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Is Dual-Task Performance in Athletes Better Than That in Non-Athletes? Why Is it Important to Elite Coaches?

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ABSTRACT

Awilai N, Benjapalakorn B, Chaiwatcharaporn C. Is Dual-Task Performance in Athletes Better Than That in Non-Athletes? Why Is it Important to Elite Coaches? **JEPonline** 2022;25(1):1-24. The purpose of this was to study the implication of the dual-task performance difference between athletes and non-athletes for furthering the advanced coaching process. Subjects were 24 university male fulsal players recruited into Futsal Group (FG) and another 24 male students into the Control Group (CG). Both groups were subject to a physical test that consisted of 3 single tasks and 2 dual-tasks. It was found that both groups exhibited no difference in both motor single tasks in terms of bio-sway indices and beanbag throwing accuracy and cognitive single task in terms of Serial Sevens correctness. The FG performed much better in the motor-motor dual task in all dimensions (i.e., higher total scores, more hit counts, and less missed counts), however, the motor-cognitive dual-task for both groups were indifferent. FG incurred much less sway in front/back direction (API) than that of the CG. The athletes motor-motor dual-task performance, despite with non-training beanbag throwing task, were better than non-athletes that may be due to the normal sports training requirement for keeping dynamic balance. However, normal training has not emphasized mental training, so the motor-cognitive dual-task performance was not statistically different. The results indicate how to develop a dual-task training program for excellence.

Key Words: Cognitive Task, Dual-Task Performance, Futsal Players, Motor Task

INTRODUCTION

Dual-task is simply doing two tasks simultaneously, like driving while talking on the mobile phone. We do it almost all the time in everyday life while athletes do so while training and competing. We even do multi-tasking, doing many things concurrently. So, why is it important? We seldom hear this jargon (19,22,46) among coaches and sports psychologists. However, mastering the dual-task performance concept is an important key to an integral approach towards skill acquisition, learning, and coaching process that embraces multi-disciplinary nature of sports coaching and sports science. In exploring the difference between athletes and non-athletes, we are exploring methodology to bring novices or newbies to professionals physically, mentally and intellectually via different learning process and a specific effective coaching process.

Dual-Task Concept in the Making

It started with the studies of the psychological refractory period effect that indicated a stubborn bottleneck encompassing the process of choosing actions and probably memory retrieval in general, together with certain other cognitive operations to new ways of thinking about continuous dual-task performance, effects of extraneous stimulation (e.g., stop signals), and automaticity (96). When the stimuli from two tasks arrive in rapid succession, processing stages in the second task are delayed due to a single channel bottleneck. Capacity-sharing models suppose that processing on both tasks occurs at reduced rates because of sharing of common resources support for postponement models of dual-task interference in the overlapping tasks paradigm, even when response times are delayed on both tasks (94,95).

However, a dual-task may become a single task, and inter-limb interference is reduced, when the spatial patterns produced by the two hands form a geometric arrangement that can be conceptualized as a unified representation (40). The brain produces simultaneity of action as the optimal solution for the two-handed task by organizing functional groupings of muscles (coordinative structures) that are constrained to act as a single unit (62).

The central capacity sharing (CCS) model predicts all of the hallmark effects of the psychological refractory period (PRP) paradigm: -1 slope of the PRP effect at short stimulus onset asynchronies (SOAs), under additivity of precentral Task 2 manipulations, additivity of central or postcentral Task 2 manipulations with SOA, and carry forward to Task 2 of Task 1 precentral or central manipulations at short SOAs. The CCS model also predicts that Task 1 response times increase with decreasing SOA. The model is a viable alternative to the central bottleneck model (124).

Dual-Task in the Elderly, the Young, in Different Contexts

In the elderly, gait disorders and cognitive frailty may influence each other and increase the risk of falling. The use of a dual-task paradigm (45) is a good way to screen for gait abnormalities in mild cognitive impairment (MCI). The neural overload is related to competition for similar visuospatial processes rather than limited attentional resources (20). Postural stability led to improved performance in younger subjects during the dual-task, but not in the elderly. The results suggest there is a ‘‘cognition first’’ principle for the younger adults, that is, the mirror image of the ‘‘posture first’’ principle observed in older adults under dual-tasking situations (7). Professional rugby league players might inadvertently avoid the heavy collisions that result in injury or in partial contact that does not result in exposure to the full force of a tackle (41).

Many daily activities require separate tasks of the arms and legs to be performed together, as in driving where one foot controls the accelerator, one arm steers, and the other arm and foot shift gears and clutch, attention to concurrent reaching and foot-pedal tracking was flexibly allocated based on phase of the tasks (79). In skill learning using a weight-bearing and cognitive-motor dual-task, increased cognitive load diminished the rate of skill acquisition, decreased transfer to new conditions, and increased error rate during an unexpected perturbation; however, young adults had a dual-task benefit from cognitive load. Executive function predicted 80% of the variability in dual-task performance. Although initial learning of a weight bearing cognitive-motor dual-task was poor, longer-term goals of improved dual-task effect and retention emerged (21).

Postural Control and Balance

Postural sway increases when a cognitive task is performed concurrently with a postural task. Dual-task practice improves dual-task performance (100). Dual-task activities adversely affect gait in cognitively impaired older people. Multiple fallers performed worse in each gait condition, but the addition of a functional or cognitive secondary task provided no added benefit in discriminating fallers from non-fallers with cognitive impairment (123). Attentional resources were sufficient to cope with the dual-task situations in the fatigue condition of the Beurskens et al. experiment (10). Only the specific exercise intervention improved gait initiation performance under the dual-task condition (126). The practice of two concurrent attention-demanding tasks results in the best performance improvement for both tasks (140). Participants with Parkinson disease (PD) showed dual-task gait velocity and good cognitive functioning at baseline (120). Dual-task conditions showed the strongest associations with gait slowing and cortical control of gait is associated with decline in working memory in people with MCI (82,84). Initial clinical trials point to the effectiveness of the approach in patients with both acute and chronic low back pain in terms of reducing the neuromuscular impairment and in control of pain (61). Fear of Falling (FOF) should be considered as an important, independent risk factor in the assessment and treatment of postural instability in patients with PD (2,45). During turning, non-freezers and controls decreased their cadence while freezers increased it, which may be related to freezing of gait (FOG), freezers adopted a posture second strategy in contrast to non-freezers when confronted with a dual task (119).

Depending on age, the task of highest priority would be the cognitive one for young adults and the postural one for older people (118). The dual-task test was sensitive enough to discriminate between elderly and young people. It revealed that the elderly adults did not utilize cognitive cues for their anticipatory postural control strategies, although the young adults were able to (68). Parkinson patients are less inclined than healthy persons to maintain a safe gait. Instead, Parkinson patients use a ‘‘posture second’’ strategy and treat all elements of a complex task with equal priority, which in daily life may go at the expense of maintaining balance and lead to falls (11). Postural control in everyday life is generally accompanied by posture-unrelated cognitive activity. When performing more demanding cognitive tasks, older adults showed increased COP displacement while young adults did not (57). A complex relation exists between postural control and cognitive or attentional demands (104).

Explicit instruction regarding attentional focus is an important factor contributing to the rate of learning and the retention of the dual-task training effect (117). Variable-priority training improves both single-task automatization and the development of task-coordination skills (116).

In sports, postural balance control has been demonstrated to be one of the limiting factors of performance and a necessary component to achieve any sport technique. Team players must process and react to multiple external stimuli while executing at the same time the skills of the game. By contrast, endurance athletes must perform the same gesture repetitively without a concurrent coordination of continuous stimuli-related actions. These differences should be considered when developing new trainings for team players in dual-tasking conditions (108). The allocation of attention during the performance of concurrent tasks is complex depending on many factors that include the nature of both the cognitive and postural task, the goal of the subject, and the instructions (113). The inability to allocate sufficient attention to postural control under multitask conditions may be a contributing factor to imbalance and falls in some older adults (114). Cognitive load alters balance control in a simple postural task (i.e., on firm support), which is highlighted by an increase of energetic expenditure (i.e., increase of the sway path covered) to balance. Awareness may not be increased and the attentional demand may be shared between balance and mental task. Conversely, cognitive load does not perturb the realization of a new complex postural task. Postural control is prioritized ("postural first" principle) when seriously challenged (1,75,115). Integrative neuromuscular training program can be prescribed as an effective program for the rehabilitation of children with autism spectrum (112). By modifying both cognitive and motor task demands, therapists can tailor their interventions to provide appropriate challenges for children at different skill levels (56). Motor learning influenced performance among subjects who received the Multiple-Task Test in order of increasing difficulty (12). Dual-task balance training in elderly adults improves their dual task performance during standing postural control (55).

The value of the vestibular sensory system to brain functions, such as perception of self and non-self-motion, spatial orientation, navigation, voluntary movement, oculomotor control, and autonomic control come from the unique and complete description of head motion and orientation in three dimensions (33). The vestibular system is one of the most complex systems of the human brain. A very small peripheral organ in the inner ear, the labyrinth, forms the peripheral receptor. This receptor forms connections with centers at all levels within the central nervous system. These centers in turn, will project back to the vestibular structures in the brain stem that controls the geography of the body, thus providing balance and an accuracy in visual movements as well as posture and gait.

This review aims to give the reader a brief overview as to what is the vestibular system, its related structures, and defined anatomical pathways (122). Visual input may dominate over the other sensory inputs in the regulation of postural control (47), while High BMI demands more displacements to maintain postural balance (48). Older adults adopt a slower, more conservative obstacle crossing strategy. Despite using a more conservative obstacle crossing strategy, older adults are at greater risk of contact with obstacles for time-constrained conditions (43). Problems of balance and postural control in PD patients result from complex interactions between motor impairment, functional abilities, and the fear of falling (39). Practitioners can use the derived exercise ranking to select exercises for BT appropriate to the level of the participants' balance ability and to implement progression in balance training (87). Balance performance is task specific in healthy and physically active seniors. Strength, power, and balance as well as balance under single and dual task conditions seem to be independent of each other (86). Dynamic balance performance varies with competition level (17). Impaired balance may limit mobility and daily activities, and plays a key role in the elderly falling. A new approach that is based on the application of external disturbances and system identification techniques is applicable in clinical practice to assess standing balance and to detect the underlying deteriorations is proposed (97).

Unilateral balance is critical to kicking accuracy in football. The ability to generate power correlates moderately with dynamic balance on the non-dominant leg in the male footballer (13). The Star Excursion Balance Test (SEBT) was used to test after the training protocol (14). The measures from the Balance Error Scoring System may not reflect the balance performance, especially in well-trained athletes who have a better balance (51). Sensorimotor training combined with RT (SM-RT) on balance is not superior compared with RT for both balance and strength enhancement. These findings have implications in time management during training for soccer players (78), which allows for clinicians and sport practitioners to develop more effective and tailored unilateral dynamic balance training interventions in male and female football players that should help improve performance and reduce the risk of injury (76). In this regard, consult FallProof! class session in action (106). Off-ice neuromuscular training can significantly improve postural control in figure skaters, while basic exercise training does not (66).

These findings provide foundational knowledge that emphasize the importance of using reliable and valid sensory testing protocols for older adults and the need for further research that clarifies the relationship between sensory impairment and balance (110). The inclusion of patient-tailored strength and balance exercises to improve balance and potentially reduce the risk of falls (65) should be an important consideration for healthcare therapists. After all, the rehabilitation of older adults should include not only the restoring of the core itself, but also include the core as the base for extremity function (63). Core “muscle strength training” can improve strength and balance of elderly women (16). Core stability training of 6 weeks duration is effective also effective in the improvement of dynamic balance in healthy, young adults (111). Front and side abdominal power tests (FAPT and SAPT), which were adapted from plyometric medicine ball exercises, are reliable tests and may be used to assess the power component of core stability in young women (23).

People can overcome the intrinsic difficulties associated with performing complex bimanual coordination patterns when provided appropriate perceptual information feedback that allows them to detect and correct coordination errors (136). The most important application of the multiple resource model is to recommend design changes when conditions of multitask resource overload exist (137).

Results showed that the attentional demand necessary for regulating postural sway increased as the postural task increased in difficulty. Interestingly, this effect was smaller for the gymnasts during unipedal stance. These findings suggest a decreased dependency on attentional processes for regulating postural sway during unipedal stance in gymnasts with respect to non-gymnasts (135).

Practical implications for sedentary individuals, physiotherapists, strength and conditioning specialists exist, especially for individuals who can benefit from core strength training with Swiss balls (109). A 6-week neuromuscular training program designed to decrease the incidence of ACL injuries improves objective measures of total and anterior-posterior single-limb postural stability in high school female athletes (98).

Enhance Dual-Task Performance Using Pilates

Although research into the training effects of Pilates or in patient populations can be undertaken using ultrasonography in submaximal exercises (36), the Pilates method has also expanded to the mainstream and is widely accepted by physical therapists and orthopedic surgeons as an appropriate method of rehabilitation. Moreover, by incorporating Pilates into a rehabilitation program, the patient's recovery process is enhanced significantly (24,69). It is much more than a list of exercises and, in fact, it is a way of connecting and conditioning the body and the mind (71,72). While the underlying intent is directed just as much, if not more so, towards the stabilizing contractions of the muscles (88), Pilates-based exercise improves dynamic balance (8,60). Pilates trained subjects can contract the TrA and maintain better lumbo-pelvic control than adults those who perform regular abdominal curl exercises or no abdominal muscle exercises (54).

The ***Pilates for Postural Faults, Illness and Injury: A Practical Guide*** for dance, movement teachers, and research findings that may be needed to be able to recognize and address common postural faults is available for physiotherapists and allied medical professionals. Also, the ***Pilates: Your Complete Guide to Mat Work and Apparatus Exercises*** is very helpful in the identification of exercises for treatment or rehabilitation programs (58,99) as well as the ***Fusion Workouts: Fitness, Yoga, Pilates, and Barre*** (127) book to find exercises for mat work.

The lower level of activation of the rectus abdominis muscle suggests that pelvic stability is maintained during 4 Pilates core stability exercises in quadruped position (102). Individuals improve their muscular endurance and flexibility using relatively low-intensity Pilates exercises that do not require equipment or a high degree of skill and are easy to master and use within a personal fitness routine (64). Pilates mat exercises increase the transversus abdominis and the internal abdominal oblique activity compared to conventional exercise programs (25). Pilates training has a positive effect on muscular strength and flexibility in dance students (4), and it decreases depression and improves balance related to falling (81). Pilates and taiji quan are effective exercise modes to improve mental parameters in college-age individuals (18) while developing balance, mobility and muscle strength of MS patients (50).

Pilates training increases core muscle strength and lumbopelvic stability, and it also improves shooting performance in rifle athletes (37). However, 6 weeks of Pilates training program was not sufficient to change physical fitness and body composition in young basketball athletes (26). Mat Pilates increased functional capacity (FC) of elderly women after 6 weeks of Mat Pilates training that consisted of 60 min·session^{-1}, 3 times·wk^{-1}. Furthermore, the exercises difficulty increased from beginners to intermediate (9). An 8-week Pilates exercise program was effective in decreasing menopausal symptoms and increasing lumbar strength and flexibility (73). Six weeks of Pilates exercise is the proper type of exercise for young girls (6). Therefore, application of Pilates should be tailored to individual needs respectively.

In conclusion, Pilates experience and muscle activation are strongly associated (5). It improves archery (93), promotes an increase in abdominal wall muscle hypertrophy, respiratory muscle strength and performance, and prevents weakness in abdominal muscles and dysfunction in ventilator mechanics (44). It is also an effective method for improvement in lower limb strength, agility, dynamic balance and coordination skills in badminton players (101), and is applicable for conditioning athletes and also an integrated approach to performance and recovery (67).

Dual-Task Gaze Control to Flow

During the execution of the putting skill, there are changes in gaze control, characterized by economy in the number of gaze shifts, the development of priority to specific gaze locations, and economy in the allocation of time between preferred gaze locations (130). Adolphe et al. (3) reported that athletes who had received *visual attention training* were significantly more accurate than an equal number of world-ranked receivers who had not undergone a similar training program. The results highlight the importance of training a sustained duration of Quiet Eye (QE) on a single location on the hoop prior to the execution of the shooting action. In fact, training QE improves accuracy in the basketball free throw (52), yet when under stress, QE is often the first thing to go. Vickers (133) reported that it moves with the stroke, and golfers lose their ability to stabilize their gaze as they putt. When you choke, the billion cells in your brain lose their effective complexity in solving the slope, curvature, distance, and location problems. The participants had significantly longer QE periods on successful putts than on unsuccessful putts. QE training in the golf putt has proven to be effective and has been shown to increase performance under high pressure (131,134,138). QE is not a by-product of performance, but instead plays a causal role in supporting the interception of a moving target through a combination of pre-programed and online control processes (121). Longer QE fixations were associated with higher performance (32). Mediation revealed an indirect effect of QE on performance through flow experience (53).

Beyond Boredom and Anxiety: The Experience of Play in Work and Games (28). ***Flow: The Psychology of Optimal Experience - Steps Towards Enhancing the Quality of Life*** (31), ***Finding Flow: The Psychology of Engagement with Everyday Life*** (27), ***Creativity: Flow and the Psychology of Discovery and Invention*** (29), ***Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi*** (30), and ***Cognitive Psychology: Connecting Mind, Research, and Everyday Experience*** (46) are critical understand the concepts and tools for coaches to have their athletes and teams to achieve "Flow" state and prevent choking. Use of dual-task training to improve performance under pressure (49). Anxiety, a cognitive secondary task affects efficiency and sometimes performance in far aiming tasks (89). Attention to performance worries rather than to skill execution generally explains choking (90).

Also, there are literature reviews to provide a summary of evidence-based research related to the sport of futsal (85). Lapresa et al. (70) evaluate the technical actions that support the development of the offensive phase of futsal of which futsal players reduced the physical performance during the second half (15). ***Consult Futsal Laws of the Game 2014/2015*** (38), and ***Futsal Coaching Manual*** (77,125) are important supportive reading to understand key performance indicators that are critical to grasp of all data available that contributes to defining priorities when training and managing competition in elite futsal (107). Although ball-possession (i.e., percentage-wise) did not demonstrate its efficacy solely on the match outcomes, hybrid ball-possession variables, particularly the total ball-possession index succeeded in significantly in discriminating between win and lost in a single futsal match as well as between successful and unsuccessful teams. The applicability of hybrid ball-possession variables to predict matches and tournament outcomes likely reinforce the importance of ball-possession strategy in futsal (59).

From overall concept of dual-task towards sports performance enhancing training using Pilates to prevent choking and achieve flow state at will, the purpose of this study was to understand states behind athletes and non-athletes under single task and dual-task conditions, paradigms, and/or contexts to lay out the framework for all strength coaches, psychological coaches, and head coaches to develop training program physically, mentally and intellectually for their athletes in an integrated manner.

METHODS

Subjects

A total of 48 subjects, 24 of which were university male futsal players selected into the Futsal Group (FG); whereas, another 24 non-athlete male students were recruited into the Control Group (CG).

Instrumentation

Typical physical fitness test equipment to measure body weight, height, fat mass, resting heart rate, and blood pressure were used to assess basic physiological data of all participants. The Biodex Balance System (see Figure 1, 5, and 6) was used to assess bio-sway indices as performance indicators of a motor task. The beanbags and target (see Figures 2, 3, and 5) were used to for perform another motor task.

Procedures

Both Groups were subject to physical fitness test to register their physiological data, three single tasks and two dual-tasks.

Single Tasks

There were two motor single tasks and one cognitive single task. The first motor single task was single leg standing on unstable platform of Biodex Balance System (see Figure 1). Three Bio-Sway Indices were recorded, namely, Anterior / Posterior Index (API) - the degree of sway in front / back direction, Medial / Lateral Index (MLI) - the degree of sway in left / right lateral direction, and Overall Stability Index (OSI) - the overall degree of sway. The second motor single task was "Throwing Beanbags" towards a target (see Figures 2 and 3). Each subject was assigned to throw 10 times; scores from all throws were accumulated as total scores, throwing within target boundary represented a hit count, throwing outside target boundary represented a missed count. The Cognitive Single Task was counting backwards by 7 from 100, also known as "Serial Sevens", the number of correct and incorrect counts were recorded.

Dual-Tasks

There were two types of dual-tasks, namely, the Motor-Motor Dual-Task and the Motor-Cognitive Dual-Task. The Motor-Motor Dual-Task was single leg standing on unstable platform of Biodex Balance System while throwing beanbag. Motor-Cognitive Dual-Task was single leg standing on the same unstable platform while performing Serial Sevens. Comparing both dual-tasks between both Groups are shown in Tables 5, 6, 7, and 8.

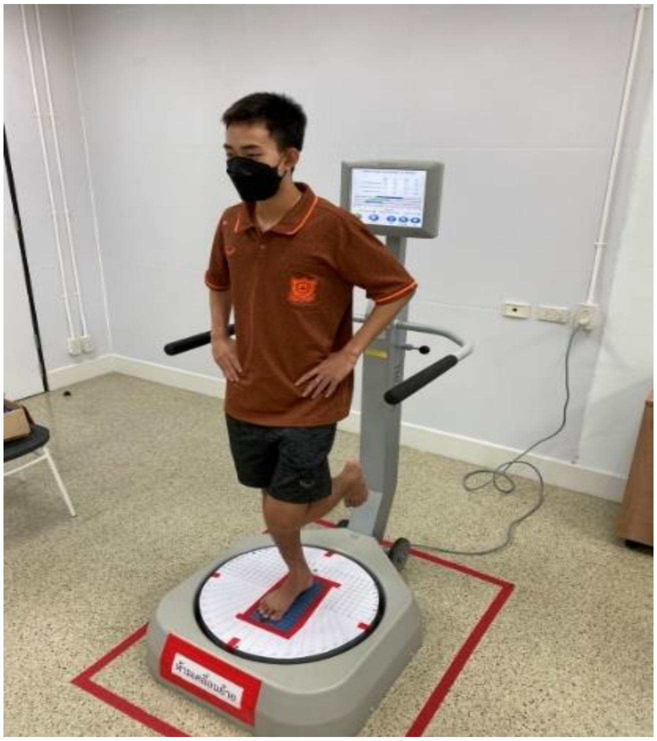

Figure 1. Motor Task. Single leg standing on unstable platform of Bio-Sway equipment to assess bio-sway indices represented a Motor Single Task.

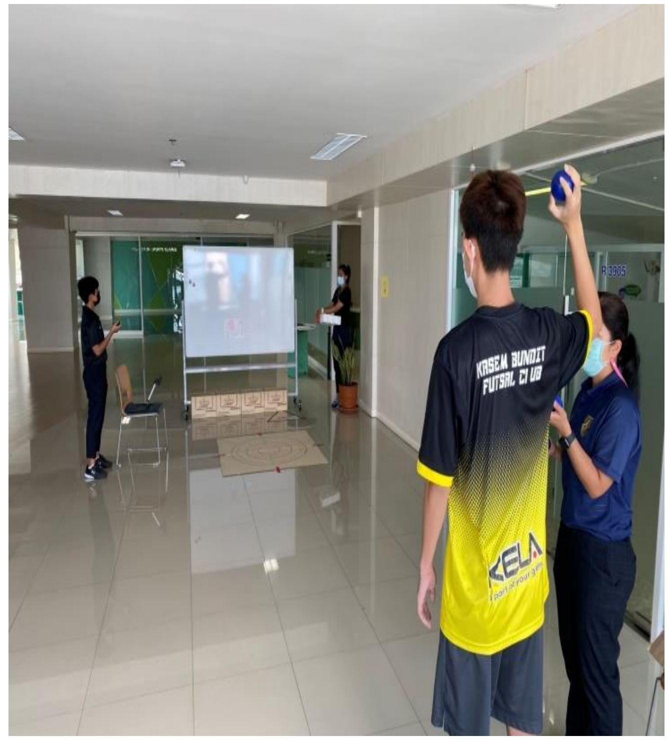

Figure 2. Motor Task .Throwing beanbag towards target represented another Motor Single Task.

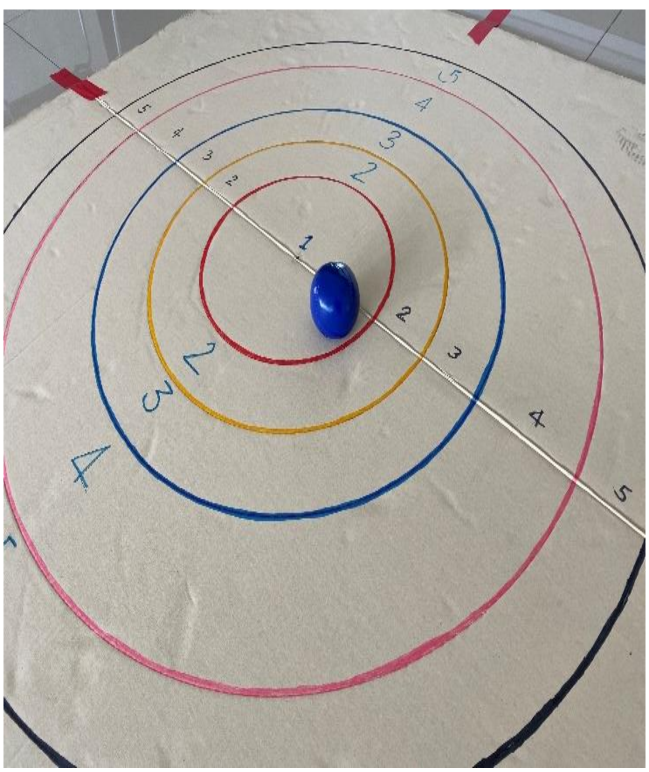

Figure 3. Target for beanbag throwing. Total scores, hit (within target) and missed counts from ten throws were recorded to compare performance.

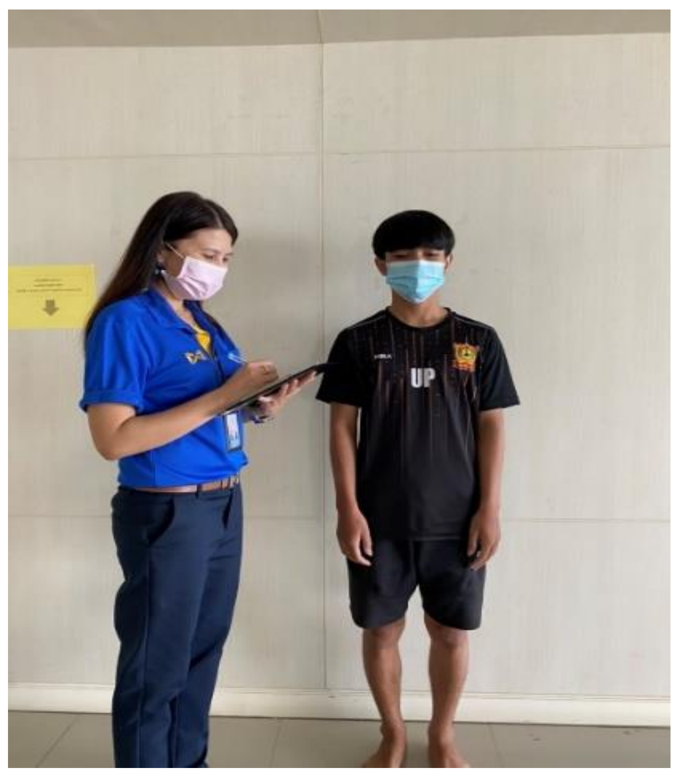

Figure 4. Cognitive task. Counting back by seven from 100, aka. Serial Sevens, represented a Cognitive Single Task.

Figure 5. Motor-Motor Dual-Task. Single leg standing on unstable platform while throwing beanbag represented a Motor-Motor Dual-Task.

Figure 6. Cognitive-Motor Dual-Task. Single leg standing on unstable platform while counting back by seven from 100, Serial Sevens, represented a Motor-Cognitive Dual-Task performance.

RESULTS

Physiological Data

Physiological data for both groups are presented in Table 1. No parameters from either Group were statistically different at the P<0.05 level of significance. Therefore, the Futsal Group (FG) was not physiologically different from the non-athlete Control Group. Any difference in single task and dual-task performance should not therefore come from their respective physiological differences.

Table 1. Physiological Data of Both Participant Groups.

Physiological Data/Participants in Groups	Futsal Group (FG) n=24	Control Group (CG) n=24
Age (yrs)	19.83 ± 1.34	20.17 ± 1.49
Weight (kg)	68.83 ± 9.75	66.83 ± 9.33
Height (cm)	172.96 ± 5.51	171.88 ± 5.78
Body Mass Index ($kg{\cdot}m^{-2}$)	22.80 ± 2.38	22.53 ± 2.20
Fat Mass (kg)	16.60 ± 3.84	16.26 ± 3.86
Resting Heart rate ($beats{\cdot}min^{-1}$)	69.50 ± 6.58	72.08 ± 4.37
Systolic Blood Pressure (mmHg)	120.33 ± 2.06	118.96 ± 1.57
Diastolic Blood Pressure (mmHg)	76.04 ± 3.77	75.17 ± 2.60
Average Resting Blood Pressure (mmHg)	90.80 ± 2.91	89.77 ± 1.95

Single Task Performance

Comparing three types of single task performance between both groups were shown in Tables 2, 3, and 4. In the first motor single task performance, comparing Bio-Sway Indices (API, MLI, and OSI) of single leg standing on unstable platform of Biodex Balance System between both Groups were not statistically different, as shown in Table 2. In the second Motor Single Task performance, comparing total scores, hit and missed counts of Beanbag Throwing between both Groups were not statistically different, as shown in Table 3. In the Cognitive Single Task performance, comparing correct and incorrect counts of Serial Sevens between both Groups were not statistically different, as shown in Table 4.

Table 2. Performance Comparison of Bio-Sway Indices Between Both Groups in a Motor Single Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Anterior / Posterior Index (API)	1.70	0.70	-1.564	0.125
Control Group	24		1.97	0.47		
Futsal Group	24	Medial / Lateral Index (MLI)	1.88	1.11	-0.742	0.462
Control Group	24		2.13	1.22		
Futsal Group	24	Overall Stability Index (OSI)	2.67	1.32	-1.090	0.282
Control Group	24		3.06	1.15		

Table 3. Performance Comparison of Beanbag Throwing Total Scores, Hit and Missed Counts Between Both Groups in a Motor Single Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Total Scores	31.14	5.42	0.692	0.492
Control Group	24		29.90	6.87		
Futsal Group	24	Hit Counts	7.83	0.82	-0.57	0.565
Control Group	24		7.99	1.11		
Futsal Group	24	Missed Counts	2.14	0.82	0.481	0.633
Control Group	24		2.00	1.11		

Table 4. Performance Comparison of Serial Sevens Correct / Incorrect Counts Between Both Groups in a Cognitive Single Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Correct Counts	4.32	2.25	0.585	0.561
Control Group	24		4.00	1.44		
Futsal Group	24	Incorrect Counts	1.28	0.75	-1.193	0.239
Control Group	24		1.54	0.78		

Dual-Task Performance

Comparing the Motor-Motor Dual-Task performance and the Motor-Cognitive Dual-Task performance between both Groups is shown in Table 5, 6, 7, and 8. In the Motor-Motor Dual-Task where the participants performed single leg standing on an unstable platform on Biodex Balance System while throwing beanbags, all Bio-Sway Indices were indifferent statistically between both Groups, as shown in Table 5. However, in the Motor-Cognitive Dual-Task where the participants performed single leg standing on an unstable platform on Biodex Balance System while performing Serial Sevens, the Futsal Group incurred much less sway in front/back direction (API) significantly than that in the Control Group at P<0.01 level of significance, as shown in Table 6. The other two indices (MLI and OSI) were indifferent.

Comparing another part of the Motor-Motor Dual-Task performance, the Futsal Group performed much better than the Control Group in all dimensions of the Beanbag Throwing accuracy (i.e., higher total scores, more hit counts, and less missed counts significantly at P<0.01 level of confidence), as shown in Table 7. However, when comparing the cognitive part of the Motor-Cognitive Dual-Task performance, the performance of both Groups in Serial Sevens was indifferent as shown in Table 8.

Table 5. Performance Comparison of Bio-Sway Indices Between Both Groups in a Motor-Motor Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Anterior / Posterior Index (API)	4.15	1.23	0.900	0.374
Control Group	24		3.88	1.23		
Futsal Group	24	Medial / Lateral Index (MLI)	3.10	1.45	1.119	0.269
Control Group	24		2.70	0.99		
Futsal Group	24	Overall Stability Index (OSI)	5.61	1.62	1.440	0.157
Control Group	24		5.02	1.18		

Table 6. Performance Comparison of Bio-Sway Indices Between Both Groups in a Motor-Cognitive Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Anterior / Posterior Index (API)	2.27	0.82	-3.834	0.000**
Control Group	24		3.21	0.89		
Futsal Group	24	Medial / Lateral Index (MLI)	2.37	1.20	1.727	0.091
Control Group	24		1.75	1.27		
Futsal Group	24	Overall Stability Index (OSI)	3.46	1.42	-1.244	0.220
Control Group	24		3.92	1.13		

* P<0.05 level of significance. ** P<0.01 level of significance.

Table 7. Performance Comparison of Beanbag Throwing Total Scores, Hit and Missed Counts, Between Both Groups in a Motor-Motor Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Total Scores	32.32	4.98	04.5	0.000**
Control Group	24		23.75	6.67		
Futsal Group	24	Hit Counts	8.24	0.90	7.83	0.000**
Control Group	24		5.85	1.20		
Futsal Group	24	Missed Counts	1.77	0.90	-7.70	0.000**
Control Group	24		4.08	1.17		

* P<0.05 level of significance. ** P<0.05 level of significance.

Table 8. Performance Comparison of Correct/Incorrect Serial Sevens Between Both Groups in a Motor-Cognitive Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Correct Answers	2.92	1.66	0.911	0.369
Control Group	24		2.57	0.84		
Futsal Group	24	Incorrect Answers	1.56	0.95	-1.892	0.065
Control Group	24		2.07	0.93		

Single Task Performance vs. Dual-Task Performance

Comparing single task performance and dual-task performance between both Groups were shown in Table 9, 10, 11, and 12. When comparing Motor Single Task performance to the Motor-Motor Dual-Task performance of both Groups, the Futsal Group incurred significantly more overall sway (higher OSI) during performing dual-task than the Control Group at P<0.05 level of significance as shown in Table 9. The other indices (API and MLI) were indifferent. However, when comparing the Motor Single Task performance to the Motor-Cognitive Dual-Task performance of both Groups, the Futsal Group incurred significantly less sway in front/back direction (API), but more sway in left/right lateral direction (MLI) during performing the dual-task than the Control Group at P<0.05 level of significance as shown in Table 10. OSI was indifferent. Also, when comparing another Motor Single Task performance to the Motor-Motor Dual-Task performance, the Futsal Group performed even better under dual-task conditions; whereas, Control Group was significantly adversely affected in lower total and hit counts, higher missed counts at P<0.01 level of significance as shown in Table 11. However, when comparing the Cognitive Single Task performance to the Motor-Cognitive Dual-Task performance, Serial sevens performance of both Groups were indifferent under both conditions as shown in Table 12.

Table 9. Performance Comparison of Bio-Sway Indices Between Both Groups in a Motor Single Task Versus a Motor-Motor Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Anterior / Posterior Index (API)	2.46	1.26	1.603	0.116
Control Group	24		1.92	1.08		
Futsal Group	24	Medial / Lateral Index (MLI)	1.22	1.20	1.625	0.111
Control Group	24		0.57	1.55		
Futsal Group	24	Overall Stability Index (OSI)	2.93	1.57	027.2	0.048*
Control Group	24		1.95	1.76		

* P<0.05 level of significance. ** P<0.01 level of significance.

Table 10. Performance Comparison of Bio-Sway indices Between Both Groups in a Motor Single Task Versus a Motor-Cognitive Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Anterior / Posterior Index (API)	0.58	0.81	-2.532	0.015*
Control Group	24		1.25	1.03		
Futsal Group	24	Medial / Lateral Index (MLI)	0.49	1.07	2.112	0.040*
Control Group	24		-0.36	1.70		
Futsal Group	24	Overall Stability Index (OSI)	0.79	1.32	-0.171	0.865
Control Group	24		0.86	1.62		

* P<0.05 level of significance. ** P<0.01 level of significance.

Table 11. Performance Comparison of Total Counts, Hit and Missed Counts, Between Both Groups in a Motor Single Task Versus a Motor-Motor Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Total Counts	-1.18	4.75	-4.971	0.000**
Control Group	24		6.15	5.43		
Futsal Group	24	Hit Counts	-0.40	0.80	-8.343	0.000**
Control Group	24		2.15	1.27		
Futsal Group	24	Missed Counts	0.38	0.80	7.943	0.000**
Control Group	24		-2.08	1.29		

* P<0.05 level of significance. ** P<0.01 level of significance.

Table 12. Performance Comparison of Correct/Incorrect Serial Sevens Between Both Groups in a Cognitive Single Task Versus a Motor-Cognitive Dual-Task.

Groups	Numbers, N	Variables	Means	SD	*t*	P
Futsal Group	24	Correct Counts	1.40	1.42	-0.72	0.943
Control Group	24		1.43	1.22		
Futsal Group	24	Incorrect Counts	-0.28	1.17	0.701	0.487
Control Group	24		-0.53	1.29		

DISCUSSION

Single Task Performance

Both groups exhibited no different performance in both motor single tasks in terms of the Bio-Sway Indices, the Beanbag Throwing Accuracy, and the Cognitive Single Task in terms of Serial Sevens correctness. Under single task conditions, all attentions are focus to just one task, that is, no division of attention, performance was therefore not interfered and adversely affected by any other distractions. Besides physiological indifference, athletes do not have any advantage over non-athletes. The Beanbag Throwing Accuracy was selected, as both Groups had not practiced it before, thus no skill effect or training experience confounded the assessment. If the task had been kicking a ball, the futsal players would have gained more advantage in their performance Indifference in the Cognitive Single Task performance also suggested that typical futsal training had not emphasized any mental training.

Dual Task Performance

Dual-task performance is the ability to perform two different tasks simultaneously or concurrently. Secondary task usually interferes with primary task causing overall performance degradation. However, if both tasks are complementary to one another, overall performance may be better. This was confirmed by the fact that the Futsal Group performed much better in Motor-Motor Dual-Task condition as seen in beanbag throwing accuracy in all dimensions (i.e., higher total scores, more hit counts, and less missed counts). However, the Motor-Cognitive Dual-Task for both Groups were indifferent, so it appeared that the athletes performed no better than the non-athletes under dual-task conditions did as in the case of the single task when the cognitive task was involved. As the futsal players have been continuously trained in keeping dynamic balance while training and playing, the Futsal Group incurred much less sway in the front /back direction (API) than that in the Control Group, as keeping balance while moving has become more natural and automatic from sports training non-athletes tend to jerk and sway more when additional burdens or distractions emerge abruptly as “posture first principle” comes into play.

Single Task Performance vs. Dual-Task Performance

From another point of view, how athletes and non-athletes differ under single task conditions compared to dual-task conditions? It was found that the Futsal Group incurred significantly more overall sway (higher OSI) during performing dual-task compared to single task than the Control Group, as athletes tend to follow “posture second principle” paying less attention to bodily movement and balance than external attention to achieve goal. Especially under motor-motor dual-task conditions, athletes may perform even better, where non-athletes may choke and adversely interfere with performance. In addition, athletes may not have routinely trained on cognitive performance, which did not improve or degrade under both conditions.

Implications for Elite Coaches

Athletes perform dual-tasking or even multi-tasking almost all the time, whether conscious or not, performance matters. From non-athletes to athletes, from novice to professionals, from conscious execution to unconscious manifestation of advanced skills, how fast skills can be acquired, retrieved and transferred, all coaches are responsible to achieve success. Integrating dual-task training into all physical, mental, and intellectual training are for all strength coaches, psychological coaches, and head coaches as new paradigm shifts for skill acquisition, learning process to be brought by dual-task based coaching process to prevent choking and achieving flow state and team flow state for ultimate excellence.

CONCLUSIONS

The terms “dual-task” may not be so familiar, but common happenings in everyday life and with normal sports training and practice. It started with simple notions that two tasks done simultaneously will interfere and adversely affect each other, and get worse with aging. Early adoptions were naturally with cognitive impairment, and fall prevention in the elderly. Later on, sports with far target aims, and then practically all fast games. The purpose of this study was to find differences between athletes and non-athletes to lay the groundwork for further complimentary training like, Yoga or Pilates for strength and awareness or consciousness ready to go further on imagery and flow state training for advanced mental and intellectual training to achieve ultimate success and excellence in sports.

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