# Muscle Spindles Sense Synergistic Activity

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## Summary

Muscle spindles (MSs) play an essential role in detecting changes in muscle length and transmitting proprioceptive feedback. Epimuscular myofascial force transmission (EMFT) between synergistic muscles through connective tissues influence MS function. However, sensory implications of EMFT remain understudied. This study examines how the activity of a synergistic muscle affects MS afferent signaling by recording neuronal activity from the trigeminal mesencephalic nucleus (Me5) in mice. We identified MS afferents from the masseter and temporalis muscles using electrophysiology, confirmed via histological analysis. Our results show that temporalis muscle contraction significantly enhances MS activity in the masseter muscle. Our findings highlight the importance of synergistic muscle activity in shaping MS feedback, contributing to our understanding of sensorimotor integration at peripheral level.

## Introduction

Skeletal muscles influence each other's sensorimotor function through epimuscular interactions [1]. MSs detect local muscle length changes, and their sensory feedback is affected by EMFT via connective tissues. Previous studies have shown that epimuscular loads from synergistic [2] and antagonistic [3] muscle stretching affect MS afferent responses. However, these studies were focused on passive muscle conditions, limiting our understanding of active states that better reflect daily movements. To address this gap, we investigated how synergistic muscle activity alters MS feedback by recording neuronal activity from Me5 in mice. We hypothesized that (1) mice serve as a suitable model for studying MS afferents projecting to Me5 and (2) synergistic muscle contraction influences MS signalling in the target muscle via EMFT. This study provides novel insights into sensory feedback mechanisms and sensorimotor integration in active muscles.

## Methods

Experiments were conducted on 11 urethane anesthetized mice. Acute electrophysiological recordings were performed from Me5 using silicon electrode arrays and confirmed by histological analysis. MS afferent activity in the masseter and temporalis muscles was examined using mechanical (jaw opening, muscle surface pressure) and electrical (intramuscular stimulation) stimulation conditions (Figure 1).

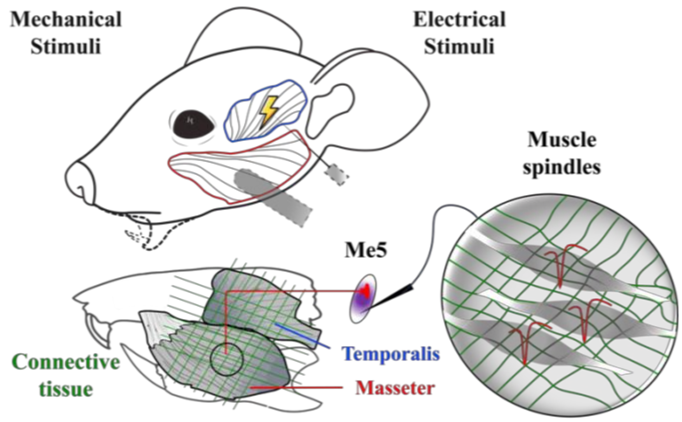


**Figure 1**: Graphical abstract illustrating the increase in masseter MS activity in response to temporalis contraction through EMFT.

Neural data were preprocessed, spike-sorted, and analyzed to assess differences in MS afferents' firing rates.

## Results and Discussion

We extracted 1433 units via spike sorting. MS afferents were identified based on their response to mechanical stimuli, classifying 51 MS afferents, including 44 from masseter and 7 from temporalis. Our results showed that activating temporalis muscle via electrical stimulation resulted in a significant (*; $P<0.05$) increase in masseter MSs firing rates, with an average increase of 53% (Table 1). Masseter contraction led to a 127% increase in temporalis MS firing rate. These findings confirm that synergistic muscle activity changes MS feedback via EMFT.

## Conclusions

This study presents the first in vivo Me5 recordings in mice, demonstrating the influence of EMFT on MS feedback.

## Acknowledgments

This research was funded by iNavigate, NeurotechEU, and TÜBITAK 2214A to EOY**;** TÜBITAK 22AG016 to CAY.

## References

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**Table 1:** Firing rates (FR) of masseter and temporalis MS afferents in response to electrical stimulation.

| CONDITION | $FR_{spontaneous}$ | $FR_{driven}$ | Change | FRspont | FRdriven | Change |
|---|---|---|---|---|---|---|
| **eMassater** | 23.17 Hz | 37.69 Hz | %62.7 * | 10.53 Hz | 23.93 | %127.18 |
| **eTemporalis** | 22.09 Hz | 33.91 Hz | %53.5 * | 11.53 Hz | 17.81 | %54.44 |
| **eM+T** | 22.59 Hz | 46.06 Hz | %103.9 * | 12.38 Hz | 30.63 | %147.32 |