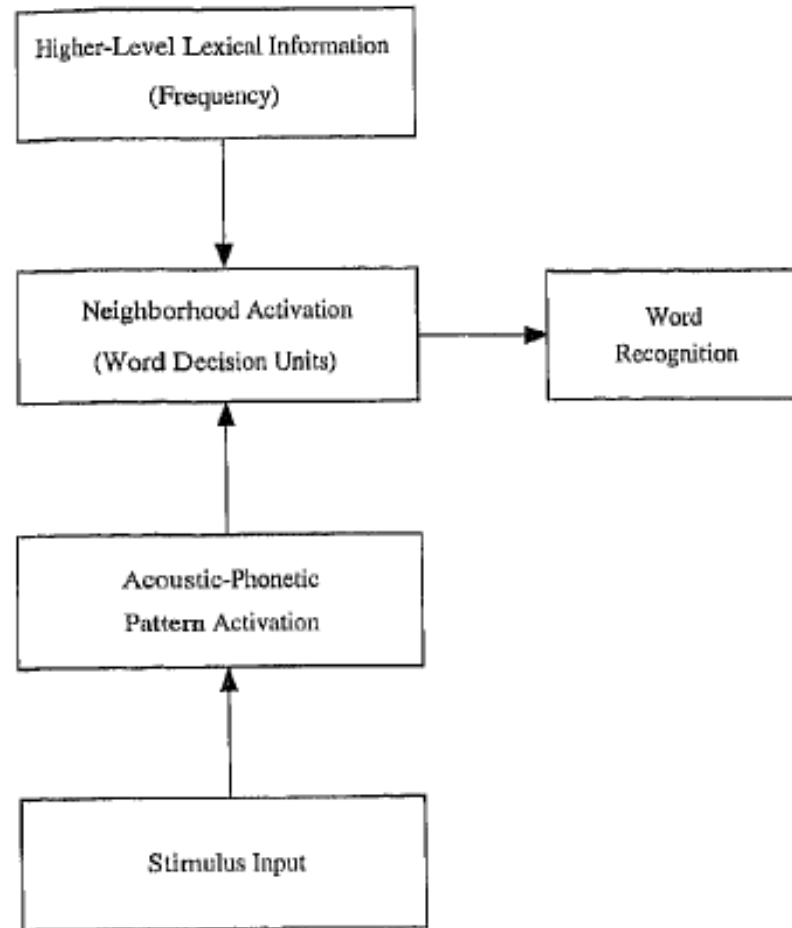


Recognizing Spoken Words: The Neighborhood Activation Model

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Feb. 2nd, 2007

Neighborhood Activation Model



Spoken Word Recognition

- Structural organization in mental lexicon
- Sensory and perceptual information

Why?

- Spoken word is not perfectly content-addressable
 - Various noises
 - Signal itself
- Listener's recognition system also noisy

→ Alternative:

stimulation on a number of candidates

Defining Similarity

- Computational:
 - Metrics based on specific computational terms
- Behavioral (operational):
 - metric based on the result of series of perceptual experiments

Neighborhood Probability Rules (NPR)

- Confusability of individual speech sound determined from all components
- Incorporating the probability of identifying the stimulus word and the probabilities of confusing its neighbors

$$p(\text{ID}) = \frac{p(\text{S})}{p(\text{S}) + \sum_{j=1}^n p(\text{N}_j)}$$

Stimulus Word Probabilities (SWPs)

- Based on the probabilities of the individual phonemes of the stimulus word

-

$$SWP = \prod_{i=1}^n p(PS_i | PS_{i-1})$$

$$SWP(dɔg) = p(d|d) * p(ɔ|ɔ) * p(g|g)$$

Neighbor Word Probabilities (NWP_s)

- Conditional probabilities for each neighbor of the stimulus

$$\text{NWP} = \prod_{i=1}^n p(\text{PN}_i | \text{PS}_i)$$

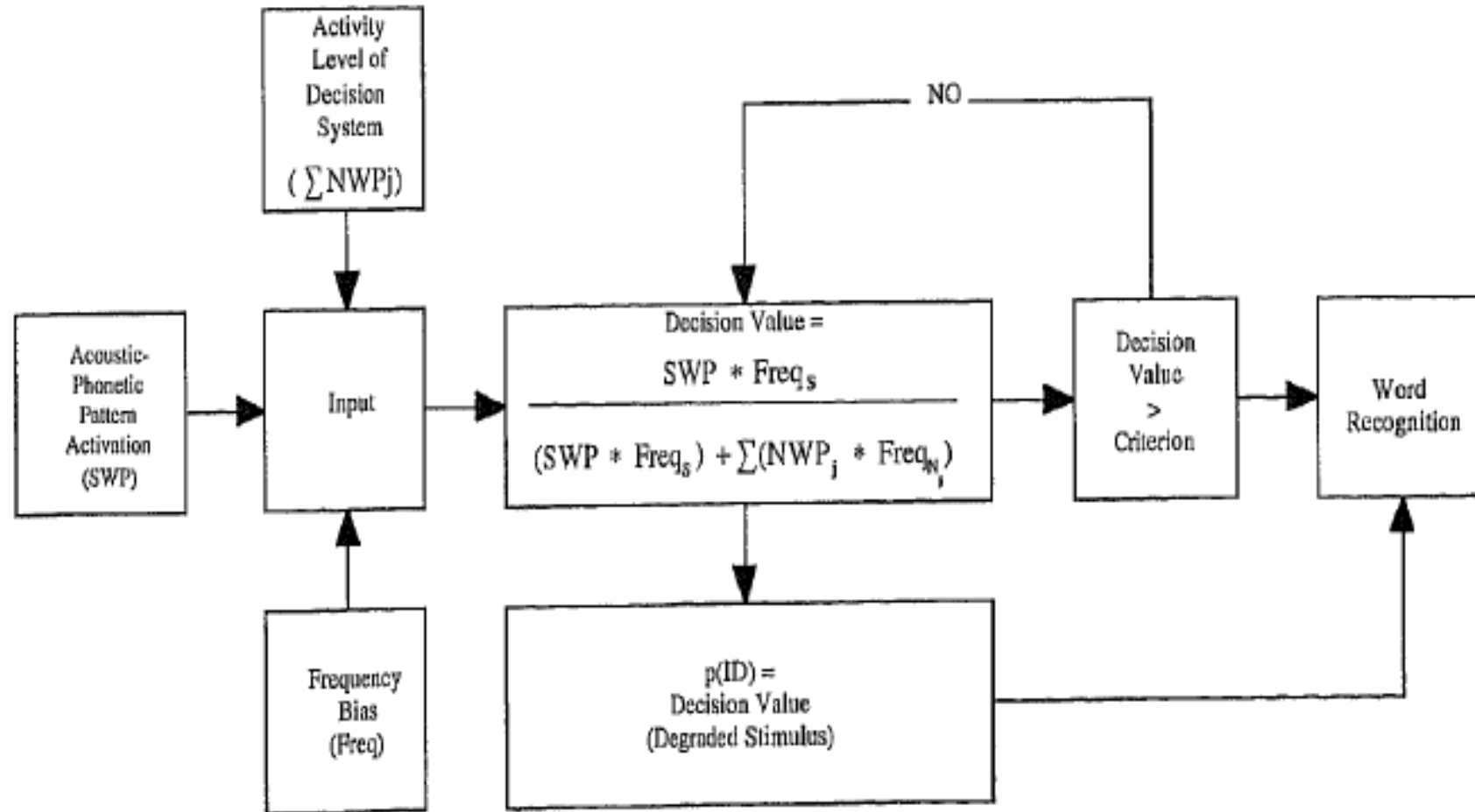
$$\text{NWP}(\text{tæg}) = p(\text{t}|\text{d}) * p(\text{æ}|\text{ɔ}) * p(\text{g}|\text{g})$$

Frequency-Weighted Neighborhood Probability Rule (FVNPR)

$p(ID)$

$$\frac{\prod_{i=1}^n p(PS_i | PS_i) * \text{Freq}_s}{\left\{ \left[\prod_{j=1}^n p(PS_j | PS_j) \right] * \text{Freq}_s \right\} + \sum_{j=1}^{nn} \left\{ \left[\prod_{i=1}^n p(PN_{ij} | PS_i) \right] * \text{Freq}_{N_j} \right\}}$$

Word Decision Unit



Experiment 1

- CVC words
- Manipulated SN ratios
- Subjects instructed to guess the words

Performance

FWNP	FWSWP	
	High	Low
High	50.56 (Intermediate)	37.76 (Low)
Low	64.03 (High)	54.73 (intermediate)

Experiment 2

- CVC words
- Subjects instructed decide as quickly as possible whether a given stimulus item is a word or nonword

Performance -1

TABLE 4. Means and standard deviations for the accuracy data for words for Experiment 2.

High-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	92.59 (4.29)	92.58 (5.20)
Low	94.73 (4.83)	93.82 (5.80)

Low-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	88.80 (7.75)	82.19 (9.21)
Low	89.57 (7.24)	83.59 (8.05)

TABLE 5. Means and standard deviations for the reaction time data for words for Experiment 2.

High-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	409 (74)	382 (75)
Low	392 (113)	377 (104)

Low-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	451 (105)	463 (126)
Low	445 (111)	421 (105)

Performance-2

TABLE 6. Means and standard deviations for the accuracy data for nonwords for Experiment 2.

Neighborhood Frequency	Neighborhood Density	
	High	Low
High	84.08 (6.85)	89.61 (4.96)
Low	89.03 (6.74)	90.44 (4.56)

TABLE 7. Means and standard deviations for the reaction time data for nonwords for Experiment 2.

Neighborhood Frequency	Neighborhood Density	
	High	Low
High	455 (118)	419 (116)
Low	447 (115)	404 (99)

Experiment 3

- CVC words
- Subjects presented with a spoken word and required to repeat or pronounce the word as quickly as possible

Performance

TABLE 8. Means and standard deviations for the accuracy data for Experiment 3.

High-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	97.67 (2.30)	98.56 (1.79)
Low	98.78 (1.70)	98.56 (1.92)
Low-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	96.78 (2.76)	97.11 (3.01)
Low	98.00 (2.38)	98.11 (2.11)

TABLE 9. Means and standard deviations for the reaction time data for Experiment 3.

High-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	840 (183)	744 (175)
Low	852 (168)	716 (171)
Low-Frequency Words		
Neighborhood Frequency	Neighborhood Density	
	High	Low
High	731 (179)	736 (192)
Low	867 (178)	685 (174)

Conclusion and Discussion

- Spoken word recognition systems is capable of considering numerous alternatives in parallel
- Cost: accuracy and reaction time