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Review On Balance Beam Models

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Article History

Abstract
Balance beam apparatus are easy to assemble structures that require minimal tools. Test parameters usually include beam path time and leg displacement. Task performance allows assessment of balance-related motor skills, provides a functional indicator of differences in motor performance between young and old animals, and examines the therapeutic effects of age, disease, locomotion, coordination, and balance between groups, and comparison becomes possible. Balance tests are used to assess fine motor coordination and balance in rodents, especially motor skills (brain injury, genetic manipulation, and/or drug therapy). It helps scientists understand basic biological studies. It also shows why some diseases disrupt balance and coordination. Using the balance beam test is very practical and significance. This test is used to assess balance, anxiety, and stroke patterns, Parkinson's disease, Huntington's disease, multiple sclerosis. Researchers use these tests not only to diagnose diseases and injuries, but also for possible treatments. If the treatment works, the number of walks should decrease and the survival time of the mice should increase. In this review we focus on balance beam model apparatus, procedure and its pharmacological applications.

KEYWORDS: Balance beam model, Brain diseases, Parkinson's disease, Huntington's disease, Strock, Traumatic brain injury, Applications.

INTRODUCTION:

In the Balance beam test, the animal's performance can be measured by measuring how long it takes the mouse to cross the balance beam, the maximum distance, how often the hind legs leave the top of the balance beam, and how it moves several times it falls [1, 2]. However, manual analysis of mouse behavior is difficult due to low inter-observer reliability, as well as very labor-intensive, sensitive to observer flow, and limited

sensitivity. There is a limit to reproduction and reproduction from the results. [4,5]. Recent advances in computational neuroscience make it possible to automate the analysis of animal behavior by predicting the animal's position (localization) and behavior in the recorded video (behavior classification).] However, using this automatic method often requires extensive computing knowledge and programming skills [4, 9].
The balance beam apparatus has a simple structure, requires minimal tools, and is easy to assemble (Figure 1). Test parameters typically include beam path time and leg displacement. Project performance allows assessment of motor skills related to balance, showing motor differences between young and old animals, age, disease, and functional effects on motor performance and coordination between groups. This allows comparison of effects and balance [10-13].
Over time, the mechanism of balance checks and tests has undergone many changes. One of the first applications of measuring balance and coordination was to characterize locomotor performance in aged animals [13]. The first balance beam tests the animal's ability to stand on a narrow pole for 3 minutes. This study was conducted for three consecutive days and the waiting time for the results was used as the outcome variable [10]. In the new version of the balance beam test, a flat plate or a circle or a horizontal or curved line. This test requires rats to learn to walk on a beam without additional training, because it can reduce fertility [15]. Tests were performed 1 or 2 days after training or when the rats retained the learned memory [11]. The measurements obtained from the balance beam are (1) the distance fixed on the balance beam (usually 80 cm), (2) the number of foot rotations (on video recording), and (3) the mass in some cases. The number of breaks or points required to do this with the mouse. In fact, it is easy to gauge whether the animal has successfully passed the test before stopping midway, will be lost at the start line, or crosses the beam before entering the safe house. However, when testing animals using a balance beam, the reliability of measuring the primary outcome (i.e., transit time) is questionable due to unavoidable interference caused by breaks and vibrations. There is sex. Although well-developed thorough balance protocols provide a useful guiding model, there is no standard analytical strategy that accounts for potential performance biases that occur naturally in animal performance [1,10,11,16].

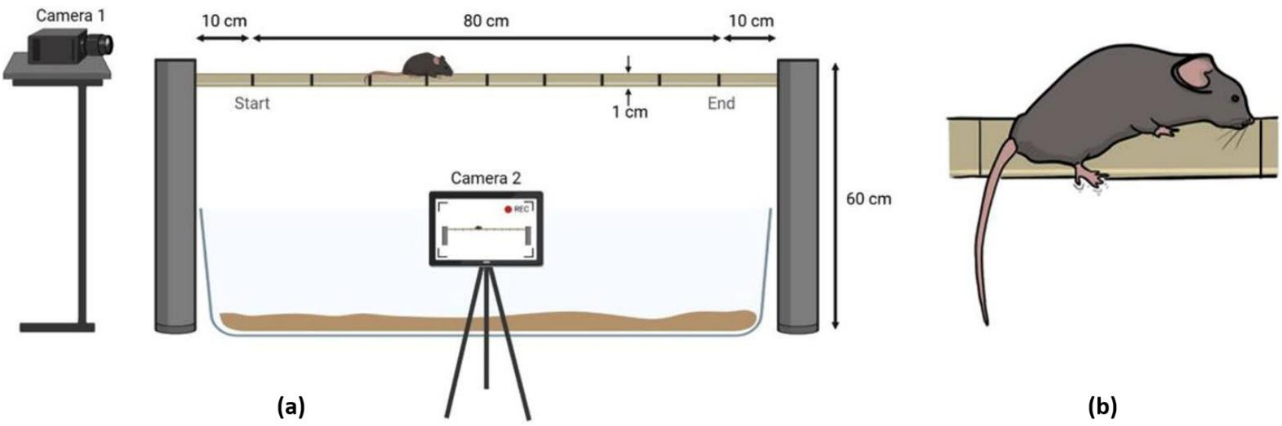

Figure 1: (a) Schematic representation of the balance beam test, (b) Illustration of hindpaw displacement defined as hindfoot landing on the beam.

Procedure:
The method used in this study was adapted from a previously developed protocol. Briefly, the balance beam device (Figure 1) consists of two simple wooden beams 1 meter long and 6 mm or 12 mm wide. The lamp is suspended by a strong tube 50 cm above the ground. Place the safe house on opposite sides of the two poles and add bedding to encourage the entry of rodents. A 25 cm deep net was placed under the beam to prevent rats from being injured if they fell onto the beam. The target distance for the rat test was defined as an additional 10 cm from the starting line and 80 cm mark from the beam. If the mouse stops or disappears before entering the safe house, complete the line. Rats were exposed to intermittent or stretched three times in each test session and five times in the second test session [2]. The time from the start line to the finish line is measured by a stopwatch and the movement of the legs is recorded by a video camera. A video camera was positioned 50 cm from the end of the beam to view the rat from behind. As shown in Figure 1, this position allows photographing the entire length of the camera beam and allows observing the movement of the frog's right and left legs [1,2,11].

Applications of the Balance Beam Test:

The balance beam test is practical and fun. The researchers used the balanced beam test to investigate the effects of neurological disorders. In diseases or brain injuries that reduce the capacity of the motor cortex, the balance function of the beam is reduced. In other words, in the model of disease or injury, less time is spent on radiation before more foot slips or falls [17,18,19]. Perez Polo et al observed rats with moderate and severe surgically induced brain injuries. After the injury, it was found that the duration of standing and walking of the mice in the beam was significantly reduced. In addition, affected individuals have significantly impaired forelimbs and hindlimbs [20].

Researchers use these tests not only to diagnose diseases and injuries, but also to develop treatments. If the treatment is effective, the number of foot movements should be reduced and the time spent on the mouse should be increased [21]. The balance beam walking test helps measure coordination and balance [22]. The result is usually calculated by determining the frequency of hindfoot slips, the time needed to cross the beam, the number of falls while walking the entire distance of the beam, and the distance in it. Pay attention to the time of rest, the number of left and right turns, and the number of left and right feet [23,24].

Since its development and widespread acceptance, balance reflex tests have been used primarily to investigate age-related movement disorders, central nervous system disorders, and genetic and pharmacological manipulations. This test has been used to assess balance beam, anxiety, stroke, Parkinson's disease, Huntington's disease and multiple sclerosis [25].

Balance Beam Test for Parkinson’s disease (PD):

The most common motor neurodegenerative disease substantia nigra pars compacta (SNc), Parkinson's disease, is characterized by progressive loss of dopaminergic neurons (DA) and intracytoplasmic α-synuclein (α-syn) inclusions. This is called Levi's body [25-28]. It is an incurable disease diagnosed based on clinical criteria and motor symptoms [29, 30]. PD deficiency occurs when approximately 40-60% of DA neurons die and 30-40% of DA content is lost, leading to major motor symptoms (bradykinesia, resting tremor, muscle stiffness, postural instability). Therefore, the potential to slow disease progression or achieve neuroprotection may be lost [31].

Development of new disease-modifying therapies for PD relies on animal models. In this generation, a significant loss of DA is required to observe changes in motor function in animal models of PD. Reliable early detection of symptoms of movement disorders is important for early evaluation of potential therapeutic interventions [33]. Therefore, various behavioral tests have been developed to screen for movement disorders, among which the balance test is particularly useful for detecting subtle deficits in motor and balance skills that cannot be detected by other motor tests. It is effective for measuring balance and equilibrium and can be used for the early detection of motor deficits in PD mouse models [35].

DeepLabCut is an open-source learning tool that can train a low-characteristic deep neural network to track user-defined features, control animal behavior, and achieve human landmark accuracy [36]. DeepLabcut Toolbox provides a graphical user interface (GUI) that helps researchers with minimal programming skills prepare annotations, evaluate networks, and analyze new videos. DeepPlebcut animal tracking output files can be loaded into other programs such as Simple Behavior Analysis (SymBA) for further analysis. SimBA is an open source method with a graphical user interface that uses DeepLubcut to create a random forest algorithm for accurate classification of behavioral patterns from videos using user-generated poses and annotations. SIMBA was developed to predict social behavior in rodents, but has been adapted to study different behaviors in different experimental protocols [9,37].

Balance Beam Test for Huntington’s disease (HD):

Huntington's disease (HD) is a neurodegenerative disease caused by a single mutation in the gene encoding the Huntington protein. HD is characterized by insidious and progressive neurodegeneration of midbrain neurons mainly in the caudate nucleus and cortical atrophy with abnormalities in other brain regions [38,39]. This disease causes motoric, cognitive and psychiatric symptoms leading to death after 15 years [40]. There is considerable evidence that exercise and a more active lifestyle have beneficial effects on the symptoms and prognosis of several diseases, including Alzheimer's disease and Parkinson's disease [41,42]. These studies show that exercise improves patients' daily functioning, sometimes after years of follow-up. In addition to these modulatory effects as measured by cognitive and motor assessments, there is evidence that exercise can slow the rate of neuropathology [43]. Until now, there is only one randomized controlled trial of physical activity in HD patients showing some functional benefits with minimal intervention [44].

Small animal studies using HD mouse models have shown that exercise can improve some aspects of motor and cognitive impairment [45]. Spontaneously induced R6/1 mice showed reduced physical activity during tail suspension, delayed motor activation in the static beam test, and changes in cognitive performance. However, this cycle is not affected by functional defects caused by other genes [46]. Studies using normal (middle-aged and elderly) mouse and rat models of exercise-induced neurological dysfunction have shown that it improves learning. However, this effect was absent in a study of rats bred for high wheel performance [47]. Studies on motor and cognitive performance have used hippocampal interstitial spatial learning tests in HD rat strains [48]. However, these types of tests do not correlate with striatal neuropathology in HD. Therefore, although there is evidence that exercise training in the HD mouse strain may be beneficial in the clinical population; Previous studies used behavioral tests with low reliability and low translational value [49].

Balance Beam Test for Anxiety:

Anxiety may be important in gymnastics, particu- larly during balance beam performance, where elements of high difficulty are performed on a 10 cm wide beam at a height of 125 cm. Factors such as risk of injury (Kolt & Kirkby, 1994; Magyar and Chase, 1996; Sands, 2000; Tofler, Stryer, Micheli, & Herman, 1996) and the subjective scoring system of the judges (Krane & Williams, 1985; Weiss, Wiese, & Klint, 1989) contribute to anxiety. Gymnasts perceive less anxiety in their own training facility than in a competition facility (Gould, Petlichkoff, & Weinberg, 1984; Kerr & Pos, 1994; Matheson & Mathes, 1991; Williams, Frank, & Lester, 2000). indicating an increase in anxiety when situational factors become more unfamiliar. Several studies have suggested that Anxiety may be important in gymnastics, particu- larly during balance beam performance, where elements of high difficulty are performed on a 10 cm wide beam at a height of 125 cm. Factors such as risk of injury (Kolt & Kirkby, 1994; Magyar and Chase, 1996; Sands, 2000; Tofler, Stryer, Micheli, & Herman, 1996) and the subjective scoring system of the judges (Krane & Williams, 1985; Weiss, Wiese, & Klint, 1989) contribute to anxiety. Gymnasts perceive less anxiety in their own training facility than in a competition facility (Gould, Petlichkoff, & Weinberg, 1984; Kerr & Pos, 1994; Matheson & Mathes, 1991; Williams, Frank, & Lester, 2000). indicating an increase in anxiety when situational factors become more unfamiliar. Several studies have suggested that This attention can be important in competitive gymnastics, especially when performing difficult balances with a height of 10 cm and a height of 125 cm. Factors such as injury risk [50,51] and judges' subjective scoring systems are of concern [52]. Gymnasts report less anxiety in the training arena than in the competition arena [53,54]. Anxiety increases when risk factors are more unusual. Some studies show that anxiety can impair balance in gymnastics. Weinberg and Gould (1995) suggested that anxiety causes muscle tension and decreased coordination [55]. From a more clinical perspective, McKee and McIlroy (1996) showed that anxiety negatively affects balance parameters measured by posturography [56].

Unexpected events (loss of balance, falls, etc.) during balance beam exercises can have a significant impact on a person's anxiety. As explained by Hardy's catastrophizing theory, this event can have a significant impact on the level of cognitive anxiety and confusional results [57,58]. This theory states that performance is influenced by physiological arousal and cognitive anxiety. The relationship between physiological arousal and performance for low learning is inverse. On the other hand, if the psychological anxiety is high, the relationship will be destroyed. This means that once your physiological arousal reaches optimal levels, your productivity (unfortunately) drops dramatically. Finally, it is cognitive anxiety that determines the effect of physiological arousal on motor performance. Fazi and Hardy (1988) found that physiological arousal is negatively related to performance only when the level of psychological stress is high. This theory asserts that the relationship between anxiety and performance is dynamic and can change within seconds. To understand the temporal dynamics of this competitive anxiety, continuous anxiety measurements during performance are needed [59].

The measurement of physiological parameters such as heart rate, skin conductance, and muscle activity allows a systematic analysis of the relationship between physiological arousal and performance [60]. Physical passion is also part of the theory of separation. However, measuring physiological parameters alone is not enough to show the true nature of the relationship between anxiety and athletic performance. There is general agreement that anxiety is a multidimensional construct and that physiological and psychological aspects should be examined simultaneously. Lovazza, Bortoli, Nouge integration of physical and psychological parameters. For example, heart rate was measured in shooting competitions and emotions were measured by interviewing the athletes before and during the competition [62,63].

Balance Beam Test for Strock:

Stroke is the most common diagnosis among adults. Between one-third and one-half of people over 65 fall at least once a year. People living in long-term care facilities experience an average of 1.7 falls per year, and

10% to 25% of falls have serious medical consequences. More than 200,000 kidney fractures occur in the United States each year, with a 6-month mortality rate of approximately 20%. Half of the elderly who have experienced at least one fall admit to persistent fear of falling, and 25% have reduced their activity level. Consequently, decreased mobility due to fear or trauma can lead to decreased independence [64].
Additionally, more than 50% of hemiplegic patients experience long-term or permanent hand disability due to upper extremity paralysis [65]. Previous studies have shown that balance training and upper extremity training have beneficial effects on balance function in stroke patients. Balance exercises involving upper extremity movements lead to changes in the center of gravity on stable and unstable surfaces, and changes in balance, such as changes in walking speed and direction, lead to improvements in balance [66]. Lower arm motor impairment is positively correlated with upper arm motor impairment in stroke patients [67].

Balance Beam Test for traumatic brain injury (TBI)
The method presented here is designed to detect dysfunction in specific brain regions induced by experimental traumatic brain injury in mice. We will discuss four different behavioral tests. First, a simple neurological assessment called NeuroScore can be done without special equipment, but it requires experience. This test detects defects in reflexes. Second, the beam balance test showed an inability to balance. This task requires the operator to score the mouse on a standard scale and requires little operator training [68]. The light balance test requires a narrow beam and is sensitive to defects in the vestibular system. The third test assesses vestibular motor coordination. Although this test is known as the beam-walking task and requires the rats to be prepared beforehand, this method is more objective than the previous two steps. . This difference is due to the time needed to cross the thin beam and reach the safe. The beam walking test requires a longer beam than the balance beam and escape box. This test measures motor coordination and balance deficits that affect the brain and areas related to movement. The working memory version of the Morris Water Maze (MWM) primarily tests hippocampal and prefrontal cortex function, or executive function. A version of the Morris Water Maze has also been shown to be used to detect contextual memory deficits [68].
This method was selected based on the records established in the literature. Each of them worked for many people in different laboratories with different mice for many years. However, until recently, activity up to 2 weeks post-injury was considered the "survival" time point. Therefore, to develop a behavioral method to investigate the chronic effects of TBI in rodents, we evaluated this particular method for its sensitivity in detecting post-traumatic TBI deficits. Although many rodent brain injury models exist today, the FPI model is one of the most widely used and used in this work. This model was first published in the 1950s, and since then more than 1000 papers have used FPI in rats [69,70]. The neuropathology of this type of injury has been well described by us and others. Briefly, neuronal damage in the hippocampus was demonstrated in a dose-dependent manner using Fluoro-Jade staining immediately after injury, ie 24 to 48 hours. General atrophy, including thinning and surface loss of the internal capsule and cortex, has been reported [71–74]. Normal beam balance is sensitive to balance post-injury and long-term post-injury test deficits. The balance's vulnerability to brain damage decreases over time. This is because the affected person has difficulty balancing the rays as they age and gain weight. It is then rotated for balance on the broad side of the beam [75].

CONCLUSION:

Balance tests are used to assess fine motor coordination and balance in rodents, particularly motor skills (in the absence of brain damage, genetic manipulation, and/or drug therapy), and are used to help scientists understand basic biology. It also shows why some diseases disrupt balance and coordination. The researchers used the balanced beam test to investigate the effects of neurological disorders. Radiation performance is reduced as a response to diseases that reduce athletic performance or damage to the cerebral cortex. The balance beam test is practical and fun. Researchers have used the balanced reflex test to study the effects of stroke, Parkinson's disease, Huntington's disease, and traumatic brain injury.

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