Somatic and/or spinal rhythmic motion with music-making may be effective on cerebrospinal fluid circulation and tonality of body condition: hypothesis for music-based interventions

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ABSTRACT Cerebrospinal fluid (CSF)-contacting neurons (CSF-N) located in the surface of both brain ventricles and the central canal (cc) in the spinal cord. The cc and CSF maintain a proliferative niche for neural progenitor cells and plays a vital role in development of the brain. The CSF-Ns sense chemicals changes and motion in the brain. The CSF physiologically circulates in the ventricles and the subarachnoid spaces. The CSF rhythmic flow and pulsation can be observed both in the brain and spinal cord. It is demonstrated as a cardiac-related CSF pulsation and respiratory fluctuation. Interestingly, a new concept of CSF motion may be contrary to the classical one that the direction of CSF motion may vary in direction and may be dynamic in its location. The CSF pressure may also depend on the body position. Brain structural adaptations are clearly found among professional musicians, amateur musicians and/or non-musicians. Moderate music-making has been considered a potential approach for rehabilitative and restorative therapy of brain dysfunctions. Recently, we find that the CSF-Ns are present in both the interior CFS in the cc and also exterior CSF around the surface of the spinal cord. We hypothesize that CSF-N as mechanical sensors in the spinal cord could sense motion of the spinal cord. However, this hypothesis still lacks the study of whether somatic movements during music-making could affect CSF movement or circulation. The myodural bridge is a ligament connecting a pair of deep, upper-neck muscles to the dura mater, which envelops the arachnoid mater and contains the CSF surrounding the brain and the spinal cord. We presume that the somatic body movement with music-making would orchestrate the CSF motion with head movement, myodural bridge stretching and puling as well as spinal bending etc.

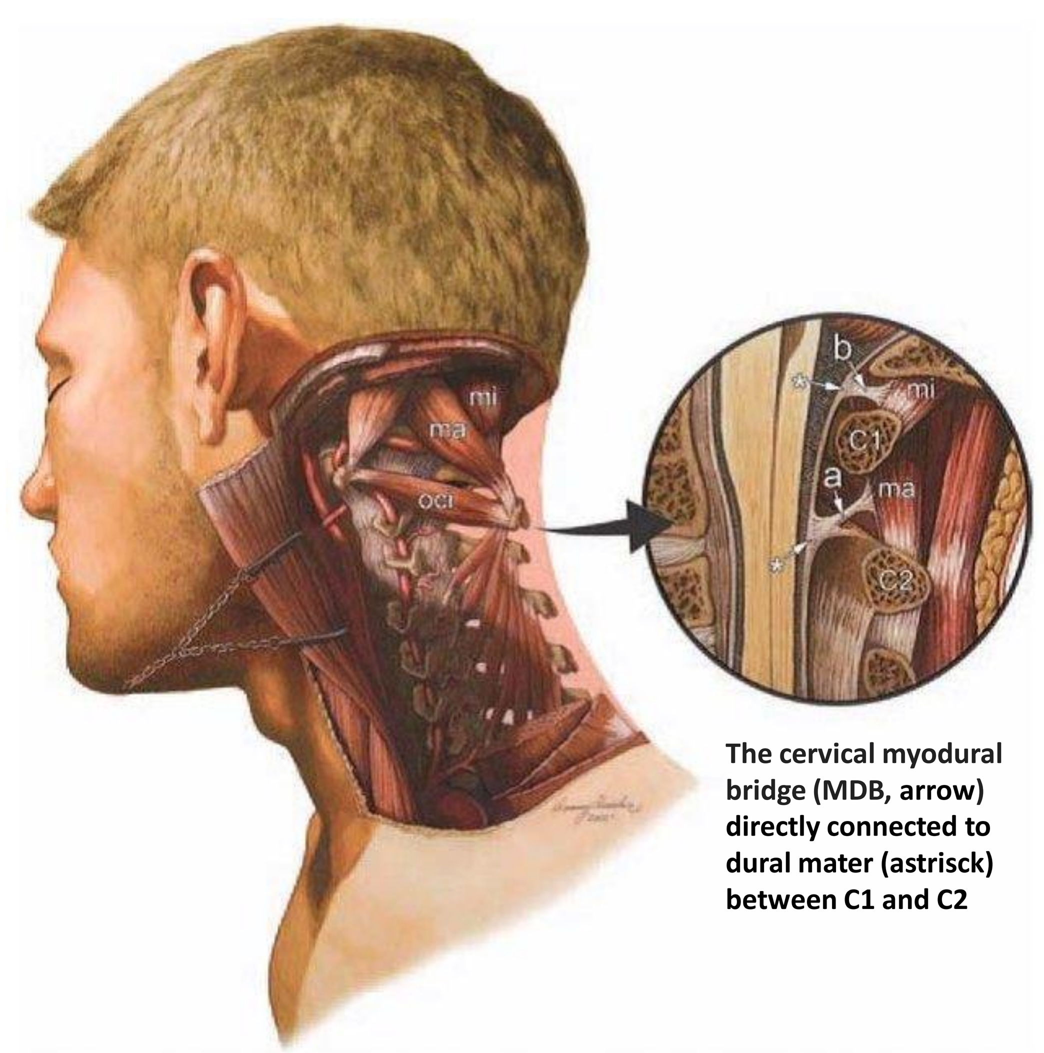

Figure 1. We presumed that head, shoulder and or upper arm motion could stretch and pull the myodural bridge (MDB), which would act on the CSF movement and circulation.
Acknowledgement: The illustration cited with permission from J Can Chiropr Assoc. 2014 Jun;58(2):184-92. (Original anatomical artwork by Frank Scali, D.C., and Danny Quirk. Clin Anat. 2013 May; 26(4):444-9)

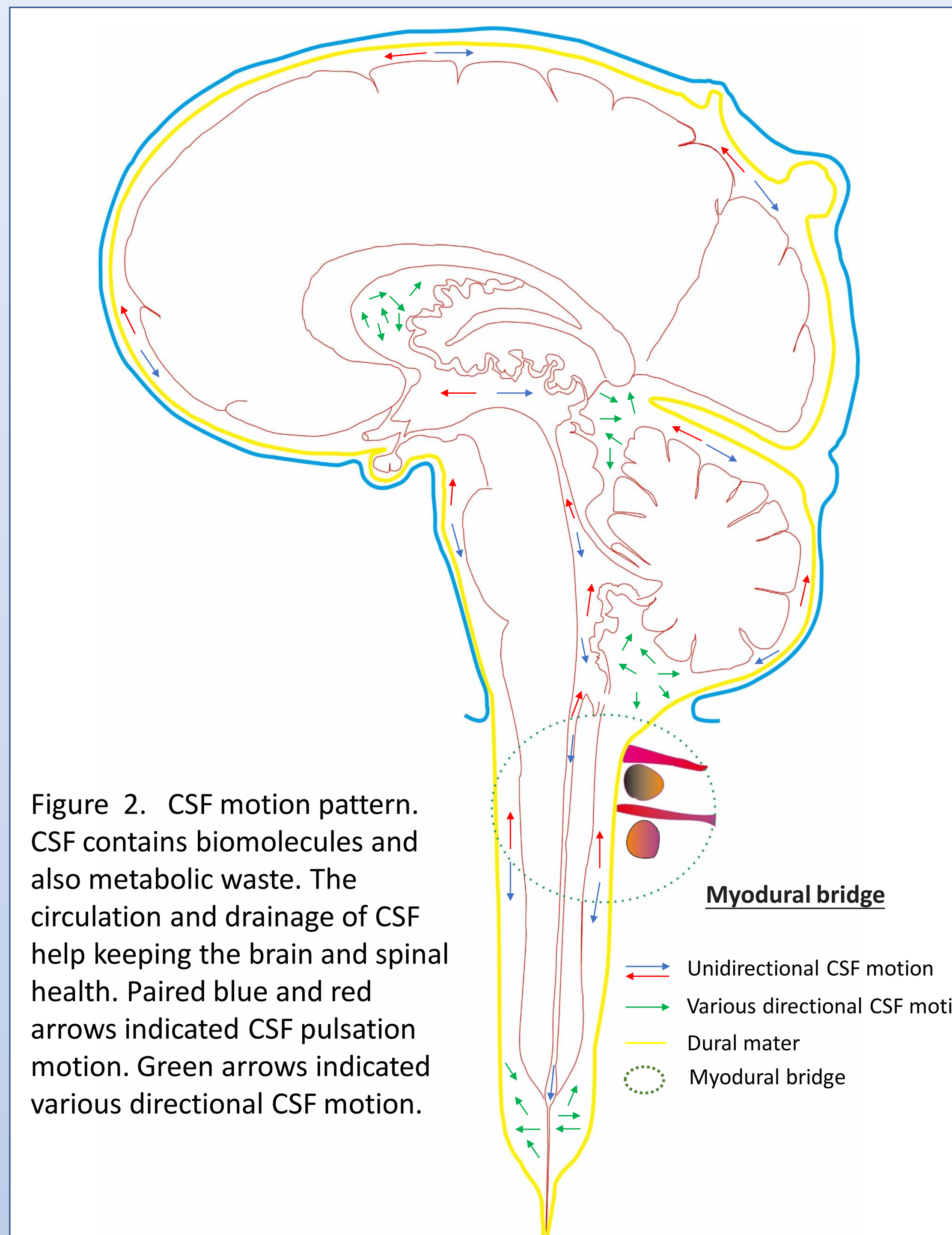

Figure 2. CSF motion pattern. CSF contains biomolecules and also metabolic waste. The circulation and drainage of CSF help keeping the brain and spinal health. Paired blue and red arrows indicated CSF pulsation motion. Green arrows indicated various directional CSF motion.

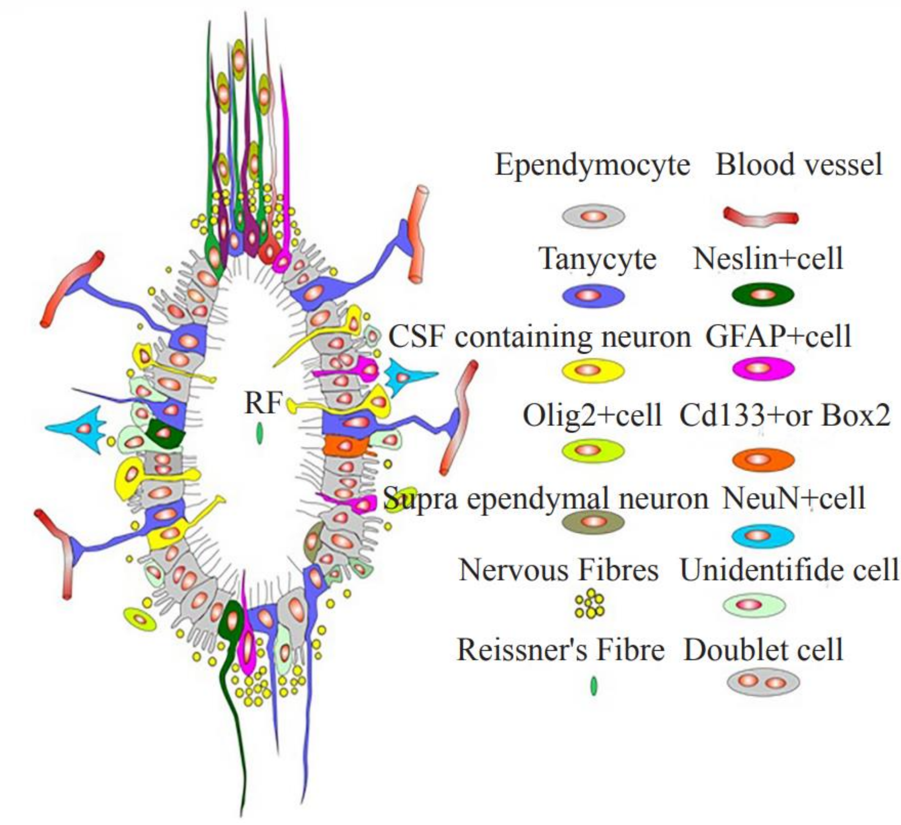

Figure 3. CSF-Ns distributed among ependymal cells or around the cc in the spinal cord. Both the cc and the CSF circulation maintain a proliferative niche for neural progenitor cells, which play a vital role in development of the brain and spinal cord. (Chin J Neurotrauma Surg (Electronic Edition), 2015, Vol.1, No.3, DOI: 10.3877/cma.j.issn.2095-9141.2015.03.013). **Acknowledgement:** Hugnot JP, Franzen R. Front Biosci (Landmark Ed), 2011, 16: 1044-1059. Review.

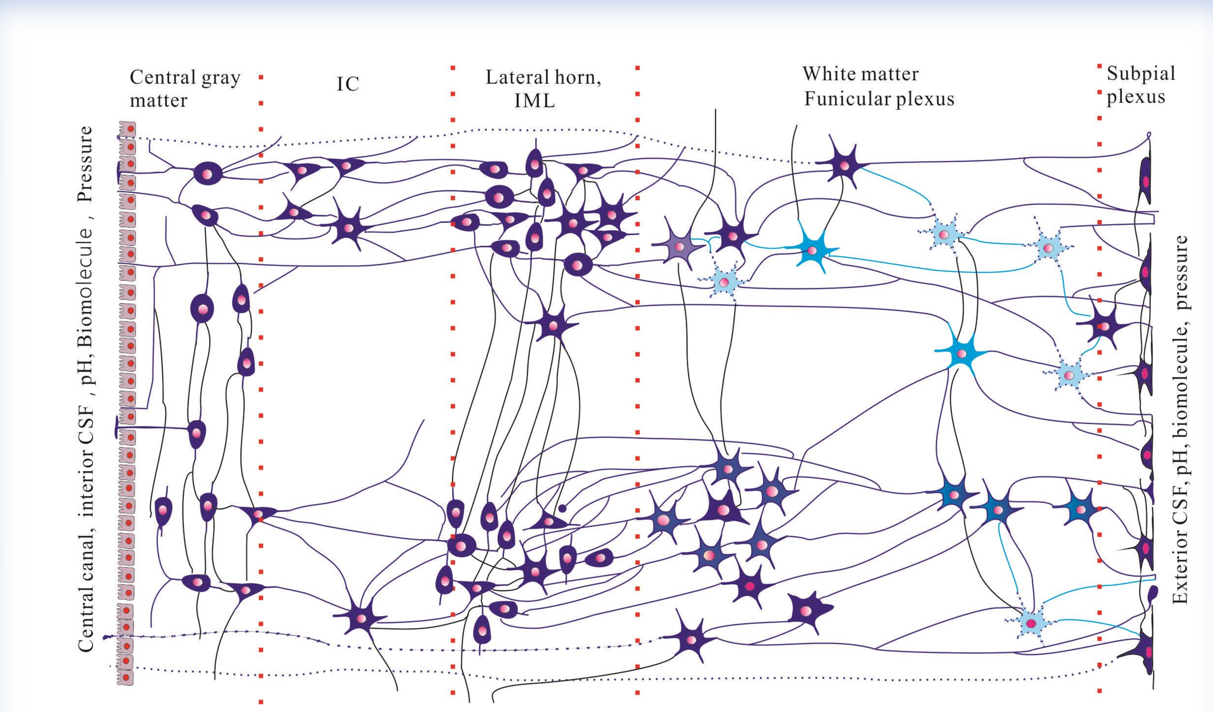

Figure 4. Diagram illustrated NADPH diaphorase neuronal connectivity in a horizontal arrangement from the cc to the pial surface in monkey spinal cord. The subpial plexus and funicular plexus reached the external CSF on the surface of the spinal cord. The pH, bio-molecules and pressure in the CSF could be detected by the CSF-N in the subpial plexus and funicular plexus. IC: intercalated nucleus, IML: intermediolateral N.
(bioRxiv preprint doi: https://doi.org/10.1101/2020.01.30.927509)

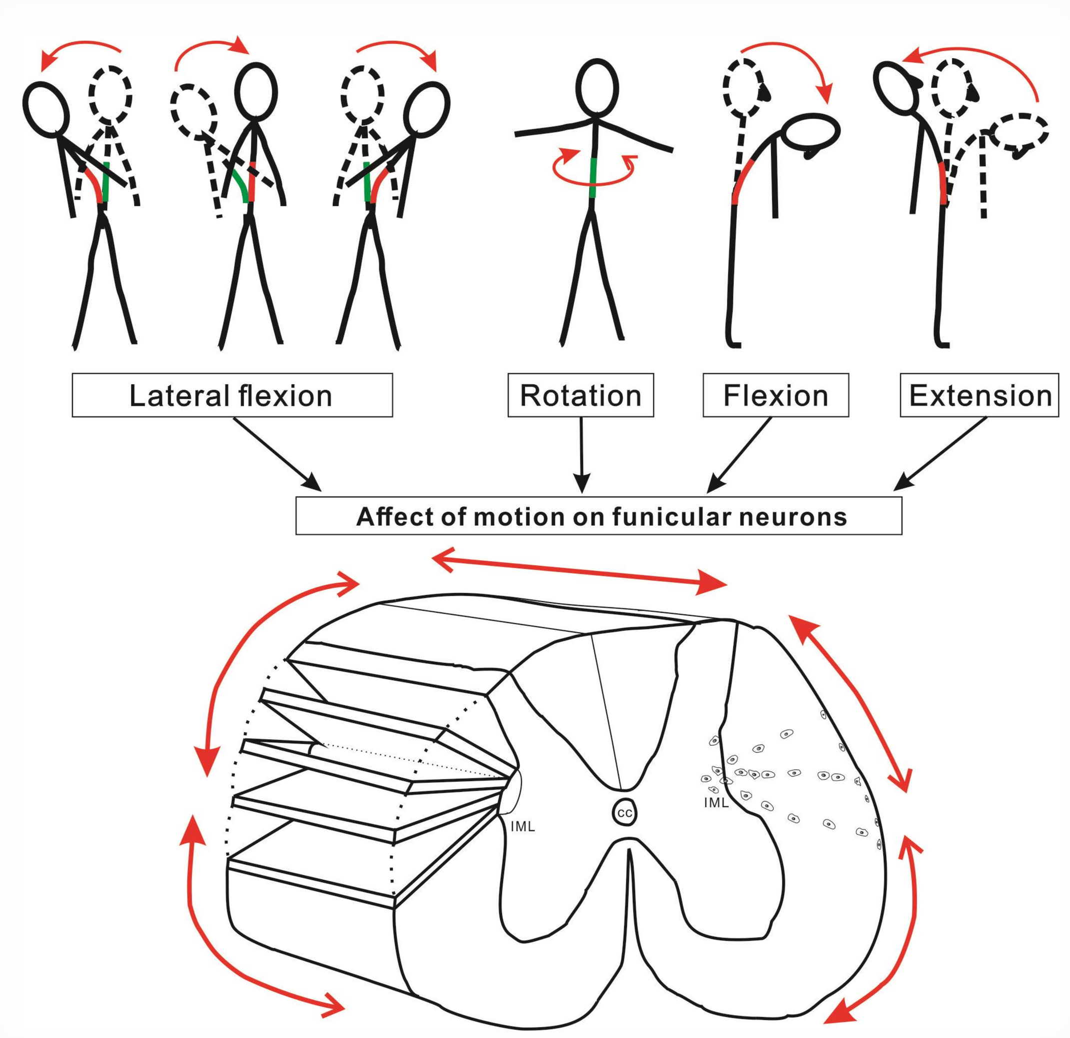

Figure 5. Schematic diagram of mechanosensory modulation featured with funicular plexus in the thoracolumber spinal cord. The supposed sensation device also mention in Figure 4 would detect spinal cord bending or the CSF flows. Body motion Arrows indicated the direction related motion pattern and posture.
(bioRxiv preprint doi: https://doi.org/10.1101/2020.01.30.927509)

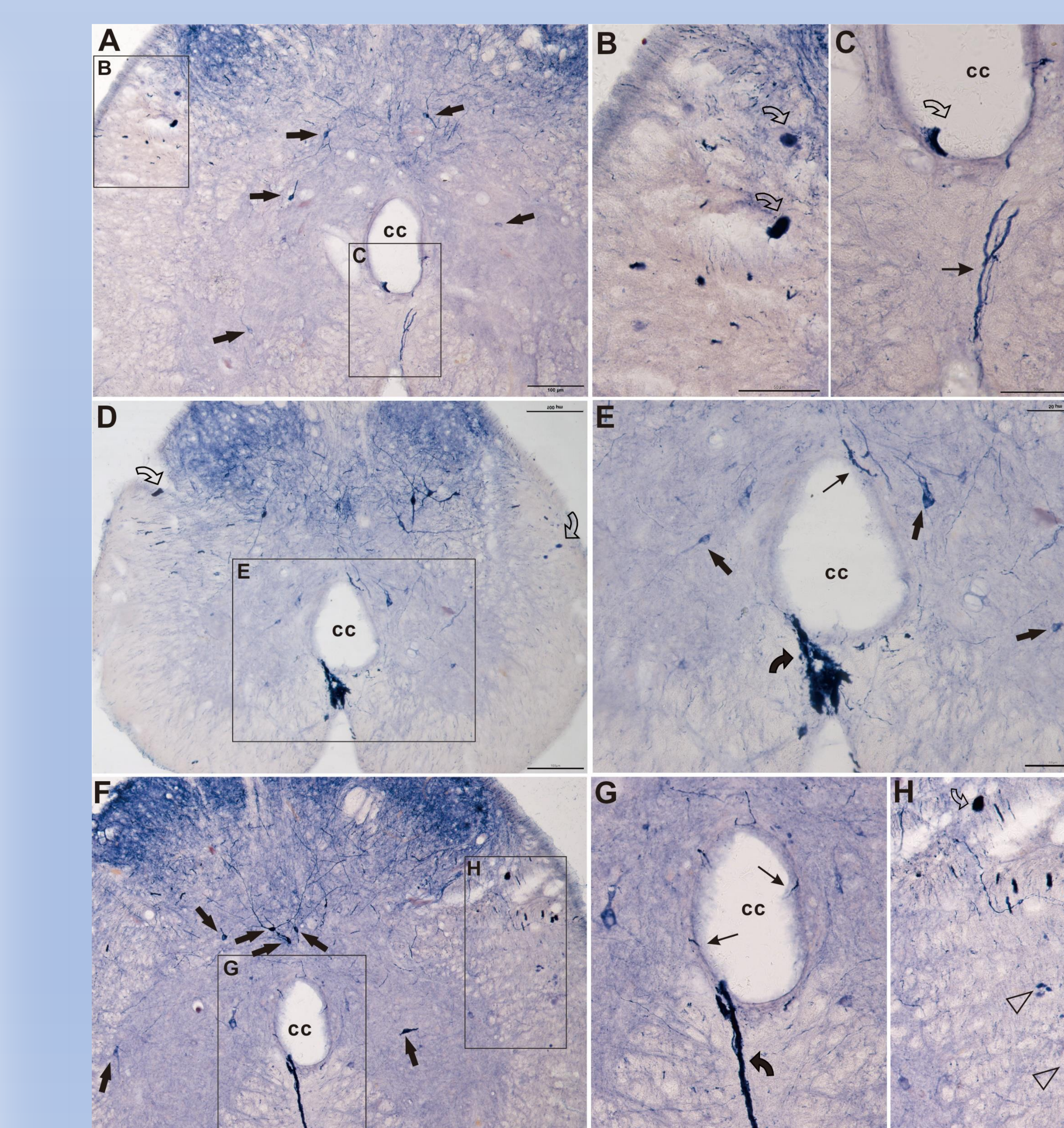

Figure 6. NADPH diaphorase pathway showed its CSF contacting locations between the cc and the anterior median fissure in the sacral spinal cord of aged dog. The swelling dystrophic neurite may be a dysfunctional CSF-N and was supposed to be an aging alteration. A, D and F showed caudal segment of the spinal cord. Arrow indicated neuron. B, C, G and H showed similar pattern for transverse megaloneurites (open curve arrow). C showed thick neurite (thin arrow). E and G showed megaloneurite (curve arrow). Bar in A, D and F =100µm, the other = 50µm. (bioRxiv preprint https://doi.org/10.1101/2020.05.02.07445.)

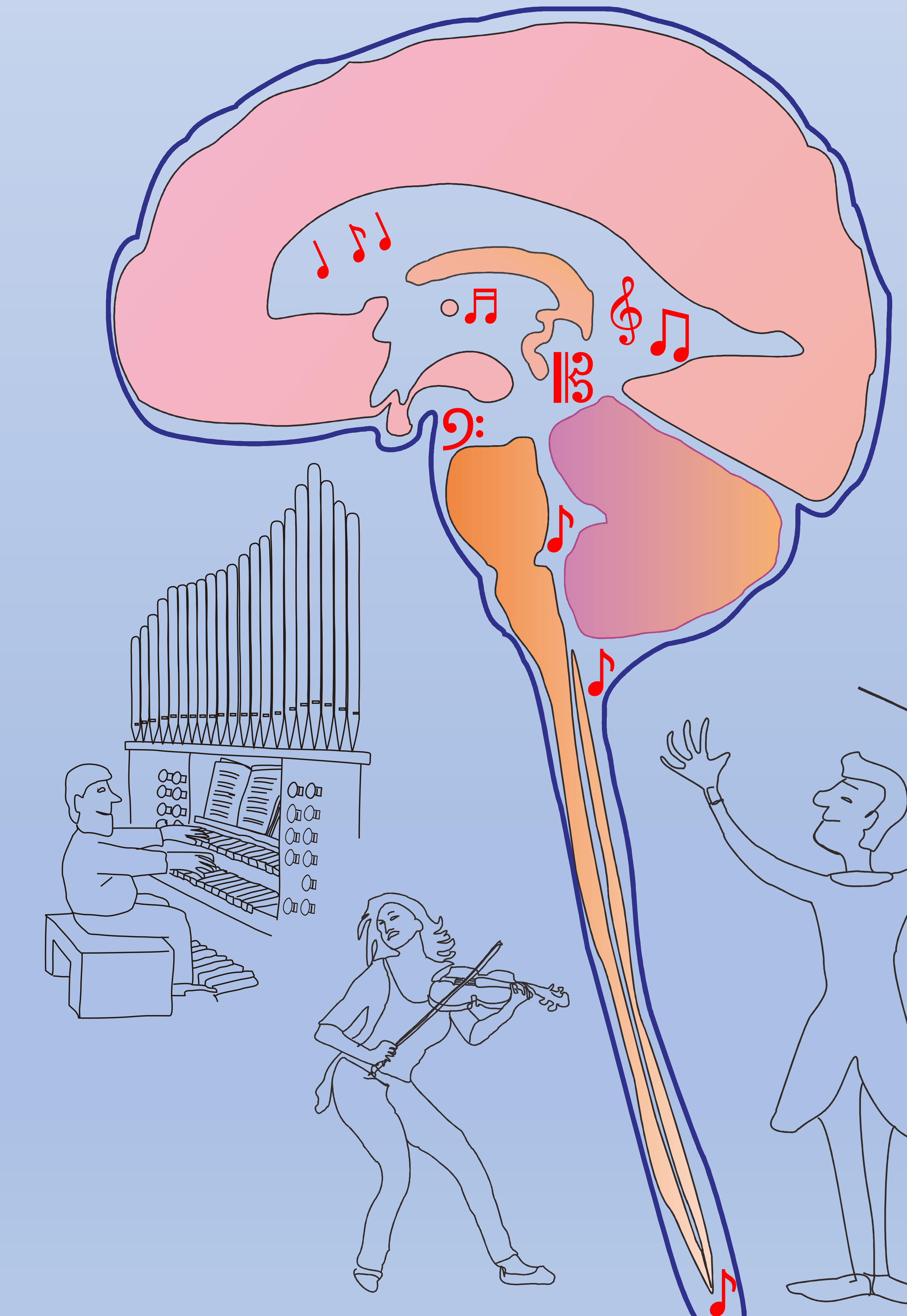

Figure 7. In summary, we postulated that the somatic body movement during music-making would orchestrate the CSF motion with head movement, myodural bridge stretching and spinal bending etc. The proposed study assumes that all rhythmic movements made in concert with classical music (movements made making music, dancing, and even repetitive movements made while listening to music) share the same beneficial effects of CSF circulation.