# Shaping of face representations throughout the life span

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## Motivation

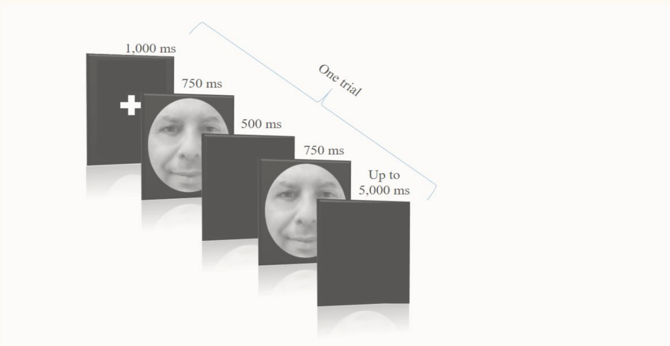
- **Lifespan dynamics:** Face recognition abilities change continuously from infancy[2] through old age[3], yet the precise pattern of this transformation is not fully understood.
- **Experience shapes perceptual expertise:** Repeated encounters with faces in our environment sculpt our internal templates, creating an own-race advantage that highlights how exposure hones recognition[5].
- **Averaging influences on judgment:** Judgments of faces, particularly under ambiguous conditions, consistently gravitate toward an overall mean[1], reflecting a long-standing regression-to-the-mean (RTM) effect across age groups.
- **Open question:** In what ways does our ability to recognize faces across the life span reflect both the build-up of specialized templates and the pull of generalized averages?

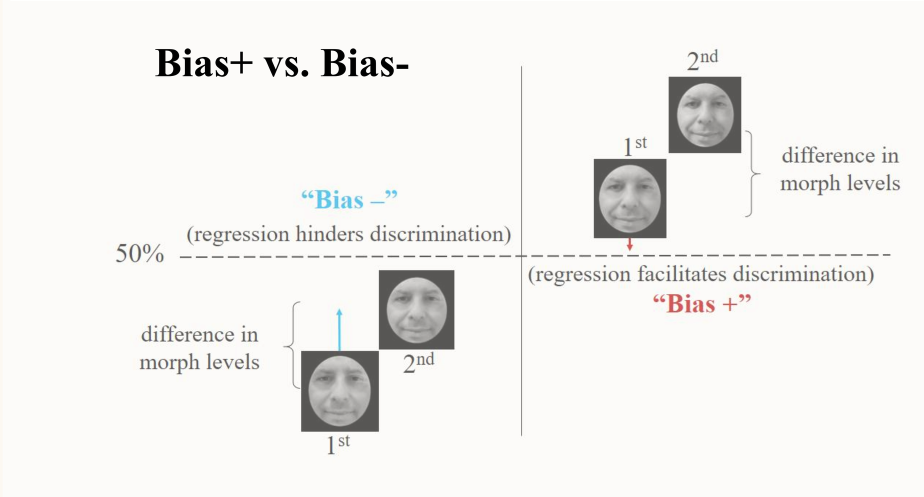
## Method

### Task

- Same/different task; two consecutive faces drawn from a sample of 100 morphed faces.
- Own race (Caucasian) vs. other race (Asian) faces.
- Bias+ trials vs. Bias- *different* trials:

| Condition | Different | | Same |
|---|---|---|---|
| Regression | Bias - | Bias + | --- |
| Different in morph level (in %) | 15 21 27 33 39 45 | 15 21 27 33 39 45 | 0 |
| Number of trails | 24 | 24 | 48 |




### Working Hypotheses:

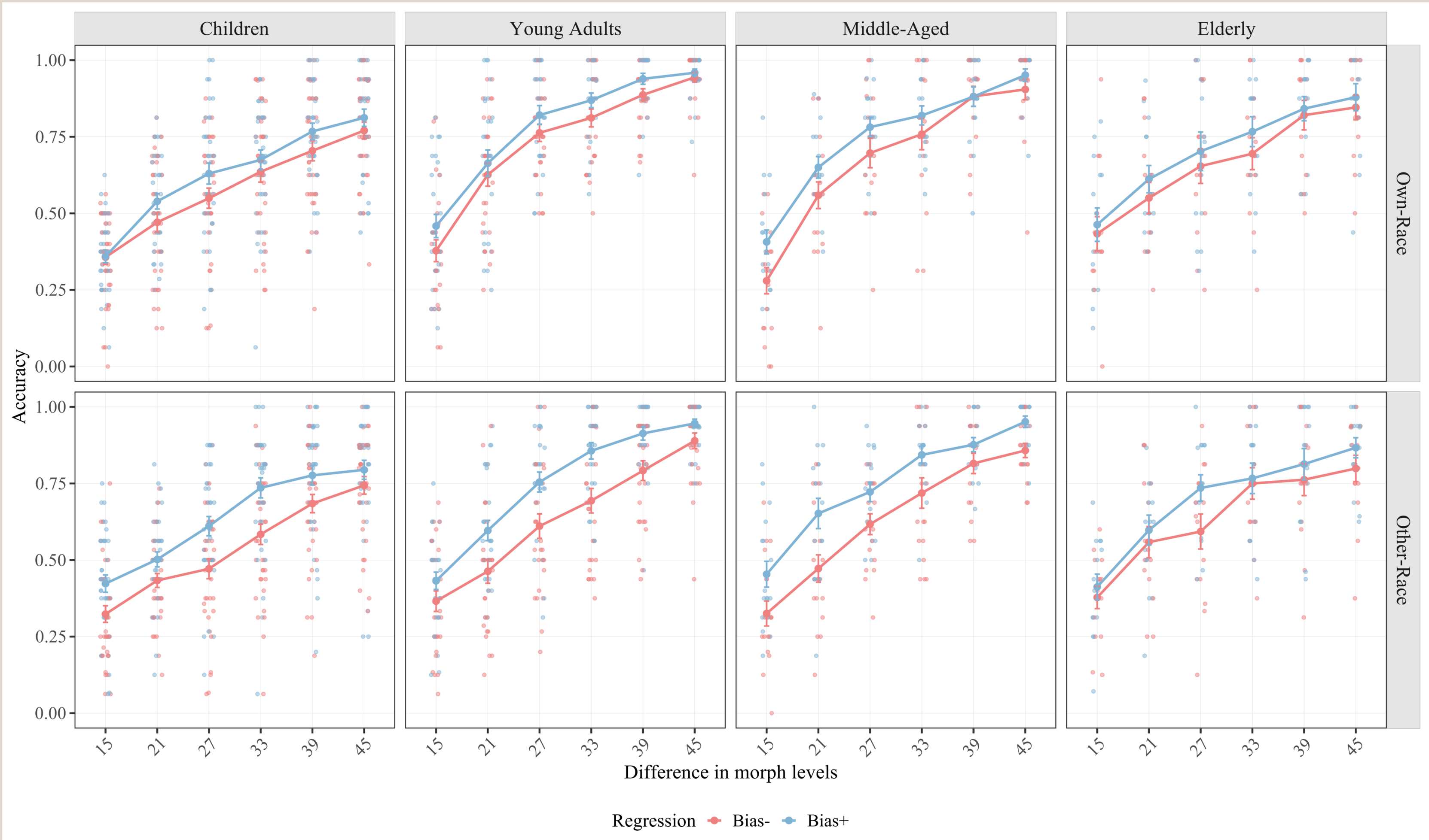
- RTM = better performance for Bias+ trials; perceived distance between the two faces increases as the first face is contracted towards the mean.
- Larger RTM effects for weaker face representations (other- vs. own-race faces).

### Participants & Procedure

- Ninety-seven native Hebrew–speaking Israelis with normal or corrected vision (50 % female), divided into four age-groups: Children ($n$ = 37; mean age = 9.25 (0.43)), Young Adults ($n$ = 27; mean age = 23.63 (5.52)), Middle-Aged ($n$ = 18; mean age = 40.82 (4.00)) and Elderly ($n$ = 15; mean age = 65.18 (7.97)).
- Faces were drawn from a Gaussian distribution and presented in two sessions; face race counterbalanced across subjects.
- Two counterbalanced sessions, each with four blocks of 96 trials sampling from a Gaussian distribution centered at 50 % morph.
- "Different" trials varied by 15 %–45 % morph steps; half designated **Bias+** (first face nearer to the mean) and half **Bias–**

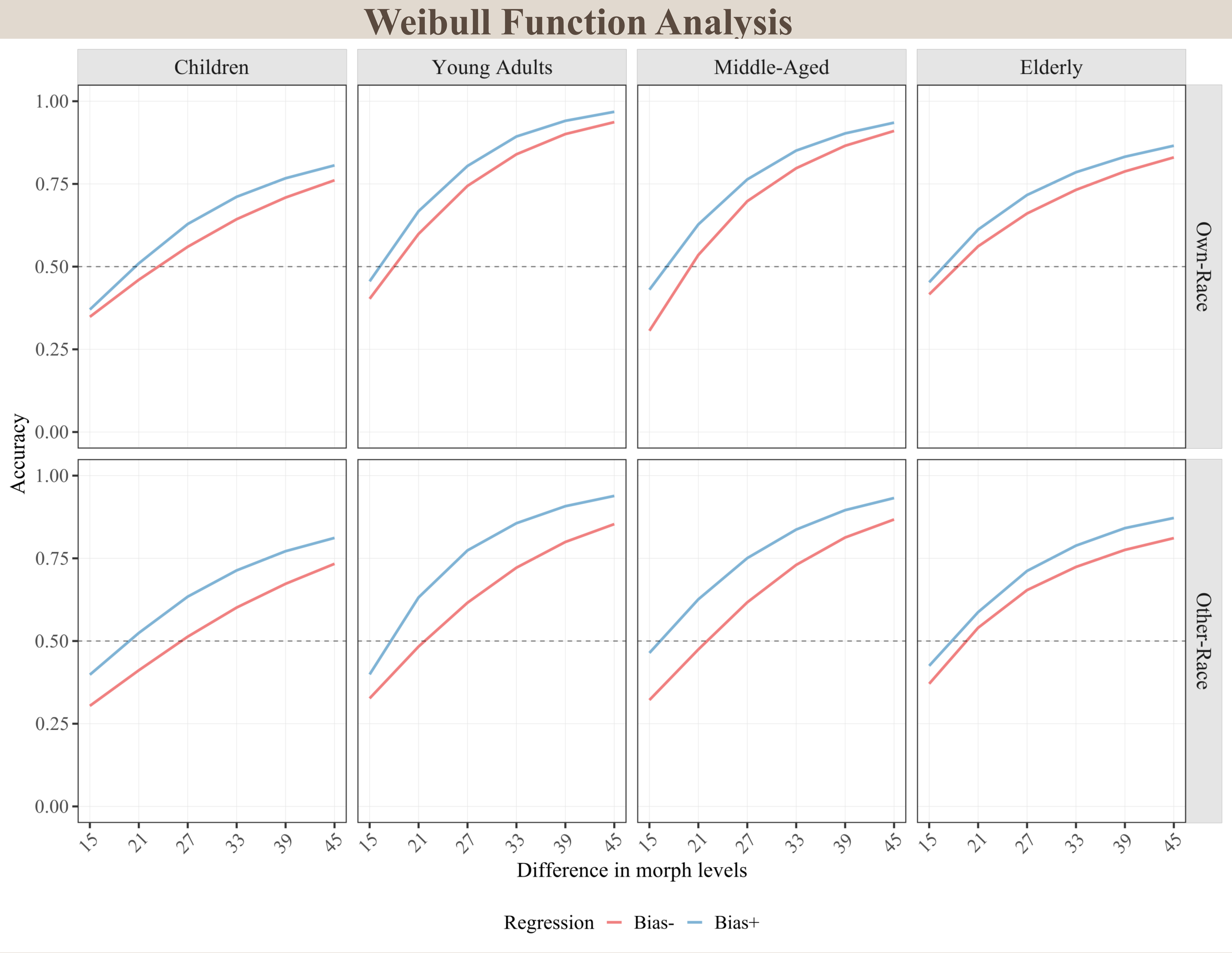
## Results

### Accuracy Over Range



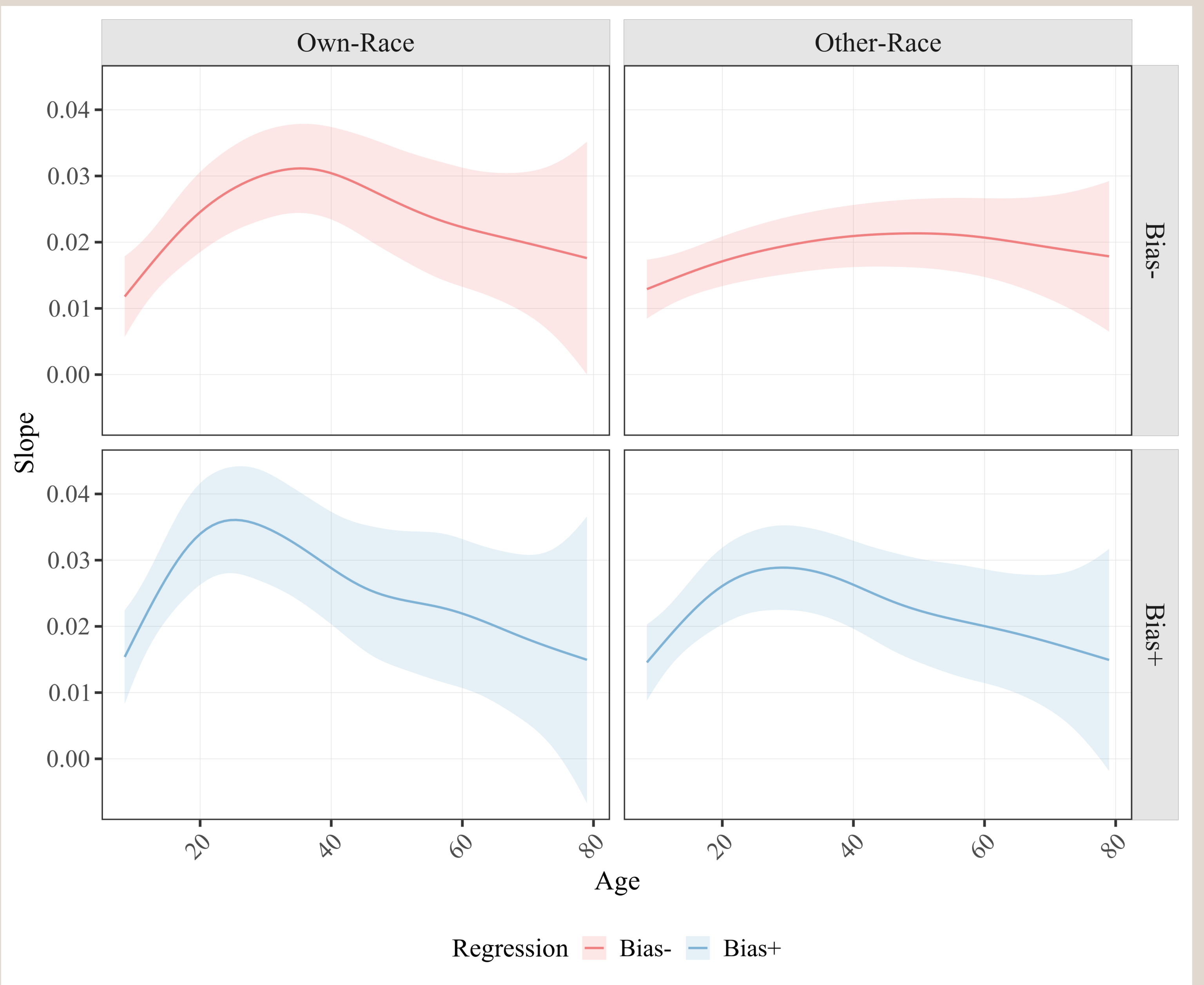

- **Age-group effect:** ($F$(3,93)=7.61, $p$<.001, $\eta^2_p$=.20) Mean ACC: Children .60; Young adults .73; Middle-aged .70; Elderly .70, showing peak in early adulthood and a decline thereafter.
- **Bias advantage emerges early:** Race×Regression interaction is significant for children ($F$(1,36)=7.62, $p$<.01, $\eta^2_p$ =.17) and young adults ($F$(1,26)=9.91, $p$<.01, $\eta^2_p$ =.28), but no interaction for middle-aged or elderly.
- **Regression disappears in elderly:** Unlike other groups (Children: $F$(1,36)=36.72, $p$<.001, $\eta^2_p$ =.50; Young adults: $F$(1,26)=29.97, $p$<.001, $\eta^2_p$ =.54; Middle-aged: $F$(1,17)=23.67, $p$<.001, $\eta^2_p$ =.58), elderly don't show regression bias ($F$(1,14)=4.21, $p$=.06, $\eta^2_p$ =.23), suggesting decline in ability to use RTM.

### Weibull Function Analysis




- **Weibull function:** A psychometric model fit to each participant's accuracy across different ranges, yielding a slope parameter that reflects sensitivity to face differences.
- **Regression effect:** Significant Bias+ vs. Bias– slope difference in children ($p$<.05) and young adults ($p$<.01), but not in middle-aged and elderly.
- **Group differences:** Elderly slopes did not differ by bias condition, indicating loss of RTM.

### General Additive Model (GAM) Analysis




- **Analysis:** GAM of Weibull slope parameter as a smoothing function of age[4], separately for Bias+ and Bias–, own- vs. other-race.
- **Nonlinear trajectory:** slope rises steeply until ~20–30 years, plateaus through middle age, then declines after afterwards.
- **Bias differences:** Own-race curve is higher but declines more sharply than other-race.
- **Model fit:** GAM model outperformed linear and quadradic models for all conditions.

## Conclusions

- ✓ **Peak and decline: Face discrimination sensitivity and own-race specialization improve steadily from childhood through young adulthood, then show a decline in older adulthood**
- ✓ **Context sensitivity: Throughout life, face perception adapts to the statistical properties of one's environment; the system shows more flexibility in youth but becomes more rigid in older age, thus limiting responsiveness to novel faces.**
- ✓ **Mechanistic insight: Together, these patterns reveal a lifelong tuning of face-space representations that peaks in early adulthood and becomes increasingly vulnerable in old age[3] as experience-driven biases weaken, undermining robust statistical integration.**
- ✓ **Change in perception: Experience-driven biases continue to fine-tune face perception into adulthood but is reduced in the elderly, hinting at subtler shifts in how faces are percepted over time.**

## References

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