# Temporal Asymmetries in Similarity and Discrimination of Prototypical and Nonprototypical Stimuli: Consequences of Differential Sensation Weighting

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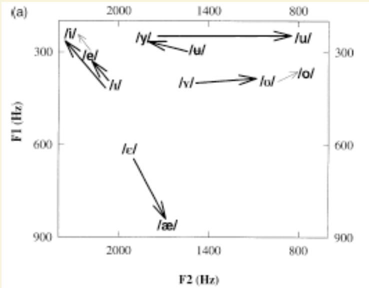
## Observations

Vowels. Discrimination tends to be best when the change is from a less peripheral vowel to a more peripheral one (closer to vowel space limits) (1-3).

[Fig. 1a of (1); infant data] Vowel pairs in formant space (F2,F1) Arrows show listening order for best discrimination.




Visual shapes. Similarities are lowest, for monkeys and humans, when the stimulus more prototypical of the set precedes the less prototypical one (4).

## Generalization

The judged similarity between two successive stimuli is lower, and their discrimination is easier, when the presentation order is central --> peripheral (in stimulus space) than vice versa.

## Modeling Approach

This temporal asymmetry can be explained by the sensation-weighting (SW) model, which was conceived (5) to account for systematic errors in comparisons of paired successive stimuli. Comparison is not just subtraction (6). What is it, then?

## Sensation Weighting (SW) Model

In the comparison each stimulus magnitude $\psi$ is weighted together with a *reference level* (ReL) $\psi_r$, usually located in the midrange of the stimuli:

$$d = [s_1\psi_1+(1- s_1)\psi_r] - [s_2\psi_2 + (1- s_2)\psi_r]$$

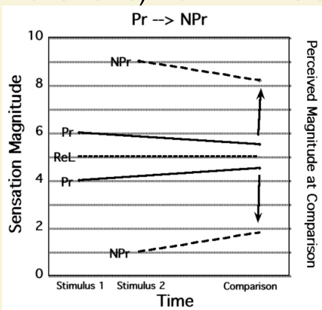
The perceived difference $d$ is generally $\neq 0$ for a pair of equal stimuli; $d = (s_1 - s_2)(\psi - \psi_r)$ = *the Time-Order Error (TOE)*. In usual conditions $s_1 < s_2$.

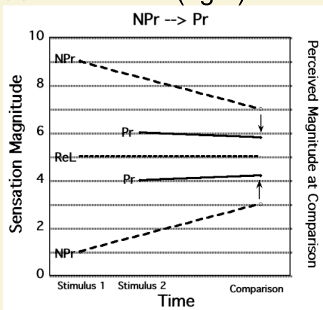
This implies negative TOEs for high, and positive TOEs for low stimulus magnitudes. The effect tends to increase with longer ISI. Thus the memory of the 1st stimulus seems to drift toward midrange (cf. 7).

## Asymmetric Similarity in SW Model

### One-Dimensional Stimuli

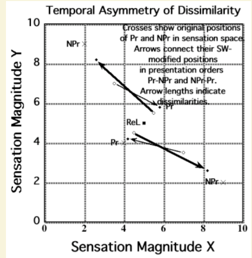
When a prototypical stimulus (Pr), near ReL, and a nonprototypical stimulus (NPr), farther from ReL, are compared, the SW model with $s_1 < s_2$ (here: $s_1 = 0.5$, $s_2 = 0.8$) predicts greater perceived dissimilarity (arrows) with presentation order Pr --> NPr (left, fat arrows) than with the order NPr --> Pr (right).




## Two-Dimensional Stimuli

In comparisons of successive vowels, the SW model, with $s_1 < s_2$ for each formant, explains why the memory of the 1st vowel seems to drift toward the neutral *schwa* (2) or the interior of stimulus space (3). Greater dissimilarities (arrows) are predicted with presentation order Pr --> NPr (fat arrows) than with NPr --> Pr (cf. 1-4).




## Related Findings

Musical intervals. For pairs of a consonant interval (simple frequency ratio) and a dissonant or mistuned interval (complex ratio) "*going out-of-tune is more noticeable than going in-tune*" (8). Melodies. Discrimination is best with listening order scalar --> nonscalar (9). For rhythms, it is best with regular --> disrupted (10).

## Perspective

The SW mechanism with $s_1 < s_2$ seems tailored to facilitate detection of potentially threatening changes from familiar, normal, or regular conditions.

## References

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