

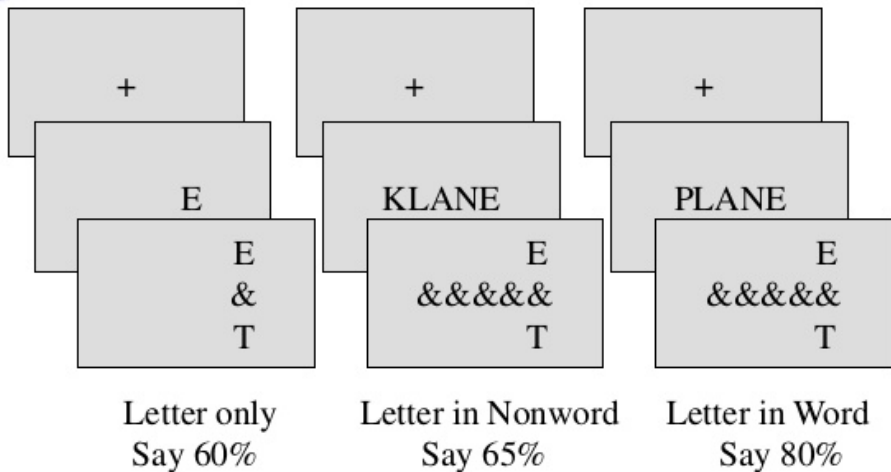
Word recognition and ambiguity

- Word processing involves multiple levels of representation
 - letter features, letters, words
- Natural assumption is that levels are identified in sequence
 - letter features $\Rightarrow$ letters $\Rightarrow$ words
- However, sometimes ambiguity at lower levels can only be resolved by higher levels
- Perhaps levels interact to find mutually consistent interpretations at all levels simultaneously
 - letter features $\Leftrightarrow$ letters $\Leftrightarrow$ words



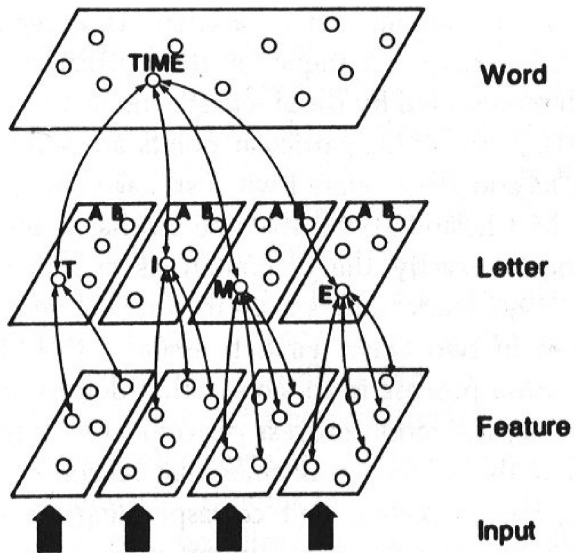
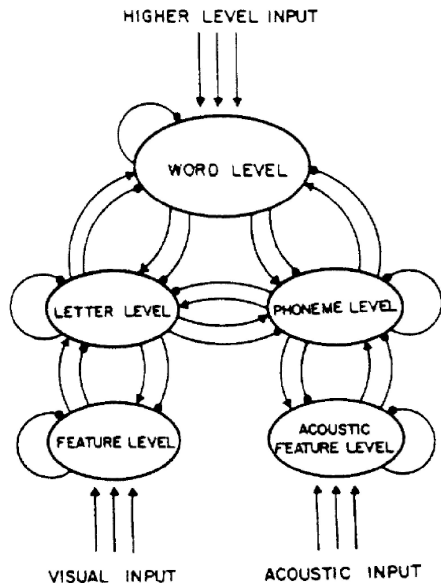


The Word-Superiority Effect (Reicher, 1969)



Why is identification better when a letter is presented in a word?

Interactive Activation and Competition model (McClelland & Rumelhart, 1981)

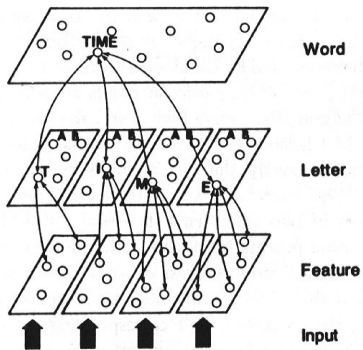
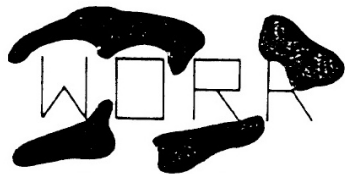


Letter font

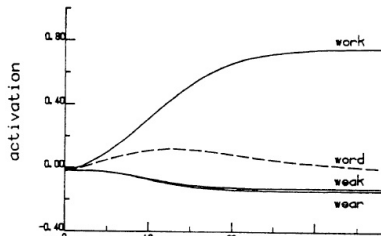
A B C D E F G H I
J K L M N O P Q R
S T U V W X Y Z



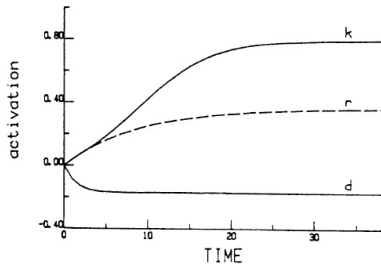
Occluded letter features: W O R [R/K]



word activations

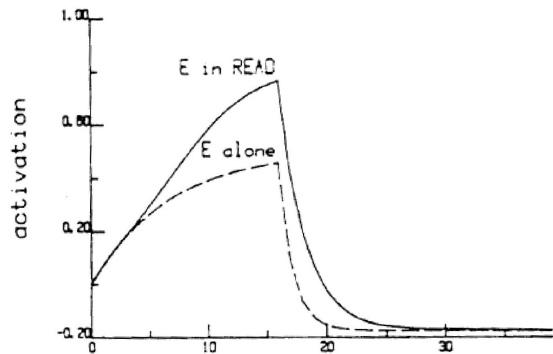


letter activations

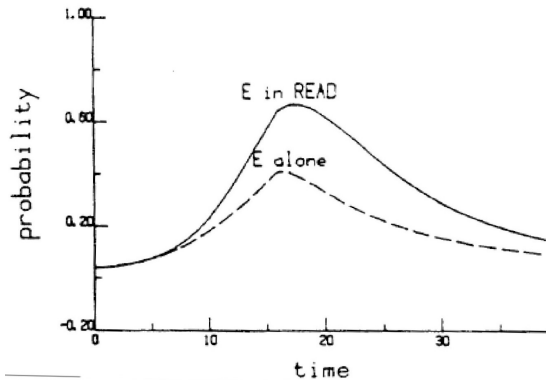


Word superiority effect

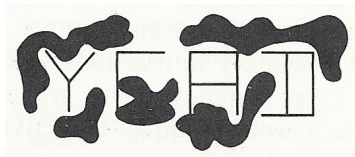
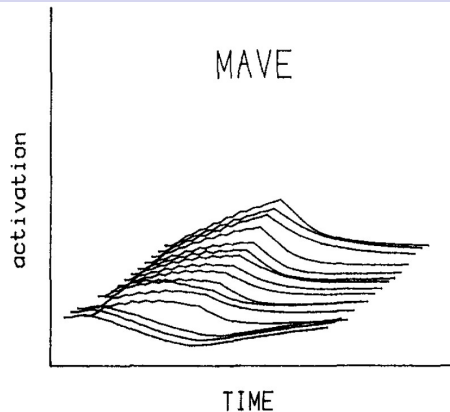
letter level activations



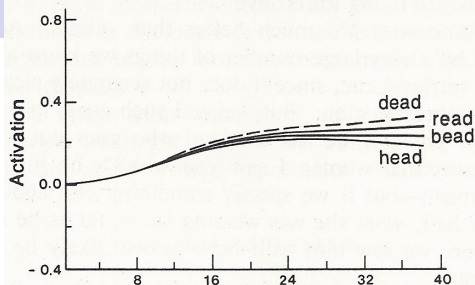
output values



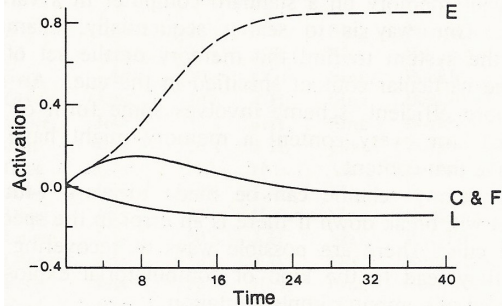
Pseudoword superiority effect



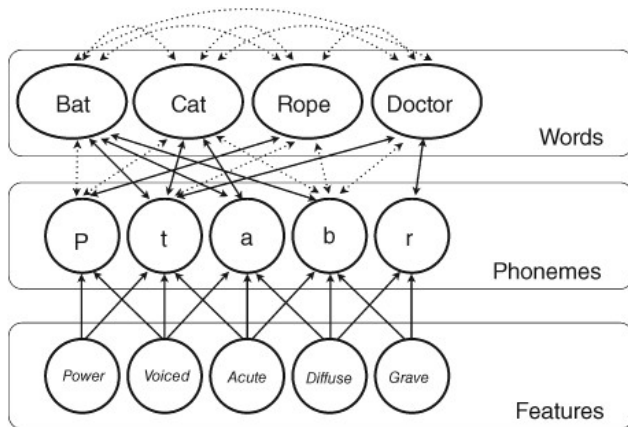
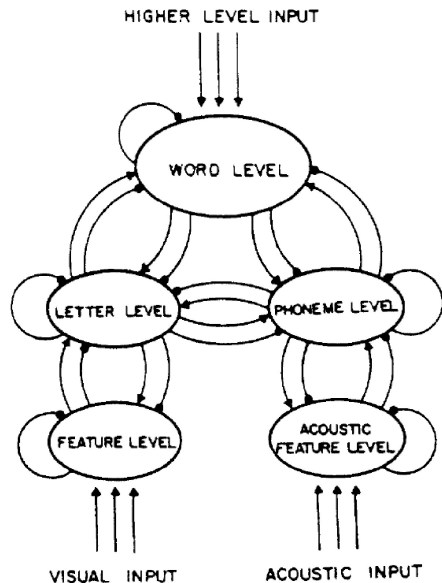
Word Level



Letter Level

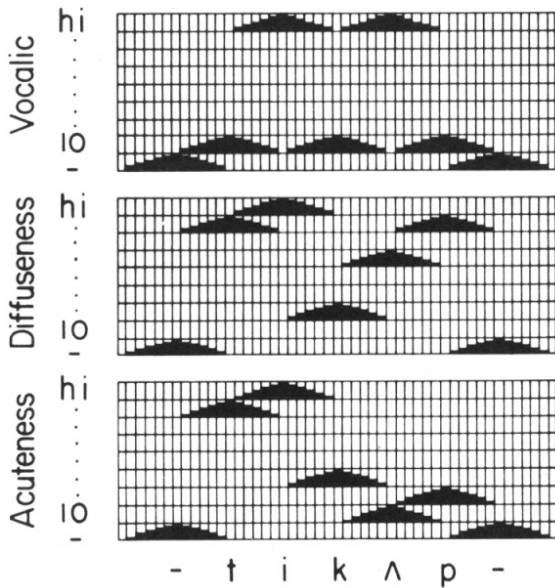


TRACE model (McClelland & Elman, 1986)

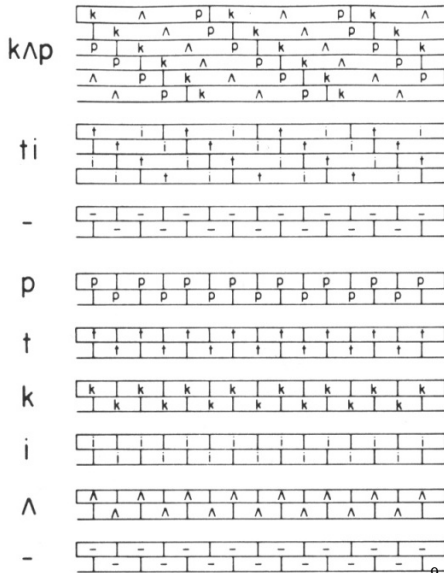


TRACE features, phonemes, words

Features



Words

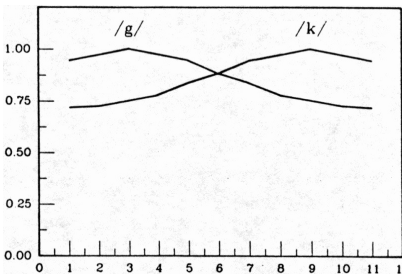


Phonotactic disambiguation

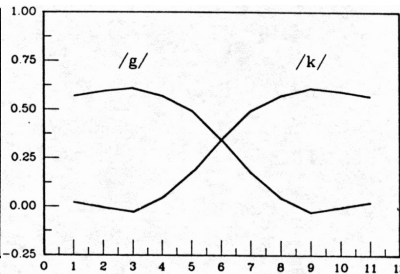
 	  	  	  
- s s l -	- s i l - r - a	- s i - l r - -	- s i - l - r -
- s l i - r	- s l i - r	- s l i - r	- s l i - r

Categorical perception

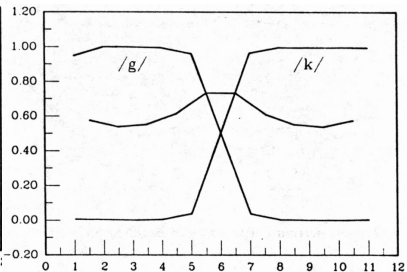
Initial activations



Final activations



Output probabilities



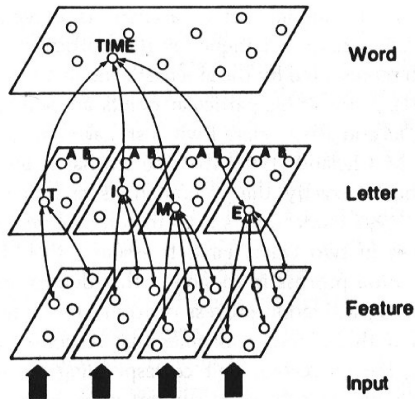
What is the relationship between units and “concepts”?

Localist representation: One unit for each concept (one-to-one)

Distributed representation: Each concept is coded by many units; each unit participates in coding many concepts (many-to-many)

Note that a representation is localist or distributed only with respect to a particular set of concepts or entities.

- The letter level of the IAC model is localist with respect to **letters** but distributed with respect to **words**



Issues with localist representations

Can be difficult to distinguish localist from distributed representations in practice

- Typically assumes multiple redundant copies (many-to-one)
- One entity typically partially activates units for other similar entities
 - Schema model: partial activation of other instance units
 - IA letter/word model: partial activation of other word units
- Similarity effects often driven by degree of overlap within other (distributed) representations

Localist representations face a challenge in specifying exactly what it means for something to be **one thing** (Plaut & McClelland, 2010)

- Unique experiences? Too many of them....
- Unique familiar objects/individuals (“grandmother” cells)? Many objects are novel....
- Classes of equivalent experiences? What determines equivalence?

Distributed representations

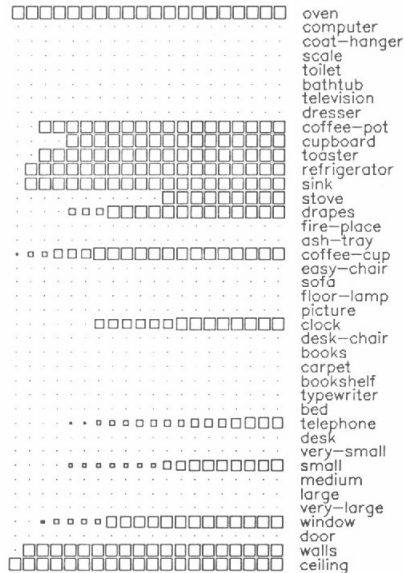
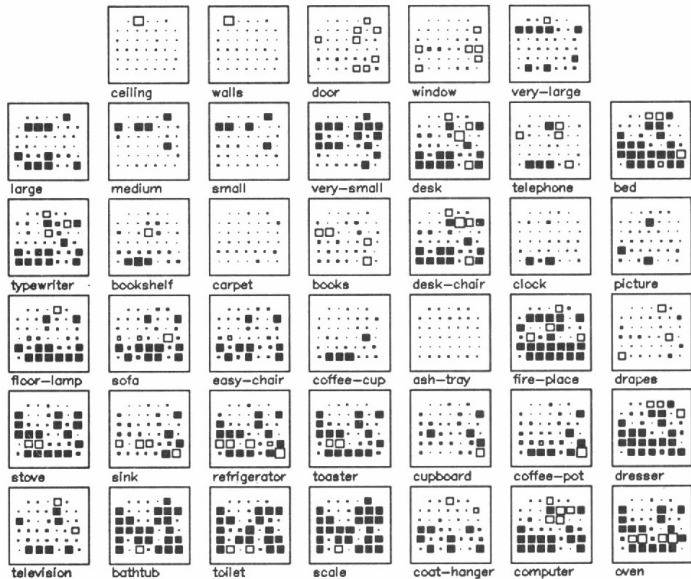
Distribution is always a **matter of degree**

- **Sparsity:** Number of units that code an entity
- **Perplexity:** Degree of dissimilarity among the entities that a given unit codes
- Different parts of the brain may use different regions of this space
- Localist representations are simply one extreme of this space (fully sparse, no perplexity)

Distributed representations are not **alternatives** to higher-level cognitive structures (e.g., schemas) but are a flexible way of **implementing** such structures with useful **emergent properties**:

- Constructive
- Automatic generalization
- Tunable to changing environments

Schema model



Memory as a constructive process

- Standard metaphor: Memory as warehouse
- Reformulation in terms of constraint satisfaction
 - **Genuine memory**: Pattern that is stable as a result of modifications to weights when pattern occurred
 - **Confabulation**: Pattern that is stable as a result of modifications to weights when **other** patterns occurred
 - **No sharp distinction** (e.g., Bartlett—eyewitness testimony)