

Leveraging Artificial Intelligence to Assess Quality of Life via Facial and Vocal Analysis in Facial Transplantation Recipients



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Purpose

- **Facial transplantation (FT)** restores **identity, function, and social connection** in severe facial disfigurement.
- As a life-enhancing (not lifesaving) procedure with lifelong immunosuppression, its use depends on demonstrable **quality of life (QoL)** benefits.
- Current evaluations emphasize surgical outcomes, with limited **objective, longitudinal** psychosocial metrics.
- Facial and vocal behaviors are promising proxies of psychological well-being but remain understudied in FT.
- This study evaluates whether **artificial intelligence (AI)** can be used to **quantify emotional expressivity** over time to enhance QoL assessment.

Methods

- Data source: We used 132 publicly available interviews from 14 English-speaking FT recipients (U.S., 2008–2024).
- Inclusion criteria: Only interviews with the recipient front-facing, unobstructed, and with audible speech.
- Steps for processing (see Figure 1 for flow diagram)
 - Step 1: Separated visual and auditory components.
 - Step 2: Marked timestamps of audiovisual segments; standardized to 30 fps and 720p; corrected lighting; isolated faces using pre-trained facial detection models.
 - Step 3: Extracted facial and speech metrics (Figures 2-3)
- Analysis: Recovery trajectories were modeled using best-fit power curves, normalized as a change from baseline, aggregated across recipients as monthly averages, and plotted vs. number of months since day of transplant (DOT).

Methods

Figure 1: Steps of Processing

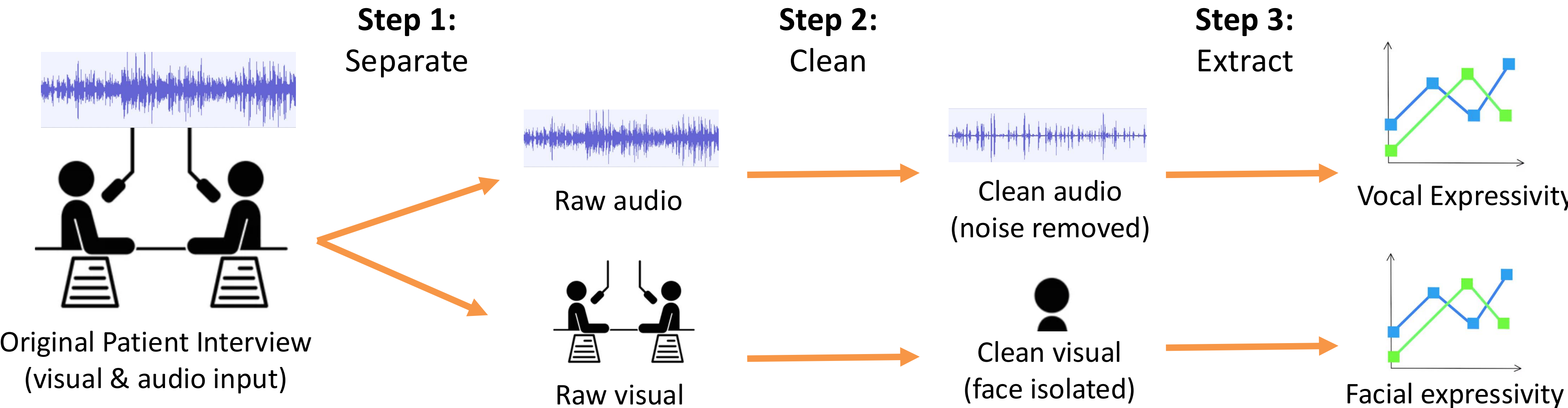


Figure 2: Facial Metric Extraction

Facial action units (AUs), first described by Ekman, represent basic facial muscle movements (e.g., eyebrow raise, lip corner pull) that can be detected from images.¹ By identifying which AUs are active and how they combine, patterns of expression can be characterized and can serve as a proxy for emotional expressivity.²

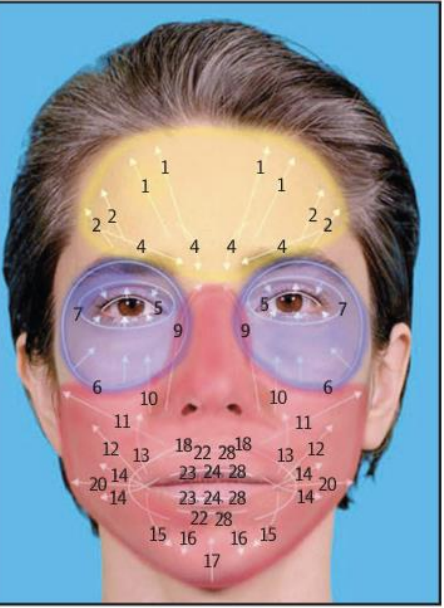


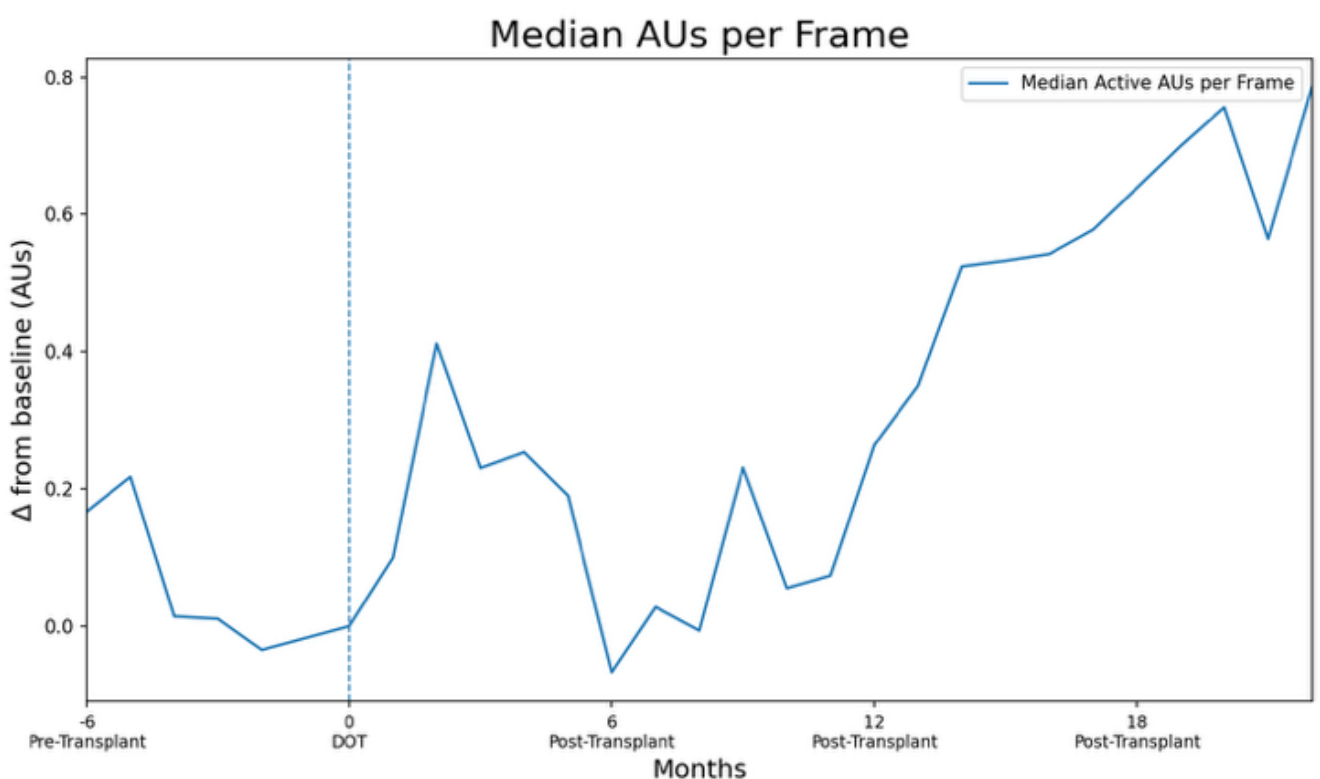
Figure 3: Speech Metric Extraction

Measures of prosody (pitch variation and intonation), voice quality, and speech rate were extracted using openSMILE, an open source audio model. Together, these features capture how speech sounds and is delivered, and when aggregated, can serve as a proxy for affective and communicative expressivity.³



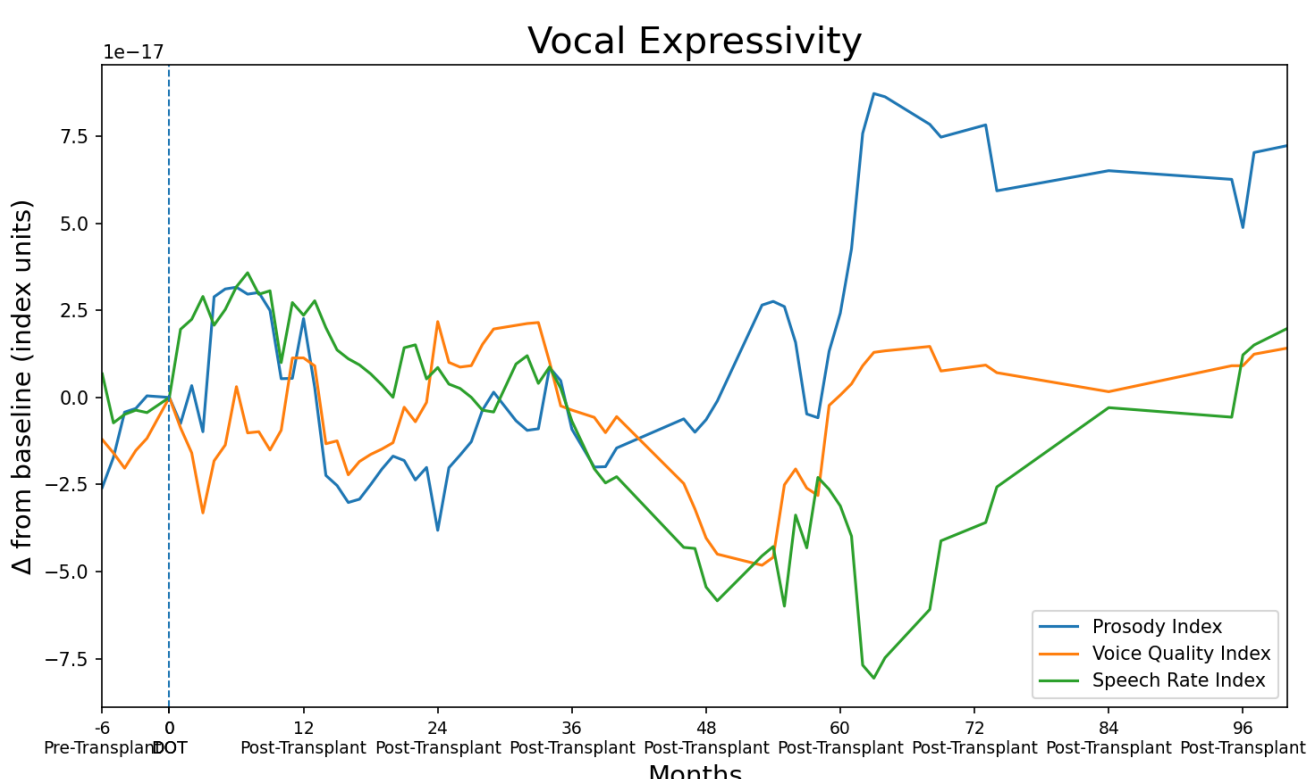
Results

Figure 4: Facial Expressivity Over Time



Displays change from baseline of median number of AUs expressed by patients in their interviews over time.

Figure 5: Vocal Expressivity Over Time



Displays change from baseline of composite indices for vocal expressivity (prosody, voice quality, speech rate) over time.

Results

- **Facial expressivity** (Figure 4) declined in the pre-transplant period and increased substantially within the first 1–2 years postoperatively, followed by stabilization.
- **Vocal expressivity** (Figure 5) analysis revealed that prosodic features improved gradually and became most apparent beyond 4 years, while speech rate and voice quality remained stable over time.
- Most recipients demonstrated concordant improvements across facial and vocal modalities, with a minority exhibiting dissociation, characterized by greater gains in facial relative to vocal expressivity.

Conclusions

- **AI-driven** analysis can provide a standard, reproducible framework for quantifying **psychosocial recovery** in FT.
- Facial and vocal expressivity demonstrate distinct but complementary recovery trajectories, highlighting the value of **multimodal** assessment.
- With further validation and integration alongside patient-reported outcomes and surgical variables, this approach may support **real-time** monitoring of QoL and inform postoperative care.

Literature Cited

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Acknowledgements

Thank you to the Hansjörg Wyss Department of Plastic Surgery and NYU Grossman School of Medicine for providing the opportunity and resources to perform this research as part of the 2025 Summer Research Fellowship.