PRIMARY ANTICIPATORY POSTURAL ADJUSTMENT MUSCLE

By Ron Hruska

Anticipatory postural (upright) postural adjustments are pre-emptive muscle activations that occur before voluntary movements to stabilize the body and counteract destabilizing forces. They are triggered by neurological system that anticipates the upcoming movement and its potential destabilizing effects. This leads to pre-emptive muscle activation to counteract these affects, sometimes referred to as a 'feedforward mechanism'.

Anticipatory postural adjustments (APA) correspond to dynamic phenomena which are centrally preprogrammed. The inertia forces associated with APA may, when the time comes, balance the inertia forces due to the movement of the mobile limb therefore counteracting the disturbance to postural equilibrium.

"It is suggested that posturo-kinetic programming could result from a differential sensitivity of the CNS to two biomechanical factors, a linear and a rotational one, which can characterize the perturbation associated with the voluntary movement." *(Bouisset S, Zattara M. Biomechanical study of the programming of anticipatory postural adjustments associated with voluntary movement. J Biomech. 1987;20(8):735-42.)*

"There are significant differences in posture control patterns between adolescent idiopathic scoliosis (AIS)and normal subjects. Subjects with AIS have asymmetric habitual muscle activities for anticipatory perturbation, whereas when coping with sudden balance threats, they react with synchronized recruitment of bilateral postural muscles." (*Kuo FC, et al. Postural control strategies related to anticipatory perturbation and quick perturbation in adolescent idiopathic scoliosis. Spine. 2011 May;36(10):810-16.)*

"APAs are generally produced about 30-50 ms before and after the initiation of destabilizing limb movements and are part of a reflex-likes system co-regulated by spinal cord and cerebellar neural feedback loops." *(Aruin AS, Latash ML. Directional specificity of postural muscles in feed-forward postural reactions during fast voluntary arm movements. Esp. Brain Res. 1995;103(2):323-332.)*

The primary anticipatory and reactionary postural adjustments that counteract the destabilizing forces away from the body's center of mass of upper-limb movements are the thoracic diaphragms, the intra-limb hip extensors, flexors, adductors and abductors, gait initiating soleus and tibialis anterior, and spinal lateral flexors, outlined below.

<u>Thoracic Diaphragms</u>

"With rapid flexion of the shoulder in response to a visual stimulus, EMG activity in the costal and crural diaphragm occurred about 20 ms prior to the onset of deltoid EMG. This anticipatory contraction occurred irrespective of the phase of respiration in which arm movement began. The onset of diaphragm EMG coincided with that of transverses abdominis.

This study provides definitive evidence that the human diaphragm is involved in the control of postural stability during sudden voluntary movement of the limbs." *(Hodges P, et al. Contraction of the human diaphragm during rapid postural adjustments J Physiol. 1997 Dec;505(Pt 2):539-548.)*

"Deterioration of diaphragm function observed after thoracic surgery is closely related to deterioration of balance maintenance." (*Kocjan J, et al. Impact of diaphragm function parameters on balance maintenance. PLoS ONE. 2018 Dec;13(12):e0208697.)*

Intra-limb Hip Extensors, Flexors, Adductors, and Abductors

"The exclusive control of balance and posture are the hip extensors and flexors, while in the direction of the dominant control is through the use of hip abductors and adductors. The ankle invertors and evertors, compared to these hip muscles, have negligible involvement in balance control during forward locomotion and are more active in adjustment of upright posture in tandem standing." (*Winter DA. Human balance and posture control during standing and walking. Gait & Posture. 1995 Dec;3(4):193-214.)*

Gait Initiating Soleus and Tibialis Anterior

"Prior to gait initiation (GI), anticipatory postural adjustments (GI-APA) are activated in order to reorganize posture, favorably for gait. In healthy subjects, the center of pressure (CoP) is displaced backward during GI-APA, bilaterally by reducing soleus activities and activating the tibialis anterior (TA) muscles, and laterally in the direction of the leading leg, by activating hip abductors." (*Delafontaine A, et al. Anticipatory postural adjustments during gait initiation in stroke patients. Front Neurol. 2019 Apr;10:352.)*

Spinal Lateral Flexors

Posture of the upper trunk is regulated by the spinal lateral flexors. Interactions between the supporting foot and hip musculature to permit variability in strategies used to maintain balance were identified in the research. (*MacKinnon CD, Winter DA. Control of whole body balance in the frontal plane during human walking. J Biomech. 1993 Jun;26(6):633-44.)*

Impairment of APAs associated with upright respiratory imbalance, center of mass limited alternation during lower and upper inter-limb swing, single leg dysregulation, hemi-thoracic diaphragm malposition and forward locomotor dysfunctional propulsion can be reduced by repositioning and retraining these APA muscles, which are addressed in the many courses offered by PRI®.

["Anticipatory insight is accompanied by a burst of activity and blood-flow changes in the right superior temporal gyrus, which is associated with learning, memory and language processing. This activity occurs just 300 milliseconds before the research participants pressed a button to report being consciously aware of the answer. The researchers detected an "ahah!" signal in the brain. They also found that neural activation linked to insight is more sudden and localized than that for analytical problem-solving, supporting the notion that insight (anticipatory, preparator) insight is an abrupt realization of knowledge rather than a gradual accumulation. (Basilio H. The brain science behind lightbulb moments. Nature. 2025 Jun;642:854-856.)]