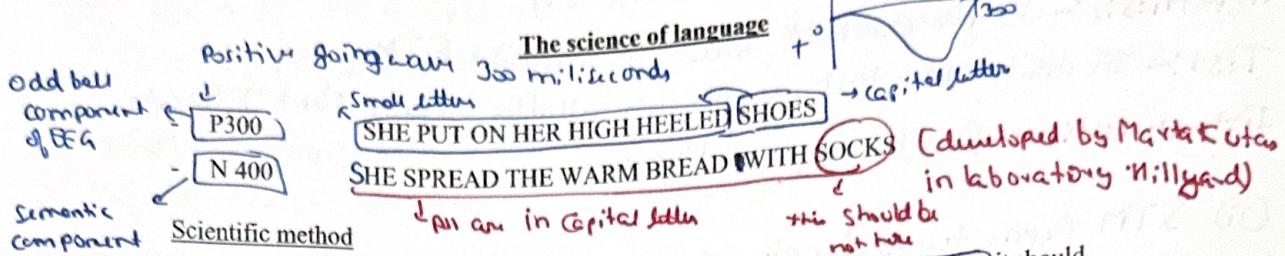


The stimuli of interest is how the brain processes those sentences in which something unexpected happens.

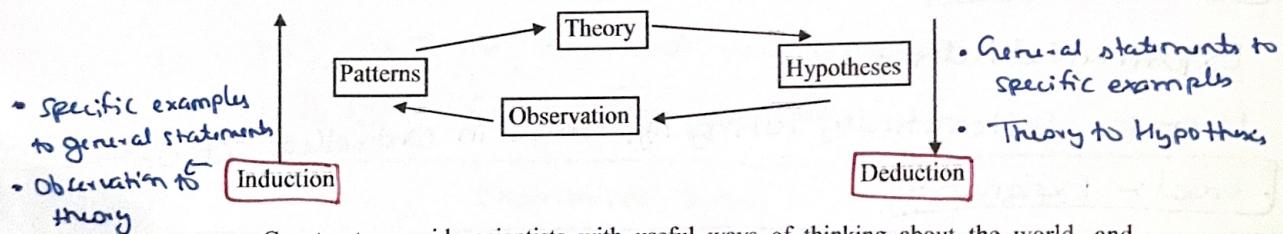
→ If structure will diff the brain gives P300 deflection  
but if meaning will diff the brain gives N400 deflection.

### Chapter-2



- A theory produces a conceptual framework for explaining a set of observations; it should make predictions about future observations that can be tested in experiments.
- A prediction that is derived from a theory is known as a hypothesis; the researcher then collects data to test the hypothesis.
- Hypothesis derived from a theory must have the possibility of being disconfirmed by data; this is known as falsifiability criterion.
- Science has three successive goals:
  - 1) Naturalistic phenomena.
  - 2) Correlation methods find patterns in the data that can be used to make predictions.
  - 3) Experimental methods seek to explain phenomena by testing hypotheses derived from theories.
- Theories are often expressed as models, which attempt to explain underlying mechanism, typically in the form of a graph, a set of mathematical equations, or a computer simulation.

### The research cycles



- Constructs provide scientists with useful ways of thinking about the world, and operational definitions then define those constructs in terms of how they are to be measured; operational definitions meant to both valid and reliable.

### Experiment design

- Hypotheses are derived from a theory by the logical process of deduction; an experiment is then designed to test the hypothesis.
- tightly controlled situation designed to test hypothesis.
- Comparison b/w two groups that are treated differently.

→ Experiment design

## Investigating short-term memory capacity

### (i) STM as no. of items (Miller, 1956)

Hypothesis:- People can hold about 7 items in STM

Test:- In digit span task, people can reliably repeat about 7 digits

Interpretation:- Results support Hypothesis

### (ii) STM Capacity as length of time (Baddeley et al, 1975)

Hypothesis:- People can hold about 2 seconds of info in STM

Test:- People can repeat about 7 short words, only 2 or 3 long words

Interpretation:- Results falsify Miller's Hypothesis, support Baddeley's.

## Methods of Science

### ① Naturalistic Observation:-

- Process of observing & describing a phenomenon
- Goal :- Description

### ② Correlations

- Mathematical techniques that seek patterns in data.
- Goal :- Prediction

### ③ Experimental Method

- Means for systematically testing hypothesis in controlled situations.
- Goal :- Explanation

## Models & theories

### (i) Model -> simplified version of phenomenon under study.

- Typically as graph, set of equation or comp program.

### ② Computer models

- Mimics behaviour under study
- Helps overcome unwarranted assumptions, flaws in logic.

### ③ Model & theory

- Good model lends plausibility to theory
- only data can support or falsify a theory

## Construct

### Constructs

- Label given to set of observations that seems to be related.
- memory, attention, intelligence, personality, even language are constructs.

### Focus

### Operational Definition

- Defines construct in terms of how it is measured.
- Intelligence → score on test
- Short term memory capacity → digit span

## Validity & Reliability

### (1) Validity

Degree to which instrument measures what it is claimed to measure:-

e.g. Bathroom Scale

- (i) Valid for measuring for weight
- (ii) Not valid for measuring intelligence

### (2) Reliability

Degree to which instrument gives consistent measurements for something

- Daily measurement on bathroom scale.

e.g. → 143, 285, 37, 191 → not very reliable

157, 155, 156, 158 → fairly reliable.

## Experimental Design

### (1) Baddeley et al. (1973)

Hypothesis: STM capacity limited by length

Method: Group A repeats short words, not no. of words

Group B repeats long words.

- Experimental group → repeats long words (Test Hypothesis)
- Control group → repeats short words (Replicates digit span task)

### (2) Branford & Johnson (1972)

Hypothesis: Context aids ambiguous story comprehension

Method: Group A sees picture, hears story

Group B hears story, no picture

- Experimental group → sees pic, hears story (Test Hypothesis)
- Control group → hears story, no picture (Baseline)

↳ Visual areas contain both marker & postage stamp

## Experimental & control groups

- (1) Experimental condition → group that is given treatment to test hypothesis.
- (2) Control condition → group that is not given the treatment.  
→ provides baseline for comparison.

## Independent & Dependent Variables

- (1) Independent Variable (IV) → various types of treatment given to different groups in experiment.
- (2) Dependent Variable (DV) → measurement of response each participant makes to the treatment.

Baddely et al. (1975)

IV:— long words or short words

DV:— no. of words correctly recalled

Result → Short word group > Long word group

Bransford & Johnson (1972)

IV:— Picture or No picture

DV:— Subjective Rating of difficulty, no. of items recalled.

Result → Picture group > No picture group

## Lect 2] Experimentation Process

- (1) Formulate Hypothesis → as expected difference in DV b/w groups.
  - Group A Performance > Group B Performance
- (2) Design Procedure → expected to produce hypothesised difference
  - Group A : Treatment
  - Group B : No Treatment
- (3) Analyse data → to determine if they support the data → calculate mean for each group, compare group means.
- (4) Interpret Results → If Group A > Group B, then Hypothesis is supported.  
→ Furthermore statistical analysis may also be required.

- Experiments compare the performance of different groups; the experimental group is given a treatment to test the hypothesis.  
The control group goes without the treatment in order to provide a baseline for comparison.
- An experiment can be viewed as a stimulus-response text.  
IV is the type of treatment or stimulus each group is given.  
DV is a measure of the response each participant makes to the treatment.
- When each participant is assigned to only one condition, we say the experiment has a between-subject design.
- When each participant is assigned to multiple conditions, we say the experiment has a within-subject design

- We express the hypothesis as a greater than or less than relationship between the groups, and if the data go in the predicted direction, we say they support the hypothesis.
- Because there are always alternate explanations for a set of results, no single experiment ever makes/breaks a theory.

Behavioural technique *Psycholinguistics - scientific study of cognitive processes involved in comprehending & producing language.*

- Two important behavioural methods in psycholinguistics are latency and accuracy.
  - a) Latency (reaction time) measures how quickly the participants respond.
  - b) Accuracy may be reported either as the % of correct or incorrect response.
- One commonly used procedure in the psycholinguistic laboratory is the lexical decision task.
- The lexical decision task is an experimental procedure in which the participants see a string of letters and responds, as quickly as possible, indicating whether it is a word or not. *Word trials present strings like TIME or STEM  
not. Nonword trials present strings like MOLE or SPERM*
- Lexical decision task can be used for testing priming effects.
- Priming is an implicit memory process in which recall is enhanced due to previous exposure.
  - a) Associated words (such as doctor and nurse) prime each other.
  - b) Combined with lexical decision task priming can be used to test a wide range of hypotheses about language processing.
- Recall tasks can be divided into four types;

*Latency → Diff. in time b/w presentation of stimulus & initiation of response  
also called reaction time.*

## \* Lexical Decision & Priming Conditions

Condition	Primi	Probe	Response	Latency
(1) Associated	DOCTOR	NURSE	Y	Fast
(2) Unassociated	DOCTOR	TORCH	Y	Slow
(3) Novel	DOCTOR	BANCH	N	Slow

## \* Total Recall

- (1) Immediate Recall
  - No time lapse b/w stimulus & response
  - Tests short term mly
- (2) Delayed Recall
  - Time lapses of several min or more b/w stimulus & response
  - Tests long term mly
- (3) Free Recall
  - Repeat items in any order
- (4) Serial Recall
  - Repeat items in exact order

## \* Primacy & Recency effects:-

- (i) First & last items best recalled
- (ii) Middle items least recalled.

## Implicit without knowing

Implicit learning - Takes place outside of conscious awareness

Artificial grammar learning task (Reber, 1967)

- Learning phase - PS <sup>participants</sup> study list of letter strings
- PS told strings generated from artificial grammar
- Test phase → PS indicate whether novel strings are grammatical or not.

eg) Sample learning it

TTPTXVS

VXVPS

TTXXVPS

VVPXVS

Sample test items

TTXVS ✓

TXVVI X

- \* Two alternative forced choice:-
- Participants must respond yes or no
- "I don't know" not an option

- a) depending on whether the time between presentation and recall is immediate or delayed.
  - b) Whether the order of recall is serial or free.
  - c) The tendency for the first and last items in a list to be recalled best is known as primacy and recency effects.
- **Implicit learning** is a form of learning that takes place outside of conscious awareness.
- a) It is typically tested with a forced - choice - task in which the participants need to rely on intuition to select between options.
- **Head-mounted eye-tracking devices** can be used to record eye movements during reading tasks or for observing how people scan the environment for context cues to aid in discourse comprehension.
- As the general finding is that the eyes do not move in a smooth fashion but rather in a series of saccades and fixations.

### Language and the brain

- In most people language functions are lateralized to the left side of the brain.
- a) Two important regions are **Broca's area** [language production] and **Wernike's area** [language comprehension].
- Subcortical structures such as the hippocampus, amygdala and basal ganglia also play a role in the language acquisition and language processing.
- **Event-related potential (ERP)** are waveforms extracted from the EEG that can track the time course of cognitive processes at the millisecond level.  
Participant ERP components are associated with particular cognitive processes.
- **The N400 is an ERP response to a semantic anomaly and is probably the most commonly tracked ERP component in psycholinguistic research.)**
- Neuroimaging techniques measure brain activity by tracking blood flow.
  - a) The two most commonly used techniques are PET and fMRI.
  - b) For safety and practical reasons fMRI is now far more commonly used than PET.
- ERP and fMRI results are frequently compared.
- **ERP provides excellent temporal resolution, while fMRI provides good spatial resolution.**

### Eye tracking & reading

- (1) **Saccade** → Quick movement of eyes while reading
- (2) **Fixation** → Momentary gaze of eyes on single location
- (3) **Regression** → Movement of eyes back to previously visited locations

Investigation of an Internet Hoax (Rayner et al, 2008)

Language of the brain: What's Inside your Head -

- (1) Brainstem → Interior portion of brain, regulates body function
- (2) Cerebellum → Walnut-sized, behind brainstem, coordinates movement
- (3) Corpus Callosum → Band of fibres connecting left & right hemispheres
- (4) Cerebral Cortex → Outer covering of forebrain, mental function giving rise to consciousness.
- (5) Occipital → Back of Head, processes visual input
- (6) Temporal → Side of head, processes auditory input, object recognition
- (7) Parietal → Top of head, body position, navigation through space
- (8) Frontal → Front of head, motor movement, planning (decision making)  
Traditional long <sup>language</sup> ~~language~~ area
- (9) Lateralisation → Some cognitive functions processed mainly in one hemisphere.  
→ Traditional language in left hemisphere.
- (10) Broca's Area → Left frontal lobe, speech production
- (11) Broca's Aphasia → Halting, effortful speech, good comprehension.
- (12) Wernicke's Area → Left temporal lobe, speech ~~comprehension~~ perception
- (13) Wernicke's Aphasia → "word salad" speech production, poor comprehension.

### What's Underneath

- (1) Subcortical structures → Brain structures located b/w cerebral cortex
- (2) Hippocampus → Temporal lobe, m/y (learning)
- (3) Amygdala → Temporal lobe, emotion (m/y)
- (4) Basal Ganglia → Base of forebrain, procedural learning (routine actions)

Listening to the Brain → measures electrical activity at scalp (EEG)

- (1) Electroencephalography → Records voltage fluctuations at scalp
- (2) Event-related potential (ERP) → Waveform extracted from EEG, signifies cognitive process.
- (3) N400 → Component signaling semantic anomaly  
→ I TAKE MY COFFEE WITH CREAM AND DOG

Watching the Brain

- (1) PET → Positron Emission Tomography → Tracks mildly radioactive substance injected into the bloodstream.
- (2) fMRI → Functional Magnetic Resonance Imaging (fMRI)  
uses magnetic properties to track blood flow

[A common brain imaging technique uses fMRI to track blood flow in the brain under the assumption that regions of heavy blood flow indicate regions of activity]

ERP vs fMRI

Technique	Temporal Resolution	Spatial Resolution
ERP	Excellent	Poor
fMRI	Poor	Excellent