When the vestibular apparatus is fired up in response to the stimulus, it sends stimulus inputs into two separate pathways to the cerebellum, i.e., a direct pathway that projects the stimulus directly into the cerebellum and an indirect pathway that projects the stimulus into the cerebellum via the vestibular nuclei in the brainstem.

Once reached the cerebellum, the cerebellum sends stimulus inputs to the ~~superior colliculus~~red nucleus, and thalamus, which then projects the stimulus inputs to the primary motor ~~and primary sensory cortices~~, and hypothalamus of the brain. These would then further project the inputs into the sensory ~~premotor~~ and prefrontal cortices. From all these ~~the premotor and prefrontal~~ cortices, responses to the stimulus ~~projections~~ are ~~sent~~ projected back to the primary motor cortex and other cortices, cerebellum, basal ganglia, reticular formation, brainstem nuclei, and spinal cord to the trunk and limbs. The premotor, motor and prefrontal lobes are for ~~executive functions,~~ volitional eye and limb movements, motor learning and planning, motor programs and sequencing, speech, social appropriateness, judgment, organizational skills, working memory, inhibition or excitation of antigravity muscles (shunt muscles), autonomic system regulation, learning and behavior.

The cerebellum also projects the responses back into the vestibular nuclei and reticular formation via its fastigial nucleus and its cortex. In fact, the cerebellar projections to the vestibular nuclei outnumber those from any sources, because these cerebellar~~'s~~ projections are very important for maintaining human homeostasis. The maintenance of human homeostasis includes postural adjustments and stability, coordinated and stereotyped movements such as walking, and eye

movements. Deficits in the cerebellum projections would show up as postural instability, ataxia in gait and movements, hypotonia, decomposition of movements, dysmetria in movements and in saccades, poor pursuits (which results in poor reading skills), dysarthria, and impaired cognitive functions.

In maintaining human bipedalism, the projections from the vestibular nuclei in the brain stem influence the spinal cord to control postural tone of trunk and limbs, thereby maintaining good posture. This type of projection is through the vestibulospinal tracts, both lateral and medial. These vestibulospinal tracts are for antigravity muscles that affect postural trunk and limbs stability and tone, postural changes to compensate for tilts and movements of the body and limbs. They are also important for stability of head positions as the human moves and for coordination of head movements with eye movements. These help to keep people from falling and to allow humans to have a good balance, postural tone and position sense (from proprioception and visual cues). Accordingly, the stability, tone and movements of the trunk and limbs are controlled.

Apart from the trunk and limbs, the projections from the vestibular nuclei in the brainstem also influence eyes to generate appropriate eye movements in response to head movements via the abducens, oculomotor and trochlear nucleus and resulting cranial nerves. This is known as Vestibular Ocular Reflex (VOR).

VOR is by which gaze can stay fixed on an object even though the head is moving or being moved. VOR is important in everyday life as in walking, talking, reading, running, jumping, being in the bus or car, etc. Exaggerated nystagmus is one of the resultant neuropathology that arises when the VOR is not working properly.

Other related functional deficits are learning problems, visual problems, balance and motion sickness, neck and shoulder pains, hand and eye discoordination, etc.

The stimulus inputs from sensory, motor, and autonomic pathways for the maintenance of body balance and homeostasis are relayed to the reticular formation in the brain stem. These inputs include those extensive connections between the vestibular and cerebellar system with the dorsal motor nucleus of the vagus, nucleus tractus solitaries, and the rest of the ~~pontomedullary~~ reticular formation of the brain stem. These nuclei together with the reticular formation regulates sleep, consciousness and arousal, breathing, feeding, swallowing, vocalizing, homeostasis, control of blood pressure and pulse, regulation of blood chemistry, gastrointestinal function, alimentation and elimination, control of posture and eye movements, and the modulation of the parasympathetic and sympathetic systems. Pathologies related to this area include dysautonomias and unusual pain and discomfort symptom patterns.

With the projections paralleling the auditory pathways and those traversing the reticular formation, the brain stem projections from the vestibular nuclei reach up to the thalamus. The projections are projected to the parietal lobes (primary somatosensory cortex and association areas) and posterior insula near the auditory cortex. Together with the cerebellar projections, these projections give the conscious appreciation of body orientation and sense. Together with visual and proprioceptive input, they generate appropriate sense of orientation and movement. In conclusion, cerebellum, brainstem, and other parts of neuraxis must function well to

integrate all projections so that the human nervous system is able to properly response to any kind of stimulus.

Summary

In light of the above, there is an objective of the present invention to provide an apparatus adapted to train neuraxis of a trainee.

One aspect of the present invention provides a training apparatus for training neuraxis of a trainee. The training apparatus comprises a base, a frame rotatably mounted on the base in a vertical manner defining a vertical axis and a cabin for receiving the trainee. The cabin has a yaw-axis, a pitch-axis and a roll-axis that are perpendicular to each other. The cabin is pivoted to the frame on a pivoting point, through which a lateral axis is defined. The lateral axis is perpendicular to the vertical axis. When the cabin is in an upright orientation, the yaw-axis of the cabin is in line with the vertical axis. The training apparatus further comprises a driving assembly that operatively drives the rotation of the frame and cabin to rotate about the vertical axis and horizontal axis, respectively When the cabin is reclined about the lateral axis into a recumbent orientation, and is rotated about the vertical axis by the driving assembly, the cabin rotates about the roll-axis.

Another aspect of the present invention provides a method for operating a training apparatus. The method comprises providing a training apparatus comprising a base, a frame rotatably mounted on the base in a vertical manner defining a vertical axis, and a cabin having a yaw-axis, a pitch-axis and a roll-axis

pitch-axis **112** of the cabin **105** are in line with the vertical axis **111B** and the lateral axis **112B**, respectively. In such arrangements, the cabin **105** is rotatable about its yaw axis **111** and pitch axis **112** through the rotations about the vertical axis **111B** and lateral axis **112B**. The rotations about the respective axis may be independently controlled and driven through a driving assembly.

In one embodiment, the driving assembly comprises a first motor that drives first or second shaft **112A** to rotate the cabin **105** about the lateral axis **112B** and a second motor that drives the vertical shaft **111A** to rotate the frame about the vertical axis **111B**.

Through the driving assembly, the cabin **105** is rotatable about its pitch-axis **112B** through the first motor. On the other hand, the cabin **105** is rotatable about the yaw-axis **111B** through the second motor. Accordingly, the cabin **105** is rotatable freely in its yaw axis and pitch axis at any desired speed and direction through the driving assembly.

Through the two-principle axes, i.e. the vertical and horizontal axes, it is possible to rotate the cabin **105** in its roll axis ~~**113B**~~.

To rotate the cabin **105** about its roll-axis ~~**113B**~~ through the two-axes rotational training apparatus **100**, the cabin **105** is first reclined to a recumbent orientation relative to the base support and maintained it in that orientation. Fig. 1B illustrates a perspective view of the training apparatus with the cabin **105** in recumbent orientation, while Fig. 1C illustrates a side view of the training apparatus with the cabin **105** in the recumbent orientation. Once the cabin **105** is

inclined in the recumbent orientation, the second motor is actuated to drive the vertical shaft to rotate. In that case, the cabin **105** is literally rotated about its roll axis in any desired angle and speed accordingly. In effect, a trainee who sits on the recumbent cabin **105** would experience a rotation about the roll axis ~~**113B**~~. As such, the neuraxis trainer apparatus **100** allows the cabin **105** to rotate about the yaw, pitch and roll axes through the two principal axes, i.e. the vertical and horizontal axes.

It shall be noted that rotation of the cabin **105** about the lateral axis and rotation of the frame **107** about the vertical axis may be controlled separately or simultaneously in any combinations. This provides limitless ranges of rotational movements to the training apparatus **100**.

It shall be noted that the cabin **105** is able to rotate freely about all the axes of rotation without any obstacles such as electrical wiring of the apparatus. The trainee sitting on the chair **101** encased by the cabin **105** is rotated thereby.

Fig. 1D illustrates a front view of the training apparatus **100**. If desired, a door may also be hinged to provide a closure to the cabin **105**.

Fig. 1E illustrates a side view of the training apparatus **100**. The cabin **105** is provided with a window **108** to provide the user with a view to the surrounding environment.

Fig. 1F illustrates a top view of the training apparatus **100**. The cabin **105** may be made of any kind of materials that perform sufficient strength and

assembly comprises a vertical motor **206**, a horizontal motor **207**, sensors **208** and motor controllers **205**. There are provided with two motor controllers **205**, one connected to the vertical motor **206** and another connected to the horizontal motor **207**. The motor controllers 205 are adapted to control the speed and direction of the rotations of the driving motors independently. The vertical motor **206** and horizontal motor ~~**205**~~ **207** are further connected to the respective sensors **208** so the operations of the motor assembly can be monitored accordingly. The sensors senses operating status of the motors and transmit the signals to the respective motor controller **205**. The motor (**206**, **207**), the sensor **208** and the motor controller **205** form a close loop connection.

During operation, the trainee sits in the training apparatus **100**. The operator of the training device **100** inputs or selects the training protocols to initiate the training through the computer system **200**. As motor controllers **205**, as instructed by the computer system **200**, control the motors to drive the cabin **105** to rotate, either independently rotating about the two principle axes, or in combination thereof. The real-time rotational movement of the cabin is sensed by the sensor **205** coupled to the motor. The information regarding the cabin movement is then feedback to the processor **201**. The processor **201** processes the information and output them as a graphical representation on the display device **203** in real-time. The graphical data can be displayed to the operator via the displaying device **203**. The graphical data is then stored in the trainee's personal folder. The collected graphical data can thus be further studied and followed-up to evaluate the trainee progress in response to the training.