SUPPLEMENTARY MATERIALS

MATERIALS AND METHODS

Eye movement recording

Saccade test was used to evaluate whether participants can rapidly and accurately change the point of fixation when a certain object suddenly appears within the visual field. The participants were instructed to fix on and follow the target, and five scanning waves of their eye movements were recorded. The test was carried out in the horizontal and vertical directions respectively. The speed of target jumping was from 350°/s to 600°/s and the frequency was from 0.2 to 1.0 Hz, and the holding time at each position was less than 1s. The latency (the time from the appearance of target to the beginning of eye movement, unit milliseconds) and speed (the maximum velocity of eyeball moving from one target to the next; unit: °/s) of saccade test were analyzed.

Smooth pursuit test was used to check the ability of tracking a stimulus moving smoothly at different velocities. The target swings back and forth in the horizontal direction in the form of sine wave (peak amplitude is 30°, frequency is from 0.1 to 0.5 Hz, peak speed is 40°/s), and the speed was from slow to fast. Electronystagmography or nystagmography was used to record eye movements for at least two complete cycles. Smooth pursuit test is quantified by the gain (the ratio of smooth eye movement velocity to target velocity) and slow phase velocity (SPV; unit: °/s).

Optokinetic nystagmus is a comprehensive response of the smooth tracking and scanning eye movement systems. The target was a string of continuously moving photoelectric devices with a speed of 20°/s or 35°/s. During the test, the participants looked straight at the front horizontal target, and they were required to follow up any target and move from one end of the target to the other for recording. Record 3–5 complete nystagmus waves respectively. The gain and SPV were analyzed in optokinetic test.

Gait analysis

Gait parameters were acquired by Jumho Electric's Gait Watch Analysis System (Jumho, Guangzhou, China). The testing process required patient to walk 12 meters, during which the system captures motion data from the sagittal, coronal, and vertical planes of the pelvis, hip joint, knee joint, and ankle joint while simultaneously performing gait analysis in the computer program. The sampling frequency of the signals is 500 Hz. The main parameters collected include step length and stride length, walking velocity, step deviation and gait phase.

Step length is the distance traveled from when one foot's heel touches the ground to when the opposite foot's heel touches the ground immediately after. Stride length is the distance covered from when one foot's heel touches the ground until that same heel touches the ground again. Stride width is the distance between the left and right feet during walking, typically measured from the midpoint of the heels. Our equipment does not provide stride width metrics. Walking velocity is the linear distance moved in the direction of travel per unit of time is referred to as walking velocity or walking speed. Step deviation is the difference between the step lengths of the left and right sides.

Each gait cycle during walking includes a series of typical posture transitions. These typical posture changes are divided into a series of phases known as gait phases. A gait cycle can be divided into the stance phase and the swing phase. Stance phase refers to the stage during walking where there is always contact with the ground. The stance phases include single-limb support phase and double-limb support phase. Single-limb support phase usually refers to the process from the heel of one lower limb touching the ground to the toe of the same side lifting off, measured in seconds, and generally accounts for 40% of a gait cycle. Double-limb support phase is a distinctive feature of walking. During a gait cycle, when one lower limb completes the action of lifting the heel and pushing off the ground with the toe, the other lower limb simultaneously performs the actions of the heel touching the ground and the entire sole contacting the ground, resulting in a phase where both feet are on the ground at the same time. This phase generally accounts for 20% of a gait cycle and its duration is related to walking speed, the faster the speed, the shorter the double-limb support phase. When walking turns into running, the double-limb support phase becomes zero. Swing Phase refers to the stage during walking where there is no contact with the ground, typically from the moment the toe of one lower limb lifts off until the heel of the same side touches the ground again, measured in seconds, and generally accounts for 40% of a gait cycle.