# Attention

Psy 20
Prof Colin Camerer

**Attention is a limited resource. How do we know?**
**And what exactly is limited?**

Driving with cell phones ~ .12 alcohol content !
(Hong Kong/Canada etc. "no hands" restrictions…do they help? No (Canada data: risk factor of 4 for handson vs 6 for handsfree)
What would cognitive psychology say? What "grabs" attention & causes more accidents?
A: phone ringing! Requires fumbling, classic attention "distractor", often turn head toward the ring, and "prethink" who is calling…)

"Everyone knows what attention is. It is the taking of possession by the mind, in a clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others." (Wm James)

## Auditory attention

Dichotic listening ("shadowing") task
Listen in both ears, repeat input into one. (Fig 3.1)
This is difficult! Why?

Filter theory ("early selection")
Sensory information filtered out at some bottleneck
(not attended to at all)
What's filtered in? Physical (which ear), pitch, etc. That's it

Evidence against: “cocktail party effect”—
hearing a relevant or familiar stimulus immediately shifts attention (Moray 1959), “Miss Chen”!. Also can shift attention automatically to track meaning (Gray-Weddeburn 60s). (Brain is searching for

relevance, familiarity or meaning—suggests cost-benefit criterion of some sort or priming based on priors)

Late selection theory:

All stimuli processed to point of recognition.

Filter happens at response bottleneck, not during processing

Wrong! Ss cued to tap at target word

Got 87% from shadowing ear, 8% from unshadowed

Latest theory: Attentuation

Information isn't filtered out at all, just the "volume" is turned down. (e.g., firing of cells in monkey auditory & visual cortex, ERP's from EEG in humans)

Brain turns volume up when it needs to.

Evidence:

Unattended information decays rapidly (e.g. 25% recognize target digit in unshadowed ear recognized if asked immediately, 5% if lagged)

Switching seems to depend on task "set". E.g. whether new stimuli (onset) grab attention involuntarily depends on whether task is to detect new stimuli. If looking for letters, distractor letter grabs attention; but if looking for letters, distractor number does not.

(External "radio monitors" receive top-level executive instruction?)

# Visual Attention

spotlight metaphor:

visual field attenuated (peripheral vision) (Fig 3.6)

can only "watch" one superimposed image at a time (Fig 3.7) (like Necker cube or visual switching)

Neural encoding: Areas of activity correspond to physical display (Fig 3.8, 1.7) (flipped asymmetrically)

Visual sensory store

Sperling task: See 12 letter display. Tone-cued to recall one row.

Recall 3-4 if tone immediate, decays to 1.5 w/ 1 second delay

→ temporary sensory store of visual images (1 sec)
("iconic memory" in the retina?)
fades in 5 secs with "lights off"-- like night vision? (afterimage)

visual field damage
Control of attention shift **separate** (parietal) from visual cortex
parietal lobe injuries slows disengagement/erases L or R field
(e.g. patient who shaves half his face, or Fig 3.13)

Visual switching effect— What grabs attention?
'90s view: new objects, and "singleton" distractors
→ system preprimed to novelty and distinction [new & special]

{Q: How would a social system respond to this knee-jerk reflex?}

Motion, brief flashes "grab" attention

'92+ (Folk) view: Earlier studies use distractors similar to targets that confounds task sets…
when unconfounded, involuntary attention **only** switches when distractors and targets are the same

"thermostat" metaphor—task "sets" thermostat, then works "involuntarily"

## Pattern/object recognition

Picking target object out of a set
(e.g., spotting defective products, shopping, military detection)

Feature-integration theory: Need to focus attention to integrate features
Test: Easier to detect a T in array of I, Y than T in I, Z

Homogeneous background effect—easier to spot target if distractors are similar e.g. H H T H vs H I T X (contrast effect, statistical, or priming)

Some images "pop out" leading to flat set-size t(N) response functions (even up to 50) (e.g., triangle among unconnected lines; right-facing cube among lefties)

## Object-based attention

Attention automatically allocated to objects (not space); objects "tracked"
e.g. "inhibition of return" experiments ("don't backtrack")

focus on square. When square rotates to new position, slightly slower to identify a probe in that position (460 ms) vs. other position (420 ms)

## Automaticity

Some processes so "automatic" they require little attention

Visual search:
better at detecting numbers among letters
(insensitive to "frame size")
...but can be trained (2100 trials)

Stroop effect:
Say the ink colors of color words or # digits (Fig 3.16)
Hard not to say the color-word/number!
More automatic for "pre-learned" processes (Fig 3.15)
Can be reversed with **much** practice (10,000) trials
Important for product design (Pittsburgh sign, stoves…)

Bottlenecks: Dual-task performance
Quick intertask interval inhibits performance on task 2 (Fig 3.17),
but ~60 ms of "overlap"
Perform control stick tracking and digit typing
seem to have limited budget of "attention" (Fig 3.18)
Two light flashes in a row:
second response slower if it follows quickly (Fig 3.19)
(psychological refractory period PRP)

Important fact: Can be trained to process simultaneously.
E.g., court typists, students who read/copy…but only because one task becomes automatic (→ poor retention) (typists "can't stop")

Automaticity often goes along w/ poor retention (what did you eat for dinner 2 days ago? Remember driving home?) Langerian “mindlessness” (e.g. asking phone operator, Can you give me the **address** rather than number—they often give the number automatically)

Multiple-resource theory

Tasks "interfere" much less if different modalities

(e.g., can listen to TV and read, harder to watch two TVs

# PERCEPTION-BASED REPRESENTATIONS

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## How are things represented in the mind?

History:

Aristotle-- visual imagery as main medium of thought.
(mnemonics used to memorize speeches)

Plato-- etched on wax tablets (indiv'l diffs due to
qualities of wax-- temperature, purity, pliability)

Wm James et al.
Galton (1883) asked pals to imagine breakfast table
(some couldn't-- big indivl diffs)

Banned by behaviorists 1913 (no "internal states" allowed)...
-- also, could not resolve arguments with critical,
"publicly observable" experiments
-- beware of homunculus/inner-movie-screen fallacy

...but behaviorism failed (language, thought, vicarious learning)
RIP 1960 (good riddance)

Return of interest in mental imagery. Why?

- rise of AI, program metaphor (LISP, prop'l logic)
- Paivio-- verbal guy, but observed that learning was affected by visualizability (--> dual-coding)
- critical experiments: mental rotation, Kosslyn scans
- neuroscientific evidence

So.... How are things represented?

Analogical/depictive/graphical/**images**

vs. linguistic/**propositional**

| **Images:** | **Propositions** |
|---|---|
| No discrete symbols | Symbols |
| Implicit, no symbol for relation (book is on top, see?) A | Operators for relations ON(book, desk) 2 symmetrical tilted lines, meet at top... |
| No rules for combinations | Grammatical rules (LISP) |
| Concrete | Abstract |

Example: Santa (1977) exps with verbal/visual images
(Figs 4.1-4.2)

Neural evidence for separate coding (Fig 4.3)

**EVIDENCE FOR IMAGING**

Mental rotation (Shepard-Cooper, Figs 4.4-4.5).
Time to match X & X rotated Y° increases w/ Y
Image scanning:
Time to "find" map location in image (eyes closed)
an increasing function of distance (Figs 4.6-4.7)

## DUAL-CODING THEORY

Paivio (1971++):

Two distinct systems of **logogens**, **imagens**.

Key exps:

1. Pictures often named while presented ("car...")
   & remembered better than words
   & visualizable (concrete) words remembered better
   (waterfall vs. overflow)

2. Neuropsych'l evidence for localisation:
   hemispheric differences (do better w/ abstract
   words presented to left hemisphere)
   deep-dyslexic patients (left hemi lesions)
   have difficulty w/ abstract words

## IMAGERY-PROPOSITION FEUDS

No doubt about importance of propositions. (language).
But do we "need" images?

(i) Philosophical (aesthetic?)
Pylshyn:
Mental images are "epiphenomenal"
-- byproduct of other process (lights on computer)

(ii) Theoretical:
Propositionalists (Anderson, 1978):
Can mimick any imagery w/ prop'ns (LISP rules[1])
because of "structure-process tradeoffs":
(process creates/reproduces/"penetrates" structure)

[1]Do they just lack imagination of a world outside LISP?

**IMAGERY-PROPOSITION FEUDS (cont'd)**

Q: What about mental rotation, smart guys?

Wiseguy A: Each propositional operator rotates object 5°, slower rotation time because more prop'ns.

Mental scanning?

"Dummy" propositions every few feet (mile markers), slower to scan longer chains of propositions

(iii) Methodological:

(a) subjects are just simulating visual perception (hence, distance & rotation effects)

but... Pinker-Finke experiments

dots • • • • •

removed...
then arrow ^

Q: did arrow point to (former) dot?
Distance effects (even tho no scan mentioned to Ss)

(b) demand effects (for Ss)-- cooperating w/ E or experimenter expectancy.

Ruled out with experiments with expectancy/demand manipulated (there is still a distance effect)

**COMPUTATIONAL THEORY (Kosslyn)**

**Both** propositional "files" and image "files".
They interact.

Evidence:

Image tracing--

See rabbit ears? Harder to "see" when rabbit is small (next to elephant)

Ambiguous figures (duck/rabbit Fig 4.11)

Hard to adjust image (--> propositional file match cements "what it is")

Neuropsychological evidence (plentiful!):

i. Monkeys: Many visual areas (32+),
half are **retinotopically mapped**
(light up like the retina-- "mind's eye"!)

ii. Tootell monkey study-- radioactive sugar leaves "image" of what the monkey saw

(inner movie screen...!?)

iii. Fox et al humans
central and peripheral vision "light up"
different areas of the brain

iv. visual areas send info'n back and forth
(not modular-- "nearly decomposable subsystems",
like cubicles in rooms of an office building)

v. vision deficits matched with imagery deficits
(blind on one side--> can't image that side)

vi. differences in small-large imagination in brain

...back to implicit-perception critique
(Are S's just reenacting perception during imagery?)

NO--

vii. brain damage patients, missing occipital lobe
--> visual angle shrank (can't "see it" anymore)

Other refs: Kosslyn, Image & Mind, 1994; Glass & Holyoak, Cognition, 1985 (mental abacus).

## Mental geography

Typical distortions in "mental maps":

**alignment/rotation**
know key features of area (e/w, n/s)
align along axis-- "chiropractic alignment"

E.g. Russia above China above India

**geographical superordinates**

larger area has property--> subareas do too
e.g. no part of Canada south of any part of US,
no part of Nevada west of any part of Calif.

**inconsistencies**
three streets form a triangle, but each 90° intersection
composition fallacy-- know Asia a certain size,
but certain areas "uninhabited"

**geocentric errors:**
own country seems larger (Taiwan vs China)

map drawn from own-country perspective

"Americanization" of Asia

**"availability" biases**
countries that are memorable or well-known
loom larger