Pain Science for the SLP

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medbridge

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Learning Outcomes

- Integrate updated understanding of pain science and the definition of pain into the understanding of clinical presentations of patients with voice and laryngeal pain
- Analyze the psychosocial realities of patients with voice and swallowing pain to inform client-centered treatment planning
- Deconstruct the basic components of the pain system to identify specific neurophysiological drivers in an SLP context
- Describe the mechanism of plastic change to illustrate its impact on functional swallow or voice outcomes

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Chapter 1

New Conceptualization

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The Revised IASP Definition of Pain

> An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage.[1]

1. Raja et al., 2020

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Continued Definition

- Pain is always a **personal experience**
- Pain and nociception are **different** phenomena

1. Raja et al., 2020

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Continued Definition (cont.)

- **Learn** the concept of pain
- Pain should be **respected**
- Although pain usually serves an adaptive role, it may have **adverse effects** on **function** and **social** and **psychological** well-being
- Verbal description is only one of several means to expressing pain; inability to communicate **does not negate** the possibility that a human or non-human animal experiences pain[1]

1. Raja et al., 2020

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Chronic Pain

- Chronic pain is defined as pain that persists or recurs for more than 3 months
  - Sole or leading complaint [1]
- Can be caused by nociceptive input, neuropathic insult, or **plastic changes** (formerly referred to as central sensitization)

1. Treede et al., 2019

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Explain Pain[1]

- Long-standing chronic pain
  - An inaccurate measure of tissue health[2]
  - This relationship becomes less accurate as pain persists
  - Pain is affected by a multitude of factors
  - The pain may be more influenced by a learned nervous system response to protect

1. Moseley et al., 2007
2. Woolf et al., 2011

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Prevalence

- General vocal tract discomfort
  - 62% of patients with hyperfunctional voice disorders[1]
- Odynophonia
  - 15% of patients with vocal fold paresis[2]
  - Primary: no studies
- Odynophagia
  - 5.1% in the general population[3]
- Globus
  - 3.8–4% ENT clinics[4]
  - 8.1% in the general population[5]
- General laryngeal hypersensitivity
  - No population-based studies
  - Chronic cough
    - Estimated 10% in the global population[6]

1. Mathieson et al., 2009
2. Koufman et al., 2000
3. Vander Schaaf et al., 2012
4. Rasmussen et al., 2000
5. Josefsson et al., 2018
6. Song et al., 2015

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Why We're Talking About Pain Science

- "Studies revealed **increased levels of neurogenic inflammatory markers** in participants with nonspecific laryngeal hypersensitivity or chronic cough when compared to healthy controls."[1]
- "Similar to hyperalgesia, participants with chronic cough had a **dysfunction of their cough suppression** mechanisms."[2, 3, 4]
- "Sensitized pain and airway hypersensitivity share neurofunctional characteristics as well. In both conditions, there have been reports of **increased activity in some areas contributing to pain modulation**."[2]
- **May belong to plastic pain conditions** such as fibromyalgia and laryngeal hypersensitivity syndrome.[8]
- Functional dysphagia: **network connectivity**[9]
- Theorized plastic change in central brainstem nuclei **(1999)**

1. Saint-Jules et al., 2025
2. Ando et al., 2016
3. Cho et al., 2019
4. Namgung et al., 2022
5. Stepp et al., 2017
6. Mazzone et al., 2011
7. Morrison et al., 1999
8. Piersiala et al., 2020
9. Choi & Pyun et al., 2021

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What Our Patients Experience

- **Vocal tract discomfort**[1,4,5,6,7,8,9]
  - Pain in the hyoid bone region, tongue, back of the throat, velum, larynx, submental muscles, jaw, or pharynx
  - Superior laryngeal nerve neuralgia, hyoid bone syndrome, laryngeal myofascial pain syndrome, carotid artery syndrome, glossopharyngeal neuralgia, thyroid cartilage and cricoid cartilage syndrome, superior pharyngeal constrictor syndrome, and Eagle syndrome
- **Odynophonia**
  - Pain with speaking and singing
- **Odynophagia**
  - Pain with swallowing
- **Globus**[2]
  - A lump in the throat
- **Cough**[2]

1. Ramos et al., 2018
2. Saint - Jules et al., 2025
3. Hockey et al., 2024
4. Fuentes et al., 2023
5. Rubin et al., 2021
6. Jose et al., 2019
7. Aydil et al., 2012
8. Shankland et al., 2010
9. Jung et al., 2017

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Psychosocial Factors

- Hypervigilance/attention
- Salience
- Distress
- Fear/threat
- Urge
- Behavior
- Guarding

1. Saint-Jules et al., 2025
2. Cho et al., 2019
3. Mathieson et al., 2009
4. Morrison et al., 1999
5. Ando et al., 2016
6. Piersiala et al., 2020
7. Rasmussen et al., 2018

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Chapter Summary

- Pain is a **patient experience** and is based on **actual** or **potential tissue damage**
- A **significant portion** of patients with voice and upper airway disorders have discomfort
- A **sizeable amount** of the population experiences globus, odynophagia, or cough
- Pain is influenced by a **multitude of factors, including psychosocial factors**

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Patient Interview

Experiencing Voice Pain

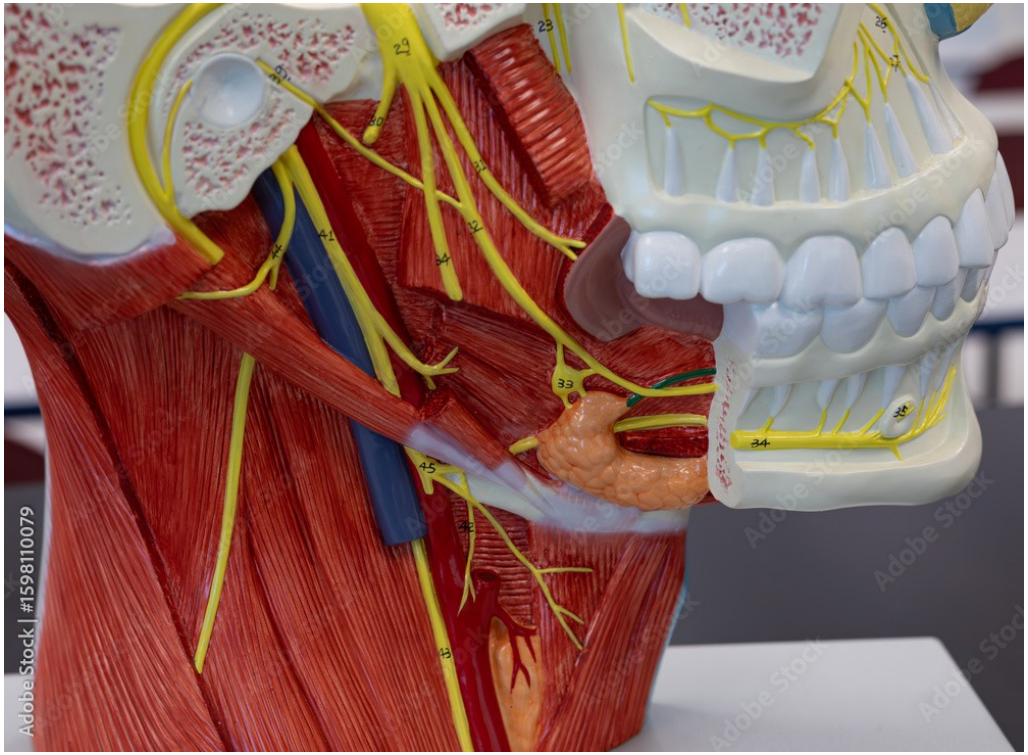
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Chapter 2

Our Pain System

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The H&N Sensory Nerves

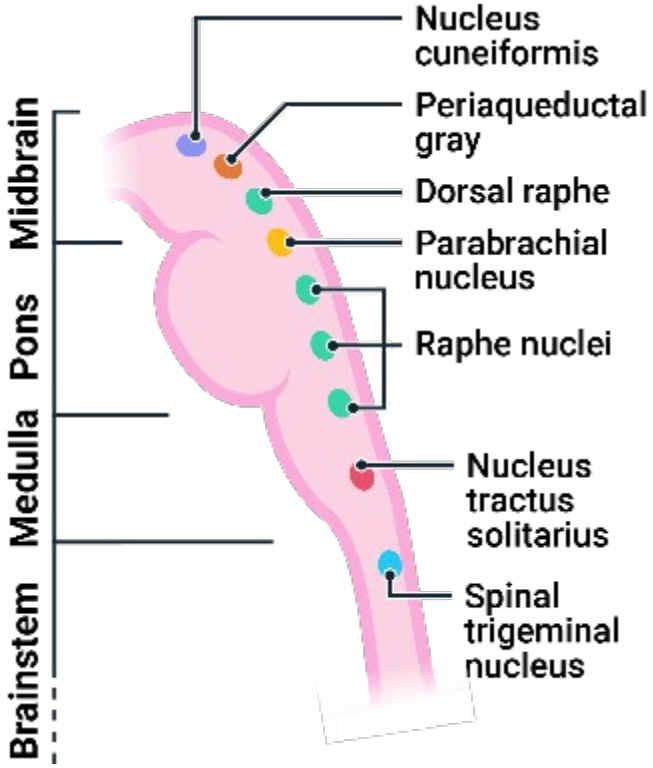


1. Castien et al., 2019
2. Malhab et al., 2025

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Brainstem Processing

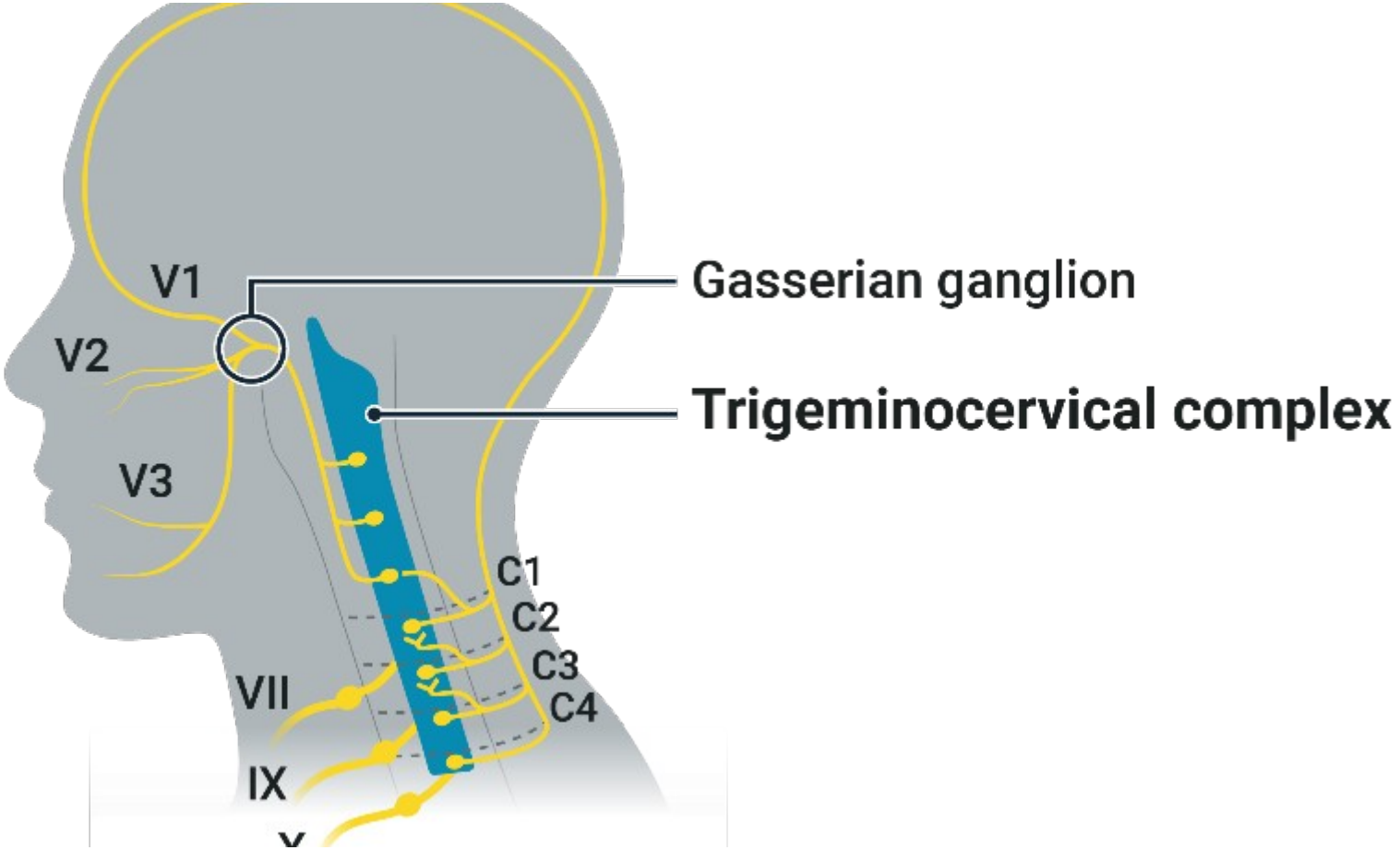
- Brainstem nuclei
- Spinal trigeminal nucleus
- Midbrain: Nucleus cuneiformis, periaqueductal gray, dorsal raphe
- Mid-pons: Parabrachial nucleus
- Medulla: Nucleus tractus solitarius



1. Chiang et al., 2011
2. Sessle et al.,1999
3. Dubner & Bennett et al.,1983
4. Jean, et al.,2001
5. Herbert et al., 1990
6. Saper et al., 2002
7. Khalsa et al., 2018
8. Gauriau & Bernard et al., 2002
9. Willis & Westlund et al., 1997
10. Craig et al., 2009
11. Mazzone et al., 2011
12. Ando et al., 2016
13. Jurgens et al., 1994
14. McGovern et al., 2017

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Trigeminocervical Complex



Castien et al., 2019
Malhab et al., 2025

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Overlap in the Throat

- **Referred** pain
- Multiple conditions with **overlapping symptoms**
- Both **visceral** sensation and **spinal** sensation

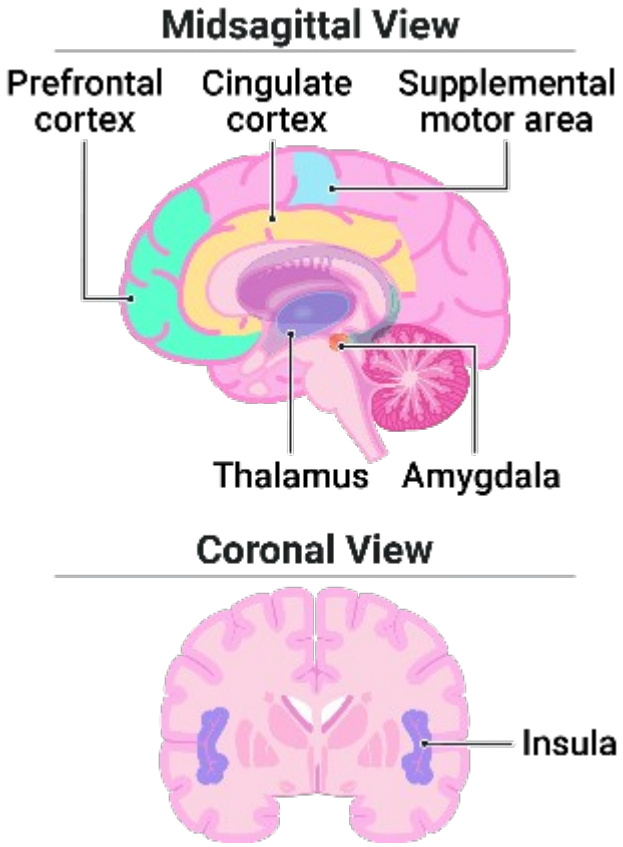
1. Ramos et al., 2018
2. Saint - Jules et al., 2025
3. Hockey et al., 2024
4. Fuentes et al., 2023
5. Rubin et al., 2021
6. Jose et al., 2019
7. Aydil et al., 2012
8. Shankland et al., 2010

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Central Cortical Processing

Thalamus

- Insula
- Supplemental motor area
- Cingulate cortex
- Prefrontal cortex
- Amygdala



1. Apkarian et al., 2005
2. Craig et al., 2009
3. Mouraux et al., 2018
4. Rainville et al., 1997
5. Mazzone et al., 2011
6. Ando et al., 2016
7. Penfield et al., 1950

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Pathways of Information Transmission

- Spinal trigeminal nucleus: **Burning, irritation**
- Nucleus tractus solitarius: **Interoception, homeostasis**
- Parabrachial nucleus: **Salience, threat**

1. Basbaum et al., 2022
2. Huang et al., 2025
3. Craig et al., 2002
4. Craig et al., 2003
5. Craig et al., 2009
6. Ando et al., 2016
7. Willis & Westlund et al.,1997
8. Chiang et al., 2011
9. Sessle, et al., 1999
10. Khalsa et al., 2018
11. Saper et al., 2002
12. Herbert et al., 1990
13. Dubner & Bennett et al., 1983
14. Palmiter et al., 2018
15. Gauriau & Bernard et al., 2002
16. Jean, et al., 2001

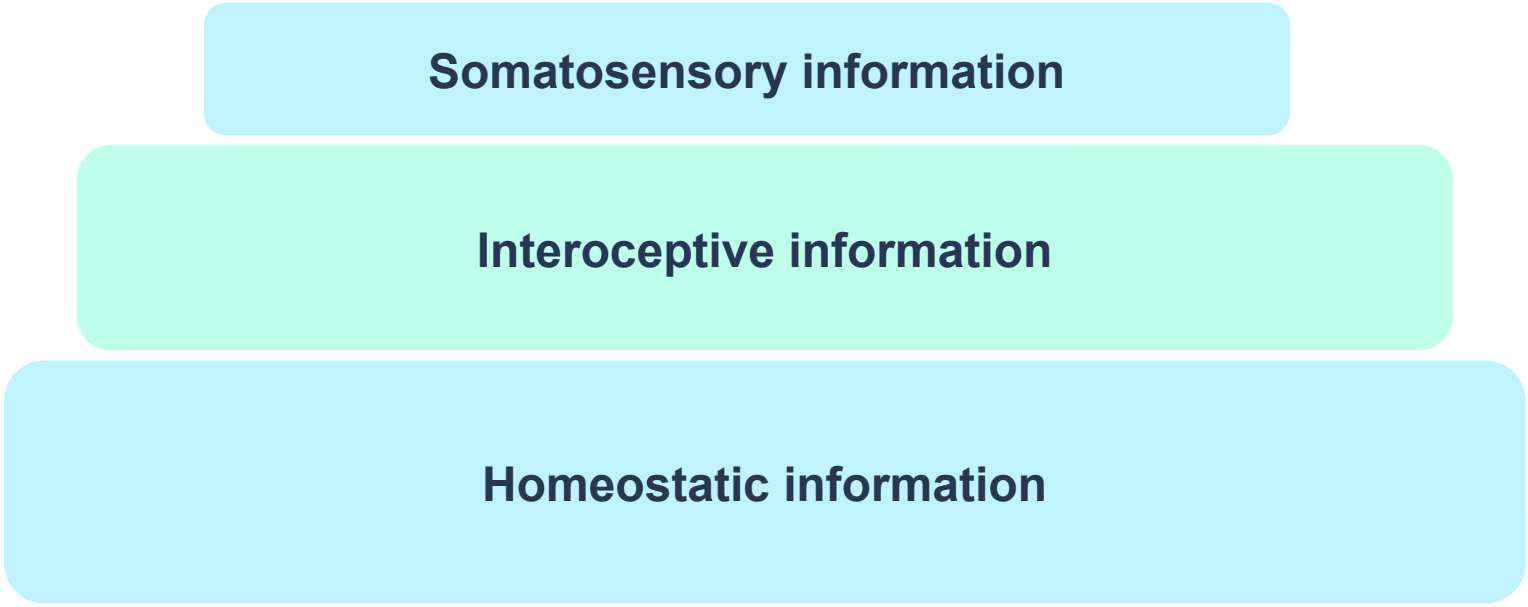
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Salience Networks

1. Basbaum et al., 2022
2. Huang et al., 2025
3. Craig et al., 2002
4. Craig et al., 2003
5. Craig et al., 2009
6. Ando et al., 2016
7. Willis & Westlund et al., 1997
8. Chiang et al., 2011
9. Sessle et al., 1999
10. Khalsa et al., 2018
11. Saper et al., 2002
12. Herbert et al., 1990
13. Dubner & Bennett et al., 1983
14. Palmiter et al., 2018
15. Gauriau & Bernard et al., 2002
16. Jean et al., 2001

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Relationship to Salience Networks



1. Apkarian et al., 2005
2. Rainville et al., 1997
3. Craig et al., 2002
4. Craig et al., 2009
5. Willis & Westlund et al., 1997
6. Mouraux et al., 2018
7. Chiang et al., 2011
8. Sessle et al., 1999
9. Khalsa et al., 2018
10. Saper et al., 2002
11. Herbert et al., 1990
12. Dubner & Bennett et al., 1983
13. Palmiter et al., 2018
14. Gauriau & Bernard et al., 2002
15. Jean et al., 2001

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Chapter Summary

- **Trigeminocervical complex** to the cortex for processing, which may explain why descriptions can be **less precise or referred.**

- **Multiple different parallel pathways: sensory, interoceptive, attentive, and homeostatic**. Interoception and homeostasis are being more influenced by **salience networks**.

- Salience networks assess if something is a **threat, relevant,** or **ignorable**.

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Chapter 3

Plastic Changes

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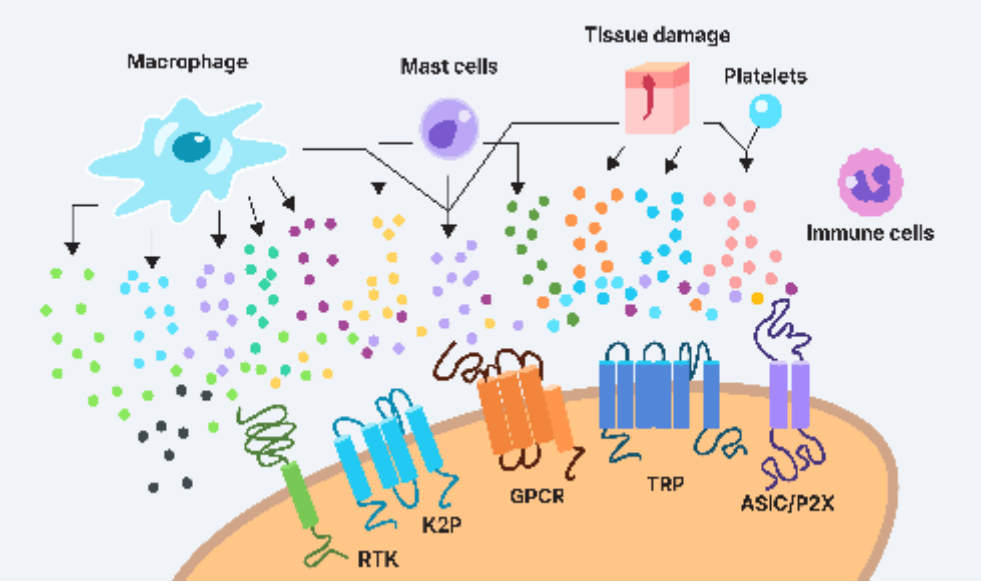
Three Different Categories of Pain

- **Nociceptive**
  - **More often acute** but can be longer term due to a continued inflammatory process
- **Nociplastic**
  - May have had prolonged nociceptive input with peripheral sensitization but can occur centrally first
- **Neuropathic**
  - **Nerve insult or injury**

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Molecular and Neurochemical Mediators

- **Peripheral sensitization**
- "Inflammatory soup"[1, 9]
- Prostaglandins[3, 4, 7]
- **Pain mediators:** histamine, serotonin, and kinins
- Cytokines[2, 4, 6]
- NGF[5]
- Nitric oxide[6]



1. Basbaum et al., 2009
2. Saint-Jules et al., 2025
3. Choudry et al.,1989
4. Shrivastava et al., 2021
5. Barker et al., 2020
6. Poluha, Grossmann et al., 2018
7. Nir et al., 1998
8. Yam et al., 2018
9. Moseley et al., 2007

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Pain Signaling

- C fibers: **Predominating** in interoceptive pathways
  - **Glutamate, substance P, and CRGP**
- NMDA receptor

1. Basbaum et al., 2009

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Glial Activation

- **Inflammatory and neuroexcitatory mediators**
  - Cytokines, ATP, glutamate, prostaglandins, growth factors
  - Orofacial pain[1, 3] and other pain types
- In some pain states, microglial BDNF can **reduce** the normal **inhibitory effect** in the central nervous system[2]

1. Chiang et al., 2011
2. Xiong et al., 2024
3. Donnelly et al., 2020

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Disinhibition

- Spinal cord or brainstem nuclei **may respond to lower-threshold** input[1]
- Descending inhibitory mechanisms that are strongly associated with voicing and breathing, such as the PAG, may become imbalanced, with less effective inhibition or possibly more facilitation[2, 3, 4, 5, 6, 7]

1. Ando et al., 2016
2. Zhang et al., 2024
3. Cho et al., 2019
4. Morrison et al., 1999
5. Jurgens et al., 1994
6. Harper et al., 2018
7. McGovern et al., 2017
8. Chen et al., 2022

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The Pain Matrix: Expects Pain

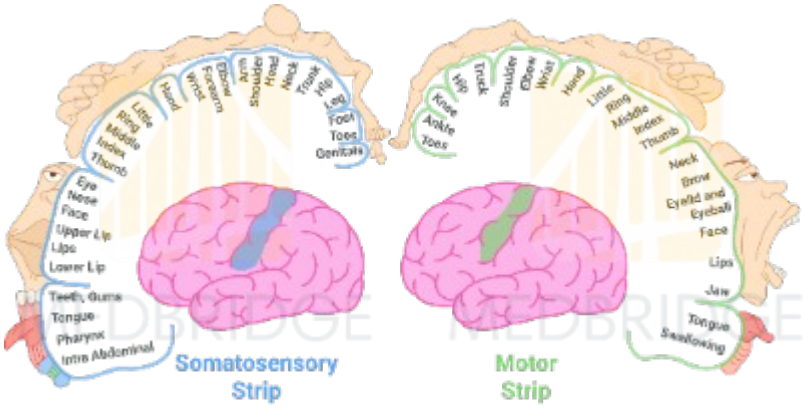
- **Salience**, **attention** and **interoception**, and **threat prediction** can become more connected making the same body signal **stronger**, more **urgent** and **widespread**
- Greater psychological and social impact of coughing
- "**Dysfunctional neural control**, rather than a psychological problem, is the **underlying pathomechanism** of functional dysphagia"

1. Namgung et al., 2022
2. Choi & Pyun et al., 2021
3. Moseley et al., 2007

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Homuncular Smudging

- Complex regional pain syndrome, chronic neck pain, chronic back pain, TMD, musician's dystonia, fibromyalgia
- Two-point discrimination being worse[1]
- **Theoretical** for throat pain



1. Moseley et al., 2008
2. Penfield et al., 1950
3. Flor et al., 2003
4. Flor et al., 1997
5. Maihofner et al., 2003
6. Wand et al., 2011
7. Catley et al., 2014
8. Moayedi et al., 2011
9. Elbert et al., 1998
10. Muller et al., 2021

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Motorically

- Tight **"activated"** muscles[1]
- **Reduced muscle specificity** in movement[2, 3]
- **Guarding** with changed **behavior**[4, 5]
- Is **not the cause** of the **pain;** may increase risk of **reoccurence**[6, 7]
- Evidence of **vocal fold atrophy** and **changes in closed quotient** compared to asymptomatic assigned females at birth[4]
- Hypomobility of the vocal folds[5]

1. Flor et al., 2003
2. Falla et al., 2004
3. Blomgren et al., 2018
4. Fuentes, Biermann et al., 20227.
5. Jung et al., 2017
6. Lund et al., 1991
7. Hodges & Tucker et al., 2011

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Peripherally Mediated Nociplastic Change

Peripheral Sensitization	Peripheral Changes	Subacute Phase	Chronic Phase
• Minutes to days • **Nociceptive and inflammatory signaling**	• Hours to weeks • **Increased spinal cord** • Brainstem processing	• Days to weeks • Increased **facilitation**	• Weeks to months and beyond • **Neuroimmune changes** that sustain the pain

1. Basebaum et al., 2009
2. Zhang et al., 2024
3. Xiong et al., 2024
4. Lotze et al., 2007
5. Moseley et al., 2008
6. Ando et al., 2016
7. Cho et al., 2019
8. Namgung et al., 2022
9. Choudry et al.,1989
10. Shrivastava et al., 2021
11. Barker et al., 2020
12. Poluha, Grossmann et al., 2018
13. Chiang et al., 2011

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Altered Body Schema



Moseley et al., 2008

Lotze et al., 2007

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Pain Science Education

“I don’t care how much you know until you validate my perspective.”

— Our patients

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Chapter Summary

- A multitude of **molecular and neuroimmune activities** occur to make the body increasingly sensitive to **perceived threats**
- Changes **occur molecularly within weeks** to months
- **These can be reversed** the earlier they are addressed, though positive progress toward **recovery is also possible later**
- The body may become **less specific** while the motor output is more activated, resulting clinically in discomfort that has spread and **significant muscle tension**

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Course Summary

- Our bodies **learn** pain, an experience that must be **respected and acknowledged** to address the symptoms
- **Overlapping** and **varied pathways** result in **referred** discomfort that is **non-descript**
- Molecular, neuroimmune, spinal cord, brain stem, and cortical changes begin over **days to weeks to years**
- Plastic changes are just that, **bioplastic**, therefore positive progress towards **recovery is still possible**

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