

Decomposing Sign Language Movements

A multi-band visualization for articulatory analysis — isolating **arm displacement**, **wrist rotation** and **finger movement** from ordinary 2D video.

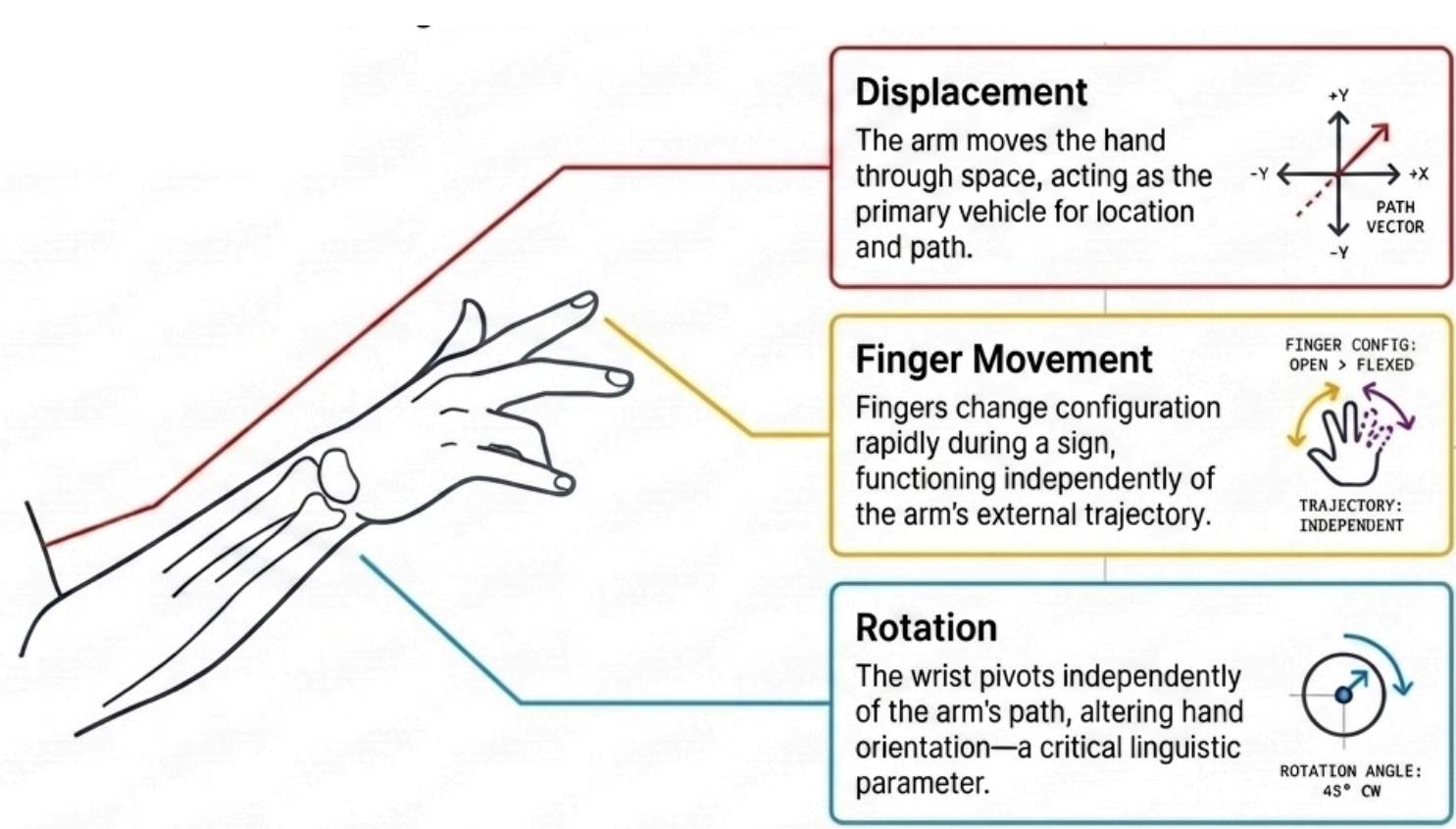
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01 The problem

Sign language movement is **multi-dimensional** and **hierarchical**: arm displacement, wrist rotation, and finger configuration unfold simultaneously, on **independent temporal patterns**.

Holistic, all-in-one parameters obscure this structure. Methods must align with the articulatory chain.



02 Contribution

- ◇ A pipeline that **progressively isolates dependent movements** from ordinary 2D video.
- ◇ The **bandogram**: a multi-band, time-aligned visualization.
- ◇ An **interactive viewer** coupling video and bandogram.

03 Pipeline

- 01 Track**

MediaPipe Hand Landmarker: 21 landmarks per hand.
- 02 Hand-relative basis**

Distal (wrist → MCP) + **lateral** (pinky → index MCP) vectors define a local palm frame.
- 03 Decompose**

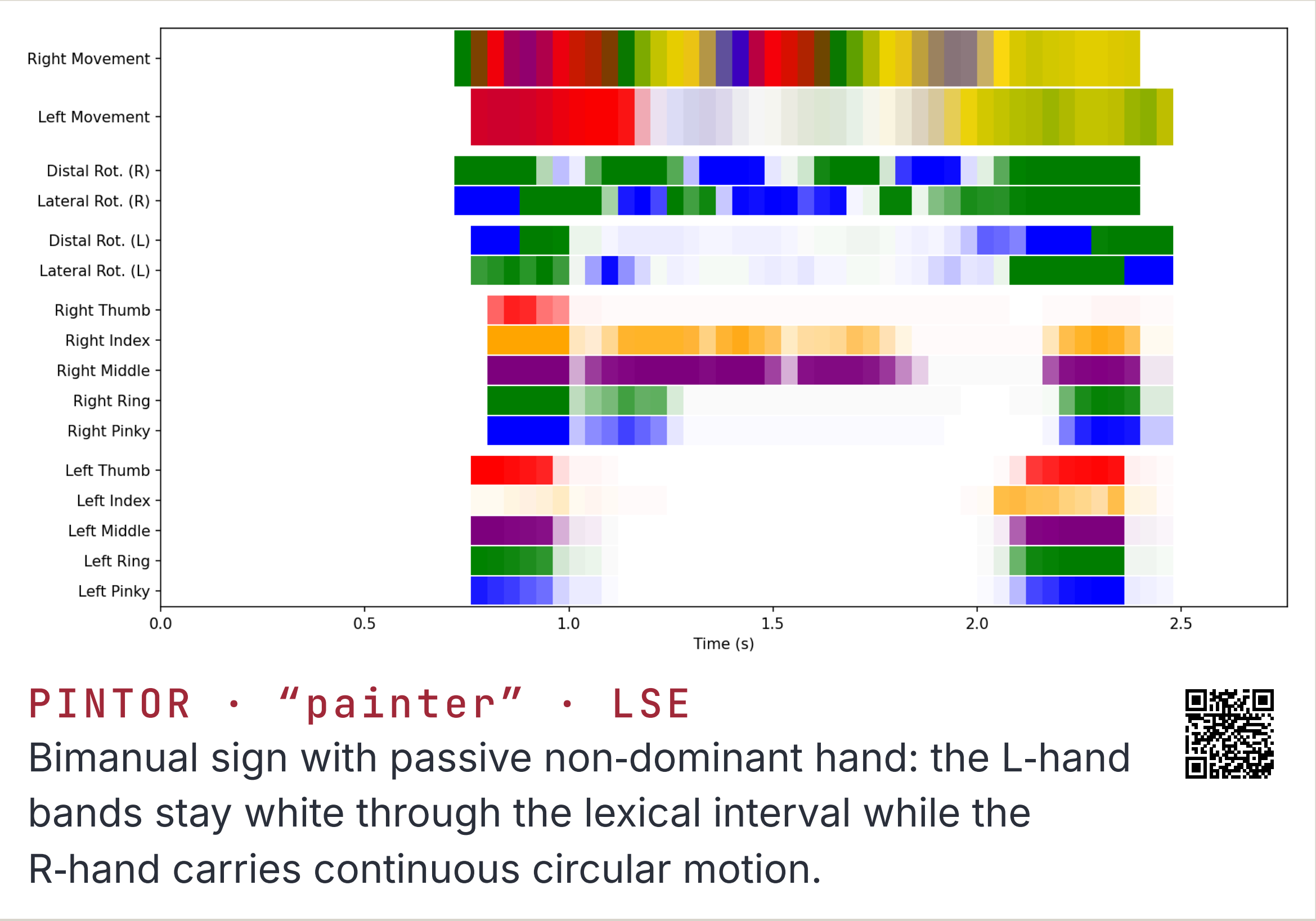
Rotation from vector angles → independent of arm motion. Fingers in the local basis → independent of rotation.
- 04 Differentiate**

Savitzky-Golay smoothing for velocity & direction; angles unwrapped before differentiation.
- 05 Finger activity**

MRS dispersion in an 8-frame window: robust where derivatives drown in noise.

FIGURE 1 · THE BANDOGRAM

An at-a-glance picture of the full articulatory state.



HAND HEADING · TOP TWO BANDS

■ up ■ down ■ right ■ left

ROTATION · CW / CCW

■ CCW ■ CW

FINGER IDENTITY

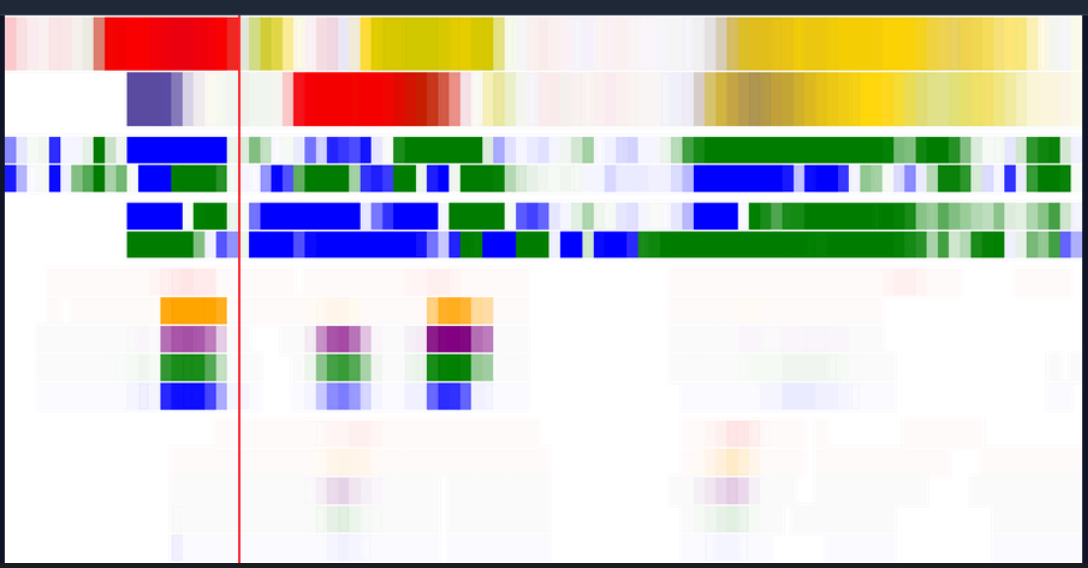
■ thumb ■ index ■ middle ■ ring ■ pinky

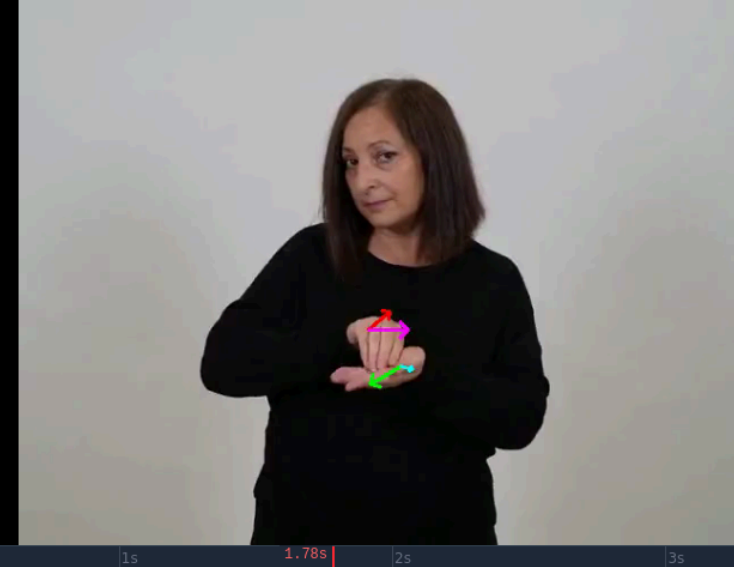
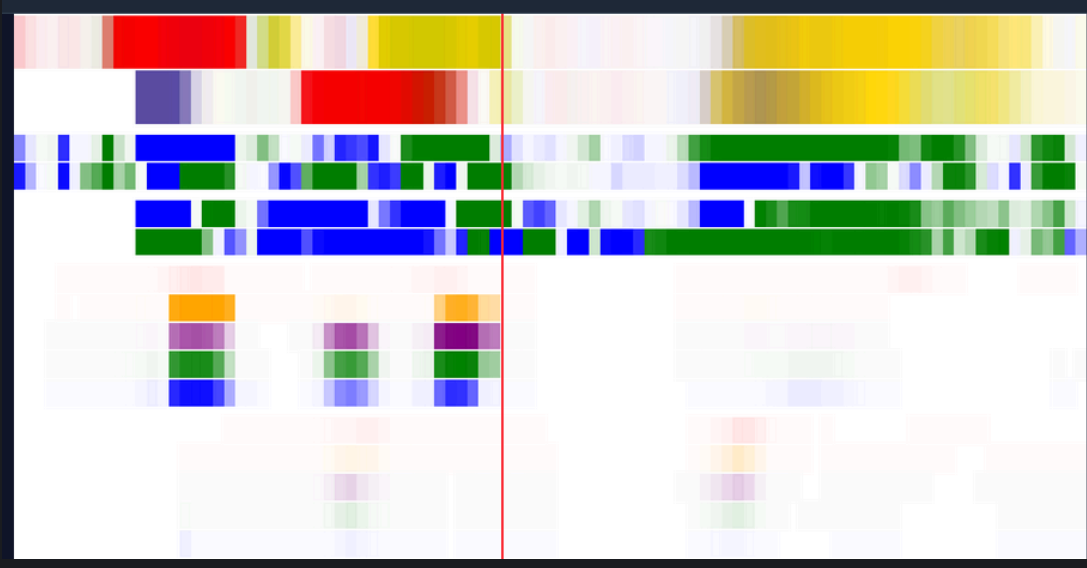
READING THE PLOT

Intensity = magnitude · hue = direction or finger. White = hold. Bright reds/golds at head/tail = preparation/relaxation; lexical content lives in the medium-speed interior.

04 Interactive viewer

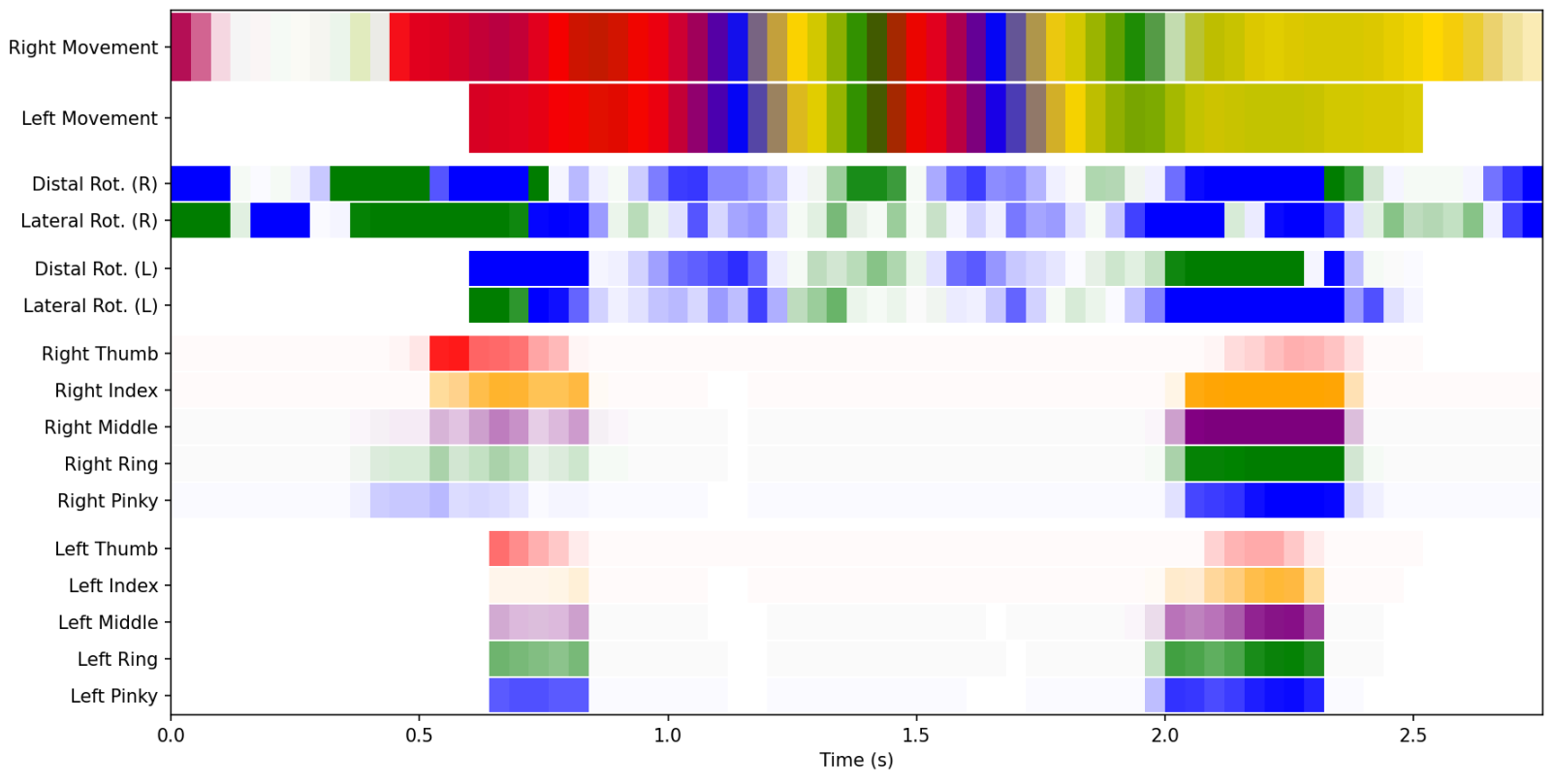
Click the bandogram to **seek**; click-and-drag to set **loop markers**. Tight video↔plot coupling lets researchers isolate sub-sign units, compare temporal alignment across articulators, and identify boundaries between sequential segments.



0.85s · ONSET
Right hand near nose, index extended.

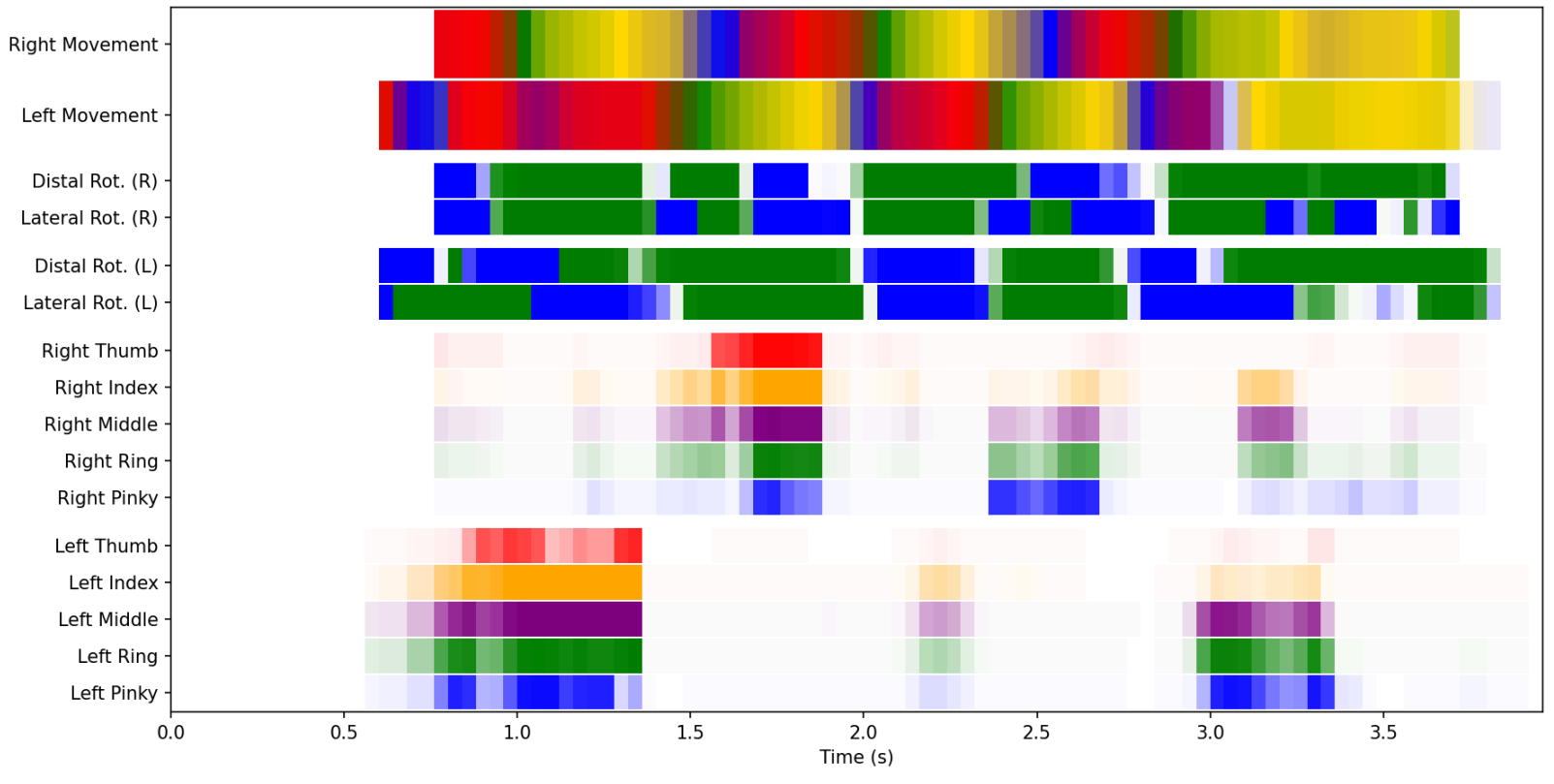


1.78s · CONTACT
Right hand closed, touching top of left hand.

ANÉCDOTA (“anecdote”), a compound sign segmented by clicking on transitions visible in the bandogram. The medial hold and early L-hand preparation evidence a lexicalized compound.

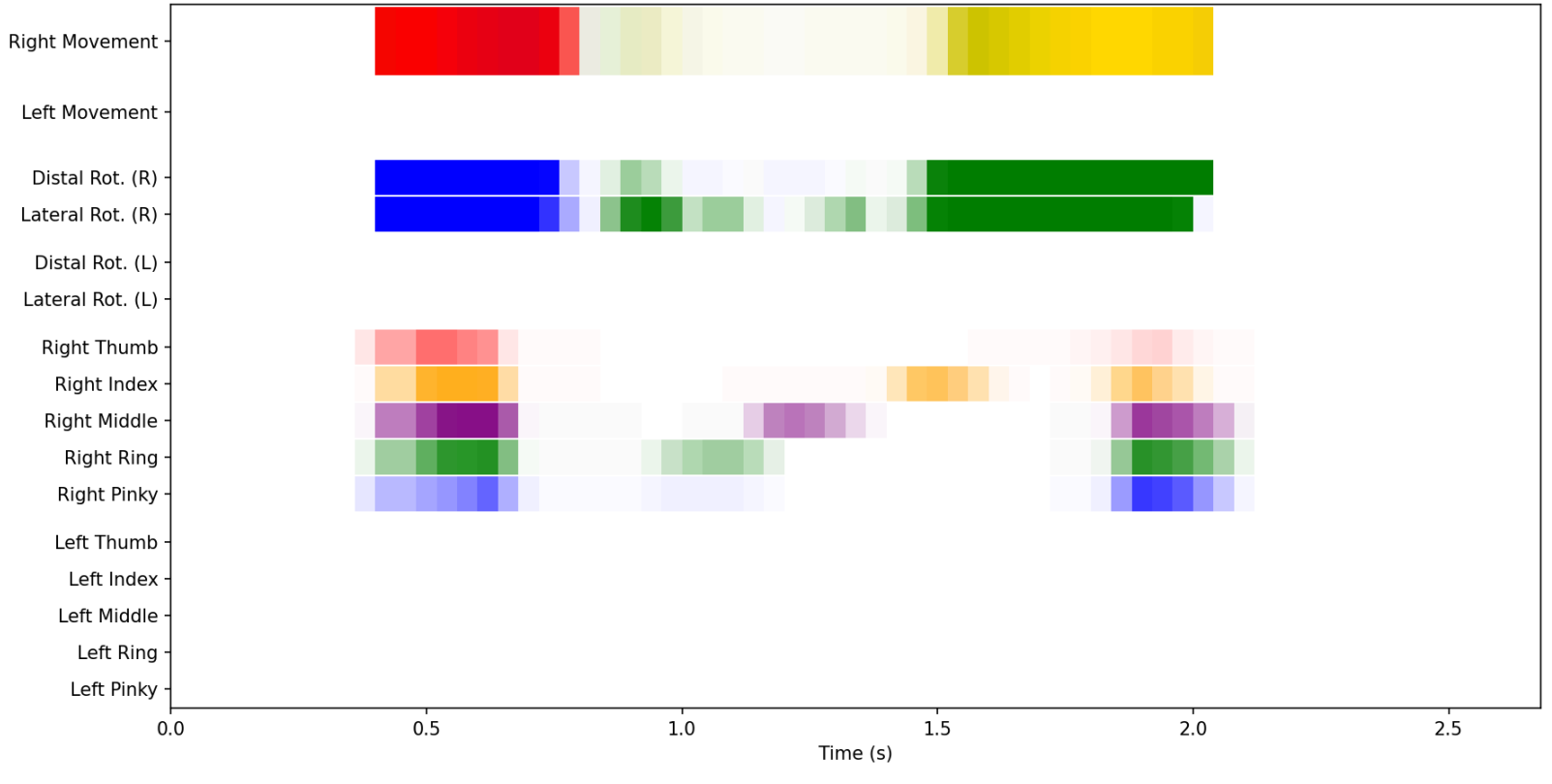
05 What it reveals



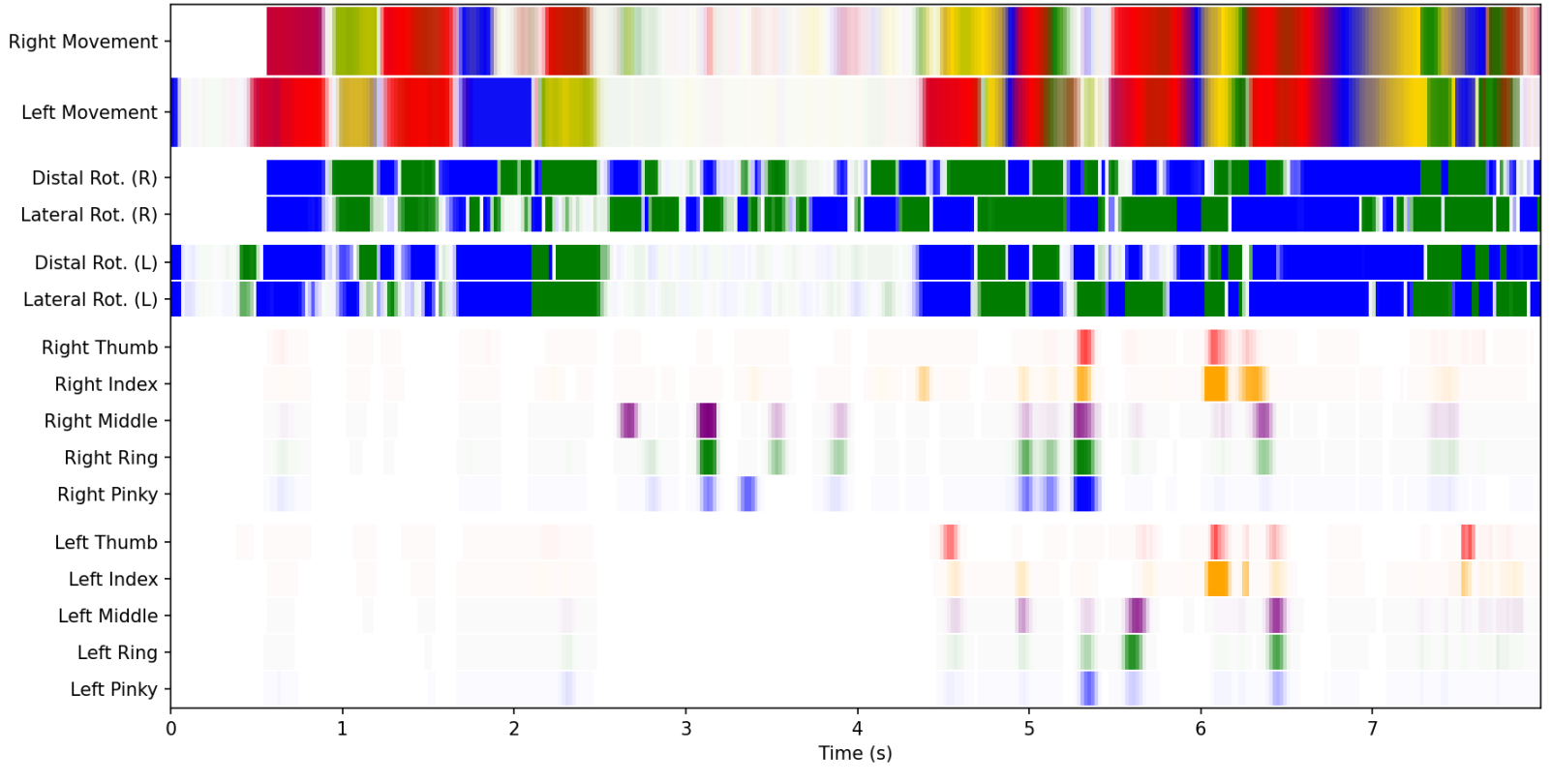
MUEBLES · “furniture”
Symmetric bimanual: parallel hues.



CONFUSIÓN · “confusion”
Inverted bimanual: mirrored rainbows.



PREFERIR · “to prefer”
Static hand, fingers fold sequentially.



DGS Corpus welcome, 0-8s
◇ Long fingerspelling section.
◇ Bimanual single movement signs with holds.
◇ Symmetric circular movements.

06 Limits & future work

Inherits MediaPipe constraints — degraded under blur, occlusion, or unusual orientations. Finger bands report *whether* a finger moves, not joint angles.

Next: corpus studies of syllable structure, cross-linguistic rhythm comparison, and integration with existing annotation tools.

ACKNOWLEDGEMENTS

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SELECTED REFERENCES

Wilbur & Martinez 2002 · Liddell & Johnson 1989 · Brentari et al. 2018 · Börstell 2023 · Bigand et al. 2021 · Lugaresi et al. 2019 · Sevilla et al. 2024.

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CODE & RESOURCES



github.com/
agarsev/bandogram
EUPLv1.2