***Dr. Ammar Yaseen Mansour***

***Clonus: 1st Pathophysiological Hypothesis  
“Asynchronous Afferent Barrage”***

*"One stretch becomes a symphony of desynchronized commands - each afferent volley demanding its own motor encore"*

*[video](https://youtu.be/ySQ7M0KPWaU)*[*To watch a detailed video explaining this hypothesis, click this link:*](https://youtu.be/ySQ7M0KPWaU)

***Clonus manifests as involuntary, rhythmic oscillations – aberrant sequential cycles of joint flexion and extension. Pathological clonus requires >5 flexion-extension cycles. While similar movements may occur in healthy individuals, they never exceed 5 cycles. When accompanied by other signs of Upper Motor Neuron (UMN) lesions, even brief clonus (<5 cycles) warrants diagnostic consideration. Clinically, we primarily investigate clonus at the knee and ankle. Though possible elsewhere, such occurrences remain exceptional.***

*Within the operational field of every spinal reflex, specialized sensory receptors serve as the reflex's trigger points. Alongside them reside other sensory receptor types – all occupying the same territory where reflex-triggering stimuli occur.*

*Each receptor possesses its own dedicated neural axon. Since receptors differ functionally, their afferent axons exhibit distinct properties – particularly variable neural conduction velocities.*

*Neural transmission is maximally rapid in myelinated alpha-type axons, yet markedly slow in delta-type axons – among others. Similarly, transmission through demyelinated axons is severely delayed. Even within a single fiber type, conduction velocity varies significantly with axonal diameter.*

*This inherent disparity in conduction velocities across afferent pathways constitutes the fundamental mechanism underlying the First Hypothesis of Clonic Pathophysiology.*

*Under physiological conditions, sensory receptors (numbering X) distribute a stimulus' energy among themselves – each according to its functional specialization. Subsequently, via heterogeneous neural pathways, signals from these receptors converge as a hybrid, non-homogenous afferent impulse carrying X distinct sensory elements.*

*The brain purifies and processes this composite input. Through meticulous filtering, decoding, and integration, it distills the heterogeneous sensory stream into a singular efferent motor command – delivered to the lower motor neuron as one unified execution order.*

*When the brain becomes functionally absent, a hyperreflexic spinal circuit emerges. Sensory neurons aberrantly connect with lower motor neurons via interneurons – bypassing cortical governance.*

*The hybrid afferent impulse (comprising X distinct signals) escapes cerebral supervision. It descends unprocessed to the LMN, retaining its raw temporal dispersion from peripheral receptors.*

*The fastest-conducting impulses trigger the initial muscle contraction. The**mid-velocity signals arrive eliciting sequential contractions.**The slowest impulses drive terminal oscillations.*

*This cascade of desynchronized muscle activations manifests as involuntary movement repetition in hyperreflexic states – the phenomenon we term Clonus. (See Figure Below).*

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| ***First Hypothesis of Clonus Pathophysiology (Temporal Dispersion → Clonic Oscillation)***  [*[video](https://youtu.be/ySQ7M0KPWaU)For video explanation, click here*:](https://youtu.be/ySQ7M0KPWaU)  ***Core Mechanism: Temporal Dispersion → Rhythmic Oscillations***  ***Normal vs. Pathological Processing***   | ***Stage*** | ***Healthy State*** | ***UMN Lesion State*** | | --- | --- | --- | | *Afferent Signal* | *Hybrid impulse (X elements)* | *Identical hybrid impulse* | | *Integration* | *Cortical processing → Unified command* | *Direct spinal relay* | | *Motor Output* | *Single calibrated response* | *X sequential responses* | | *Feedback Loop* | *Purposeful termination* | *Self-sustaining oscillations* |   ***Key Pathophysiological Steps***   1. *Stimulus Application*    * *Activates heterogeneous receptor cohort (muscle spindles, Golgi, nociceptors)* 2. *Temporal Dispersion*    * *Variable conduction velocities → Staggered afferent arrival at spinal cord* 3. *Spinal Relay Hijacking*    * *Interneurons deliver raw volleys directly to LMNs* 4. *Serial Motor Firing*    * *Fastest volley → Initial contraction (e.g., dorsiflexion)*    * *Intermediate volley → Secondary contraction*    * *Slowest volley → Tertiary contraction*   *"One stretch becomes a symphony of desynchronized commands - each afferent volley demanding its own motor encore"*  ***Clinical Validation***   | ***Observation*** | ***Explained by Hypothesis*** | | --- | --- | | *>5 beats pathological* | *Minimum volleys needed for sustained rhythm* | | *Ankle predominance* | *Longest nerve → Maximal temporal dispersion* | | *Velocity-dependence* | *Faster stretch → More receptors recruited* | | *33 Hz frequency* | *Matches 30ms delay (1/0.03s = 33 Hz)* |   ***Conclusion: The Neurology of Desynchronization***  *This model reveals clonus as:*  *"A temporal breakdown in neural orchestration - where lost cortical conduction exposes the inherent asynchrony of sensory pathways, converting singular stimuli into rhythmic motor cascades."*  *Diagnostic Imperatives:*   1. *Test for >5 beats even without hyperreflexia* 2. *Prioritize ankle assessment (highest diagnostic yield)* 3. *Early intervention prevents circuit entrenchment* |

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*In other contexts, you can also read the following articles:*

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| *[video](https://youtu.be/ClqHfY65WQI)* | [*The Spinal Reflex, New Hypothesis*](https://drive.google.com/file/d/1Nh0yxWLf3gPOlSKdftIZykUjb3xpsPBe/view?usp=sharing) *of Physiology* |
| *[video](https://youtu.be/qlgZUbWVXzs)* | [*The Hyperreflexia, Innovated Pathophysiology*](https://drive.google.com/file/d/14TlTu_9KrF0DGbEDE_VgCpYdSAzBMVU7/view?usp=sharing) |
| *[video](https://youtu.be/kwwsHHKh0AQ)* | [*The Spinal Shock*](https://drive.google.com/file/d/1qQ6Ch-mVj1boww9SAhkPVTwFhX2kVoXR/view?usp=drive_link) |
| *[video](https://youtu.be/rBk0X29hs6w)* | [*The Spinal Injury, the Pathophysiology of the Spinal Shock, the Pathophysiology of the Hyperreflexia*](https://drive.google.com/open?id=1qQ6Ch-mVj1boww9SAhkPVTwFhX2kVoXR) |
| *[video](https://youtu.be/rBk0X29hs6w)* | [*Upper Motor Neuron Lesions, the Pathophysiology of the Symptomatology*](https://drive.google.com/file/d/1kwE-QYZWVzHsadu0wFL4Ckl5o2hGaxMe/view?usp=sharing) |
| *[video](https://youtu.be/G6my9xo1iM8)* | [*The Hyperreflexia (1), the Pathophysiology of Hyperactivity*](https://drive.google.com/file/d/1vZcRPdwBC4iqv8jwi3YewvOv9yKfegt4/view?usp=drive_link) |
| *[video](https://youtu.be/q1mMORyoNLY)* | [*The Hyperreflexia (2), the Pathophysiology of Bilateral Responses*](https://drive.google.com/file/d/1Gd85ZcKFIMG_0H6QeE7mez4-XvP1o2OV/view?usp=sharing) |
| *[video](https://youtu.be/5iViwU_y3-M)* | [*The Hyperreflexia (3), the Pathophysiology of Extended Hyperreflex*](https://drive.google.com/file/d/18soM_THFCzezkfBfBEG9UdoO0qWHLGlz/view?usp=sharing) |
| *[video](https://youtu.be/PteMImPyZ0A)* | [*The Hyperreflexia (4), the Pathophysiology of Multi-Response Hyperreflex*](https://drive.google.com/file/d/1xRj0t5guxfzMsl3b0aeg6SHdWCwlQIEw/view?usp=sharing) |
| *[video](https://youtu.be/crbdk1RTU64)* | [*The Clonus, 1st Hypothesis of Pathophysiology*](https://drive.google.com/file/d/1WoXzIR5GdtpjYZ-4UjfFt62Kat6rn8K8/view?usp=sharing) |
| *[video](https://youtu.be/DKdPe-RJsn4)* | [*The Clonus, 2nd Hypothesis of Pathophysiology*](https://drive.google.com/file/d/1YOWvqNtk818HbIQVaevYI-dwIk4Bonsj/view?usp=sharing) |
| *[video](https://youtu.be/1nP8K8aW3uE)* | [*The Clonus, Two Hypotheses of Pathophysiology*](https://drive.google.com/file/d/1YOWvqNtk818HbIQVaevYI-dwIk4Bonsj/view?usp=sharing) |
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| *[video](https://youtu.be/55zCk35swKs)* | [*The Nerve Transmission through Neural Fiber (3), The Action Electrical Currents*](https://drive.google.com/open?id=1w62cTew8Rdr0nQnaBUvVQmhc2vNI7iTj) |
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| *[video](https://youtu.be/_uIAVuMdTvw)* | [*Nodes of Ranvier, the Functions*](https://drive.google.com/open?id=15E7qLoDIl4glTeAKBs15tvn-5Q99p1nF) |
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| *[video](https://youtu.be/zGRVmB0zta0)* | [*Nodes of Ranvier, Second Function*](https://youtu.be/OqH6r2qhmxY) |
| *[video](https://youtu.be/uP4QKEZsanA)* | [*Nodes of Ranvier, Third Function*](https://youtu.be/IFSf8eo8V9Y) |
| *[video](https://youtu.be/WtCIWXXP8wU)* | [*Node of Ranvier, The Anatomy*](https://youtu.be/WtCIWXXP8wU) |
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| *[video](https://youtu.be/CGyaV6w5594)* | [*The Neural Regeneration*](https://drive.google.com/open?id=18k3PJaNlLYsL_B6K6Mvb1Fg5gYHJJuSN) |
| *[video](https://youtu.be/1CkexgXUv2A)* | [*The Wallerian Degeneration Attacks Motor Axons, While Avoids Sensory Axons*](https://drive.google.com/open?id=16UIXUrcsMn2_pHNeDbAlIkqjwK6vVA8R) |
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| *[video](https://youtu.be/ZlNvPM0fh8A)* | [*Carpal Tunnel Syndrome Complicated by Complete Rupture of Median Nerve*](https://drive.google.com/file/d/1sHhWsaH47QJ5PzCDWlFd2KqiExBcONyl/view?usp=sharing) |
| *[video](https://youtu.be/rJoXOrr_IIE)* | [*Biceps Femoris' Long Head Syndrome (BFLHS)*](https://drive.google.com/file/d/14y1g0Y9ThOqYRwJOsh1e5FIuxUurYDgJ/view?usp=sharing) |
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| *[video](https://youtu.be/jjl8SMMkLeA)* | [*Adam's Rib, could be the Original Sin?*](https://drive.google.com/open?id=10CEzaQ2cbFr6CQI-d8VTur7Ekq2VnyF0) |
| *[video](https://youtu.be/Ofn55E_fYJI)* | [*Barr Body, the Second Look*](https://drive.google.com/file/d/1-aKUsKo4-IIkdd9BsKK70iYutlycSwl6/view?usp=sharing) |
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