Dual-task presentation

Physical Therapy Inservice

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Progressive overload is a basic concept in physical training. Generally, we increase our training load by increasing the amount of weight in order to get stronger, number of repetitions in order to build endurance, speed to build power, or complexity to build stability and coordination. These are all important in athletic performance, but focusing your training *solely* around these purely physical parameters may leave you unprepared for the mental load of game-time situations.

During training, you can focus almost all of your attention on the task and maintaining proper form, but during a game or daily life, you will be experiencing distractions that will pull your attention away from your form.

This is where dual-task training is important.

1 What is Dual-task training?

A dual-task refers to the ability to perform two tasks at the same time. Dual-task training is based on Dual-process theory[1]. Dual-process theory proposes that when performing multiple tasks, the human peformance is determined by two types of processing systems: Automatic processing and controlled processing[1,2]. Automatic processing refers to the intuitive and fast forms of processing that use low amounts of attentional resources[2]. *Automatic processing* is reactive to triggers for example the question "What is your name"[2]. Opposite of automatic processing, *controlled processing* is *slow* and requires conscious interpretation of requisite information and processing as well as the *attentional control* to complete the task[2].

Dual-tasks involve the simultaneous performance of both *automatic* and *controlled* processing[2]. Dual-tasks are relevant in everyday life when walking and talking. Walking is primarily an automatic task while talking requires controlled processing. In sports, a soccer player could receive the ball, realize his teammate is open, assess the positions of opponents, and pass the ball[2]. Dribbling and passing the ball are automatic processes for experienced soccer players[2]. Assessing the field for open teammates, opponents, and considering the team's strategy would require controlled processing[2].

Dual-task training has 3 forms:

1. Cognitive-Motor Dual task
2. Motor-motor dual task
3. Cognitive-Cognitive Dual task

2 Dual-task cost

Dual-task cost refers to the decrease in performance of either task when performing both tasks simultaneously[2]. Acutely, dual-task cost should result in significant detriments in performance[2]. When dual-tasks are performed chronically, adaptations will occur and the dual-task cost will be minimized[2].

$$\text{Dual-Task Cost Equation} = \frac{(\text{DT} - \text{ST})}{\text{ST}} \times 100$$

3 Sport performance

Sports are one of the main examples of activities that innately have dual-tasks due to the complex and dynamic environments. To have success in a sport, an athlete must simultaneously consider themself, the ball, teammates, opponents, rules, and situational requirements such as attacking or defending[3]. When competing in a sport, there could be even more variables such as referees, coaches, spectators, and competitive pressure[3].

Attentional overload in sports can come in many forms. Attentional overload causing cognitive failure during a motor-cognitive task could take the form of a player focusing on their movement and not on their surroundings. As a result, this athlete would have poor situational awareness and would move well, but make poor decisions.

Attentional overload causing motor failure during a cognitive-motor task would be exemplified by a player focusing on their surroundings and the other players, but losing focus on their motor pattern, resulting in a mistake and even injury.

4 Working memory capacity in elite athletes

The ability to dual-task is impacted by working memory capacity (WMC), the ability to inhibit irrelevant information[2]. An individual with low working memory capacity refers to individuals who struggle to ignore irrelevant factors[2]. Whereas someone with high working memory capacity refers to individuals who have strong focus and attention and can filter out what information is important for future decisions[2].

Improving one's working memory capacity can result in significant performance benefits. When elite, intermediate, and non-athlete basketball players were analyzed on a multiple object tracking (MOT) test in order to measure attentional skills that mimic the cognitive load of tracking the ball, teammates, and opponents simultaneously on the court[4]. MOT is a cognitive task where participants attempt to track 2, 3, and 4 objects at once[4]. Each successive increase in number of objects increases the attentional load[4]. There was no significant difference between the groups when tracking 2 objects, indicating that attentional load was not high enough to affect performance[4]. When the load was increased to 3 and 4 objects, the elite basketball players performed significantly better than the intermediate and non-athlete players[4].

5 Choking

Choking is a common problem in competitive sports and refers to performance breakdowns due to perceived pressure of competition[5]. This can occur at any level, from amateur to professional[5]

When viewed through the context of dual-process theory, choking appears to be a form of dual-task interference. As the perceived pressure of competition increases, this adds an extra load to the attentional resources[5]. This process is also influenced by poor inhibition of perceived pressure[5]. If the athlete cannot mentally adapt and mitigate this cognitive load, this will force the attention to be taken away from areas focused on sport performance resulting in poor decision making and/or poor motor patterning. Performance breakdown due to competitive pressures is most noticeable in closed tasks such as basketball free throws or golf putting where there *should* be very few factors taking up

attentional resources. Many athletes blame themselves and assume they need to "push" through the barrier or simply continue their training program but at higher intensity to overcome choking.

Based on dual-process theory, focusing on single-task more intensely will not provide a meaningful benefit to one's working memory capacity and therefore choking will persist. For these athletes, dual-task training can help to improve working memory capacity and reduce choking. Ducrocq et al.[5] found that 10 sessions of computer-based dual-task training resulted in a significant improvement in tennis shot accuracy under pressure compared controls[5].

6 Injury prevention

In a systematic review by Gonzalez-Millan et al., dual-task costs during jumping resulted in a stiffer landing at the joint level resulting in increased vertical ground reaction forces and peak joint torques, a decrease in peak knee and hip flexion angles, and overall reduced stability and postural control[6]. These results suggest that dual-tasking during jumping is associated with injury risk[6]. Since dual-task is an inherent aspect of sports, it should be trained to create chronic adaptations and improvements in working memory capacity in order to reduce dual-task cost and therefore injury during sport.

Ness et al. found that neurocognitive deficiencies in reaction time and visual processing speed were predictive of future ACL injury which supports the idea that low working memory capacity can increase injury risk[7].

7 Transfer to sport performance

Fledderman et al. tested the effect of dual-task cost on competitive beach volleyball players[3]. When performing jump-blocks as a single task, low load dual task, or high load dual task, the players demonstrated worse jumping performance with each successive task[3]. Based on these results, Fledderman concluded that the secondary cognitive task took attentional resources away from the motor action of jumping resulting in worse performance[3].

Fledderman then sampled another group of volleyball players and had them perform multiple object tracking (MOT) dual task training for 8 weeks[8]. After 8 weeks of dual-task training, there was a statistically significant improvement in cognitive skills of sustained attention and processing speed[8]. There was no significant difference in the volleyball-specific jump task[8]. This indicates that although the athletes improved their attention and processing speed, these cognitive skills did not reduce the dual-task cost during the jump-block[8]. In a similar study, soccer athletes were given 10 sessions of 3D-multiple object tracking (3D-MOT) and demonstrated significantly more improvement in passing decision-making accuracy than controls but no difference in dribbling or shooting[9].

The multiple object tracking (MOT) intervention consists of a participant attempting to follow multiple objects on a screen at once without losing track of any of the objects[8,9]. Fledderman's MOT intervention significantly improved cognitive function but did not transfer to jump-block ability. Romeas' MOT intervention did not improve soccer dribbling or shooting ability. The 3D-MOT training did significantly improve passing ability of the soccer players, which is a skill that requires observation of multiple moving objects at once[9]. This shows the importance of finding dual-task training that transfers to sport specific skills.

8 Importance in daily life

Dual-task training has applications far past sport performance. Elderly individuals demonstrated a significant improvement in fall risk within 6 weeks of dual-task gait training[10]. The importance of preventing falls in the elderly cannot be understated. Sylliaas et al. found that when an individual has more than 2 falls a year, this significantly increases risk of death[11]

9 Importance in Rehabilitation

Dual-task training also plays a role in rehabilitation. Traumatic injuries, such as ACL tears are associated with alterations in sensorimotor cortical activation[7]. Ness et al. found that these changes can persist for months and even years following injury or surgery[7]. post-op ACLR patients demonstrated no differences in postural stability during single task balance exercises when compared to controls[7]. However, during dual-task balance exercises, these patients would sacrifice cognitive ability to maintain postural stability[7].

These results indicate that relying solely on single tasks during balance can overestimate an individual's physical ability. Performing balance exercises and measuring physical efficacy as well as cognitive accuracy would better demonstrate the dual-task cost and potential re-injury risks.

10 Resources for exercise ideas

- Kevin Wilk, DPT
  - dual task SLB with catches
  - dual task blazepod catch and touch example
  - dual task SLB with catches

https://youtu.be/vq_wR8V0OWA

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A post shared by Kevin Wilk, DPT, FAPTA (?)

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