	0.23	0.28
Transverse	200 pre-post IC	0.900±0.068	0.933±0.054	0.853±0.150	0.854±0.140	(1,35)=3.22	0.08	(1,35)=2.32	0.14	0.23	0.40	0.03	0.75	0.03	-0.57	0.95	-0.01
	IC-TO	0.939±0.066	0.949±0.035	0.923±0.092	0.927±0.072	(1,36)=0.89	0.35	(1,36)=0.44	0.51	0.54	0.20	0.26	0.38	0.54	0.16	0.76	-0.07

ST: single task; DT: dual task; CST (DT): control single (dual) task; FST (DT): FAI single (dual) task; Toe off (TO); E.S: effect size; (*p*<0.05).

Table 4
ICC during different conditions.

Planes of motion	Time window	CON ST	CON DT	FAI ST	FAI DT
Sagittal	200 pre	0.933	0.915	0.943	0.710
	100 pre	0.975	0.948	0.919	0.818
	IC	0.962	0.956	0.879	0.907
	100 post	0.971	0.963	0.928	0.924
	200 post	0.983	0.968	0.950	0.949
	TO	0.870	0.932	0.882	0.898
Frontal	200 pre	0.973	0.965	0.964	0.960
	100 pre	0.988	0.965	0.954	0.935
	IC	0.979	0.968	0.968	0.975
	100 post	0.967	0.952	0.897	0.852
	200 post	0.927	0.967	0.958	0.909
	TO	0.920	0.910	0.911	0.930
Transverse	200 pre	0.944	0.946	0.934	0.914
	100 pre	0.986	0.973	0.752	0.809
	IC	0.991	0.968	0.756	0.908
	100 post	0.975	0.965	0.846	0.852
	200 post	0.989	0.975	0.809	0.973
	TO	0.953	0.967	0.924	0.903

ST: single task; DT: dual task