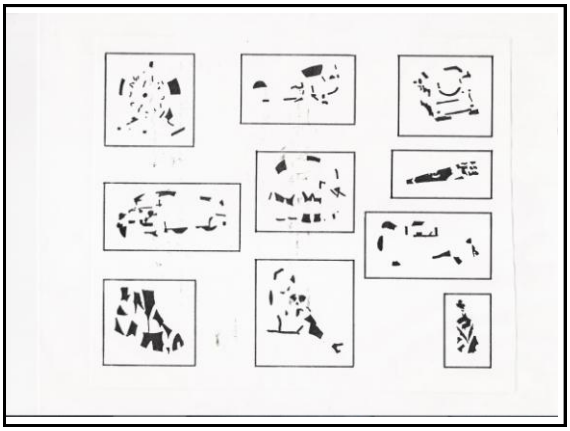
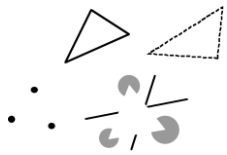
Chapter 3

Visual Perception



Features First

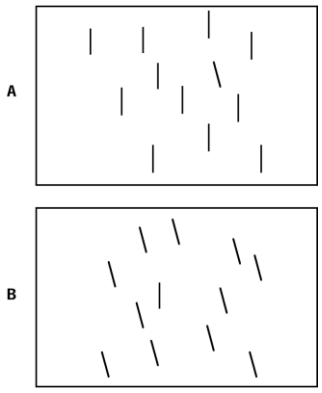


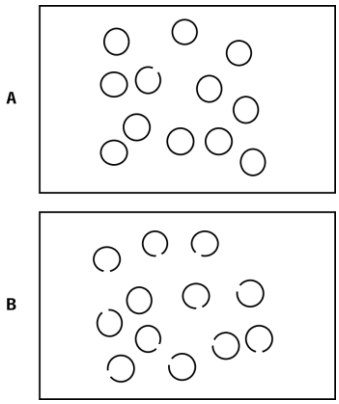
Visual Search and Features

Visual Search – look through array of stimuli to find target distinguished buy one or more features.

- locate easily a target defined by single feature (colour, orientation) – "Pop out"

- harder to locate target defined by combination of features
  - ZAP on Visual Search





- Show demo of difficult object recognition

Visual Search and Features - 2

Search Asymmetries – easy to locate broken circle in set of complete circles, or slanted line in set of vertical lines
- harder to locate complete circle in set of broken circles or vertical line in set of slanted lines

Implications
"Gap" and "Tilt" are features; "No gap" or "No tilt" are not features
Visual search data – identify elemental features of visual system.

Visual Perception

Interpretation of Visual Stimuli – depend on but not determined just by visual input. - multiple interpretations (e.g. ambiguous figures)

- interpretation depends on perceptual organization
- active input from perceiver – not passive process
- object recognition depends on how visual input is parsed (analyzed) and organized.

Object Recognition

Feature Detectors – operate in parallel, info from detectors must be organized and bound together.

Parsing and Figure-Ground, Depth and Orientation

- which parts go together & which belong to different objects?
  - partially obscured objects
- What is focus (figure) and what is ground (background)?
- Associate 2 visible parts of visually obscured object.
- Is object right side up? Sideways? Upside down?
- Which parts of object are obscured by other objects?
  - Impossible objects

Object Recognition - 2

Figure-Ground – ambiguous figures (face vs. vase, Necker cube, wife & mother-in-law). Info not in stimulus, organization must be imposed by perceiver.

- 4th ed of text has good examples showing how organization comes before feature detection.
- Organization → informs interpretation of features

Object Recognition -3

- Priority of features – visual search task
  - Stimuli differing in simple feature pop out
- → Importance of both top-down & bottom up processes
  - parallel processing

"Laws" of Perception

1) Interpretation of stimulus input must fit with all the information available.
2) Ockham's razor: simplest possible explanation.
3) Interpretation must be reasonable, not rely on coincidences.

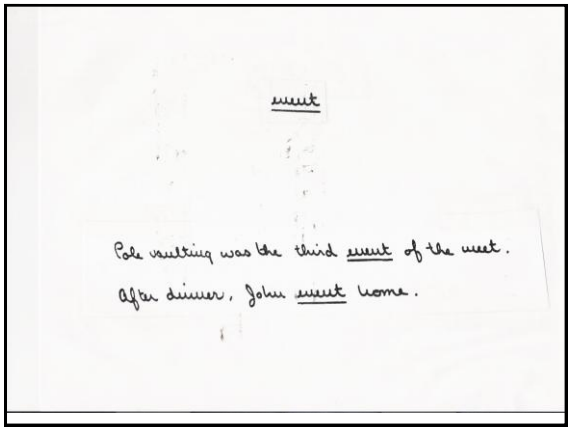
Recognition: First Considerations

Object Constancy – recognize objects in different positions, different orientations, when partially obscured, under different lighting conditions.

- recognize different exemplars, e.g. different types of dogs, letter A written in different handwriting styles

Context Effects – perception of objects influenced by context

- human handwriting – students' exams



Features First

Recognize objects from features (e.g. recognize a person from their hair or silhouette, the way they walk, shape of nose etc.)

Feature detectors in visual system: lines, edges, angles (3-D corners), curves, more complex units

Features in **perceptually organized input** (after Figure/Ground, Parsing, Depth, Orientation have been processed)
- Dalmatian example – only see dog's features (head, legs, etc. when field has been correctly organized.
- contours that aren't there (see Figure 3.7

Features First

Advantage of Features

1) Features as general purpose building blocks (lines, curves, angles etc.)
   - Some features innate; others learned
2) Features may enable us to categorize objects (e.g. letters of alphabet)
   - all As have short crossbar in middle, two slanted lines which meet at top
3) Features cause us to focus on common attributes.
4) Features detected early in perception, & then assembled into more complex wholes.
   - integrative agnosia – sufferer can detect specified features, but can't judge how features are bound together to form complex objects.

Word Recognition

Logic of Word Recognition Studies

- present words for very short durations (tens or 100s of milliseconds) in a *tachistoscope* (now by computer).

- word followed by post-stimulus mask (set of letters or symbols that appear in the same place as word) (Why?)
- Measure accuracy: % letters or words identified or *threshold*: duration at which word is recognized by a subject X% of the time.

Word Recognition: Definitions

Word-Frequency Effect

- The more frequent is a word, the lower its recognition threshold.
- E.g "event" (freq = 179) vs. "went" (freq = 4162)

Repetition Priming

- If a word is repeated, the threshold is lower for the second or subsequent presentations than for the first.

Word Recognition: Definitions

Word Superiority Effect

- Present Letter (E or K)
- Then present letter (E or K), nonsense word (e.g. JILE or JILK) or word (DARK or DARE) plus mask. (Why??)
- S responds yes or no to indicate whether the target letter had been in second stimulus
- Ss do better for words than nonwords or letters, & better for well-formed than ill-fomed nonwords.

Word Superiority Effect

Recognizing single letter harder than recognizing letter in context of a word or well-formed nonword.

Identifying letters and words are parallel processes with mutual facilitation

Identification of elements (letters or features) facilitates ID of objects, and vice versa

Bottom-up and top down processes interact

Well-Formedness

(Legitimate Spelling Patterns or High Pronunciability)

Recognizing unfamiliar word-like stimuli (e.g. jilk or *grack*) faster than random strings of letters (e.g. *lkgi* or *rwokl*)

Recognizing a letter in context of low-frequency word faster than in context of well-formed nonsense word which is faster than in context of poorly-formed nonsense word.

Well-formedness effect is continuous, not all-or-none.

Word Recognition Errors

Word-Frequency Effect

- The more frequent or probable is a word, the lower its recognition threshold.

Over-regularization Errors and Well-formedness

- A word with low-frequency spelling pattern (ill-formed word) is likely to be misread as a well-formed word.
  - nonsense word (e.g. *blafe*) likely to be read as a word (*plate* or *blade*)

Feature Nets and Word Recognition

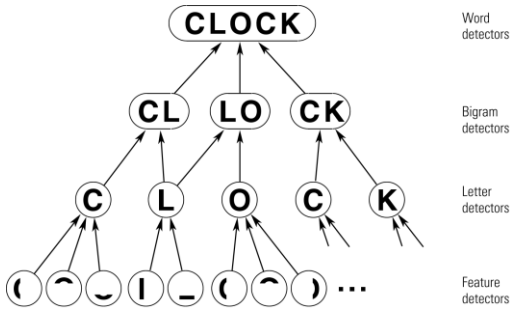
Parallel distributed processing (PDP) models - feature nets

- computer models that simulate neural connections

Network of "detectors" in hierarchical layers

- first layer: feature detectors (lines, curves, angles, etc. See Chapt 2).
- second layer: letter detector
  Strong activation of features → activation of letters containing those features
- third layer: bigram detectors
  Strong activation of letters → activation of bigram detectors
  - activation of *t* and *h* increases activation of *th* detector → increased activation of words containing *th*

  High-frequency bigrams activated more easily than lo-frequency bigrams.



Feature Nets and Well Formedness

- higher level: word detectors
  - active when appropriate letters & letter pairs are seen

Detectors have resting or baseline activation levels; need input to increase activation level to threshold.

Detectors analogous to cell assemblies, but aren't neurons.

Baseline activation level determined by (1) Frequency and (2) Recency of activation

Well-formed nonwords receive activation from bigram detectors. *JICE* and *SPRAKE* perceived faster than *ICJE* and *KPSERA*

Confusion and Ambiguous Stimuli

- Very short presentation, blurred input or type (CORN)
  - → some features of some letters not processed → letter not recognized. E.g. CO*N
  - Not all features of R processed → A, B & P activated as well as R

- Uncertainty resolved at higher level, e.g. bigram detectors

  RN more frequent bigram than BN; RN needs only weak input to fire but BN needs strong input

- Word level detectors → AN frequent bigram, but COAN not a word. COBN & COPN also not words. CORN frequent word.

Recognition Errors

CQRN or *COPN* will be perceived as *CORN*.

- letters *O* and *Q* have features in common. *O* will be activated when *Q* is presented. Same for *P* and *R*.
- *CO and OR* detectors weakly activated when *CQRN* presented
- *CO* and *OR* have higher baseline activation than *CQ* and *QR*; Need less input to reach threshold.

Rapid presentation of *CQRN* gives erroneous perception of *CORN*

Network always biased towards frequent words or spelling patterns.

Parallel Processing and Distributed Knowledge

Knowledge of spelling pattern frequencies not stored in given location

-- no "look-up" of frequency information or activation level, no active ordering of possibilities

-- no local representation (e.g. a number rating strength of detector)

Knowledge of spelling pattern frequencies operates through activation thresholds and connections between detectors.

→ simple mechanical process

- knowledge distributed throughout network in *pattern* of activation thresholds.

Inferences (perceptions) are not active. Making inferences not problem-solving process.

Efficiency vs. Accuracy Tradeoff in Feature Nets

100% accuracy requires processing every possibility → lose efficiency

Environment is highly predictable. Language is redundant.

Feature nets rely on predictability & redundancy to increase efficiency.

Theme of Reisberg's book – "heuristic" processing

Note: Page 81 of 4th ed. – implies we don't process all letters when reading. This is not true. Skilled readers do process all letters. Skilled readers don't guess. They use knowledge of spelling patterns, word frequencies, situational context, language structure (syntax) etc. very efficiently.

- Skilled readers better proof readers than poorer readers

Speed Reading

Speed reading or skimming to obtain specific information from text is useful strategy

Skimming does not allow absorption of material read. Must attend to content & rehearse in order to remember.

Proof Reading

Skilled readers normally read for meaning, and do not read to detect spelling errors.

Harder to proof read one's own work – detectors highly primed.

To proof read effectively, must learn NOT to read for meaning.

Descendants of the Feature Net

McClelland & Rumelhart

Included **inhibitory connections** in addition to **excitatory connections**. E.g. activation of one letter (T) may inhibit activation of another (Q) because Q seldom follows T.

Top-down as well as **bottom-up connections**. E.g, word detectors can influence letter detectors.

Context effects: bread and b.....r

Neurological evidence

- neurons send information from brain to cells in retina, cortical cells send info to LGN cells. Etc.

Descendants of the Feature Net

Recognition by Components (RBC Model)

Geons (Geometric Ions) – simple 3-D shapes -- basic building blocks of object perception.

- approx. 3 dozen needed
- Geons can be recognized from any angle (e.g. cube, cone, cylinder, C-shape)

RBC Model – hierarchical

- feature detectors (lines, edges, curves, angles, etc.)
- geon detectors (analogous to bigram detectors)
- combinations of geons (See Neisser, p. 80)

Objects easily identified if geons identifiable – Figure 3.15

Modalities Other than Vision

Recognition Errors in Hearing

Frequency effects, effect of well-formedness, & repetition priming found in auditory perception.

"Regularizing" Errors found.

Restoration Effect

- Single phoneme deleted from tape recording of a word, e.g. delete /s/ from *legislature* and insert a burst of white noise.
- People hear the word (and some accompanying noise), and don't realize that sound is missing.
- People hear a note in a familiar melody even when note has been replaced with noise.
- See Required Reading by Warren

Facial Recognition

Evidence that Facial Recognition involves Specialized Mechanism

1) Facial recognition depends on orientation moreso than recognition of other stimuli. Upside-down faces hard to recognize. Larger effect of orientation for faces than for other objects.
2) Prosopagnosia – visual recognition of objects okay, but person can't recognize faces.
   - loss of face recognition plus (1) cow recognition, (2) warblers, (3) cars, (4) dogs.
   - get effect of orientation for these other stimuli e.g dog judges.
   - prosopagnosia not merely loss of face recognition
     - involves recognition of individuals in highly familiar categories

Facial Recognition

Hypotheses

Two recognition systems: (a) Recognition of simple parts & assembly into wholes – general object recognition

(b) larger-scale configurations→Specialized system - recognition of individuals within familiar category.
- can't operate with upside-down stimuli
- fusiform face area (FFA)

Damage to (a) → object agnosia but faces ok
Damage to (b) → prosopagnosia

Top-down Influences on Object Recognition

Effects of Large Context

Tulving, Mandler & Baumal: Target word presented in context of one to 8 words. Context appropriate or not. E.g. At the circus, the children saw ….

- Recognition facilitated by appropriate context. Inappropriate context interfered.
- Not guessing effect. Context somehow speeded perception.
- → perception connected with other knowledge

Interactive Models

Two types of priming

- Bottom-up or data driven priming (e.g. repetition priming)
- Top-down or conceptually driven priming
  - Based on wide body of knowledge, expectations
- Interactive models – involve both types of priming