

# Theories of Language Comprehension: India and Beyond

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# Discourse Processing

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- Introduction
- From Syllables to Mental Matrix:
  - (i) Working Memory
  - (ii) Anaphora Resolution
  - (iii) Process of Inferencing

- Models of Discourse Processing:
  - (i) Construction-Integration Model
  - (ii) Structure Building Framework
  - (iii) Even Indexing Model
- Neural Basis for Discourse Processing

# Discourse Processing: Introduction

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**Discourse**= 'Connected Sentences'

- ✓ Originally, it means 'conversation' or 'dialogue'.
- ✓ Literal Meaning: 'running back and forth'
- ✓ Discourse is any sustained linguistic interaction: a paragraph, a chapter, a 500-page novel, a face-to-face conversation, a letter or an email, essays, stories, lectures, meetings, debates, instant messaging sessions...
- ✓ It is a larger linguistic unit of collocated, structured, and coherent group of words.
- ✓ It is also known as: text or narrative.

# Discourse Processing: Introduction

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## **Discourse**

- ✓ 'Coherence' is the central theme that binds the related sentences together into a discourse.
- ✓ Thus, a discourse: makes sense, sentences are relevant and coherent, gives a single idea.
- ✓ Ex: John and Mary went to a birthday party last Sunday. The gift they bought was meaningful in the sense that Bill wanted to have it for four long years from the time he graduated. After spending a whole day with Bill, they returned. They decided to stop by their grandparents on their way back and fix their car.
- ✓ Discourse Processing in Psycholinguistics draws insights from sociolinguistics, anthropological linguistics, and philosophy of language.

# Discourse Processing: Introduction

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## **Intrinsic Features of a Discourse:**

1. **Position:** Opening and ending sentence
2. **Order:** There is a order between the events presented in the sentences.
3. **Adjacency:** Sentences are more meaningful due to the nearby sentences.
4. **Context:** Sentence meaning in discourse can be understood only in the context.

# Understanding Discourse

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1. Discourse goes beyond understanding mere words. Although, **understanding individual words** and **individual sentences** is an absolutely necessary prerequisite.
2. A hearer takes the meanings of the individual sentences and **integrates** them into **a coherent framework** by discovering the links between and among the meanings of the sentences.
3. The information is thus represented mentally in an **elaborate matrix of existing knowledge**, attitudes, and emotional biases we might have about the topic/ writer or speaker/ the reason we are reading or listening to it.
4. This requires an **intricate orchestration** of number of different processes such as storing the information in the working memory, finding references for anaphoric elements, and building inferences...
5. Thus, **Discourse processing is an active cognitive processing.**

# Understanding Discourse:

## Working Memory

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During processing, the words are retained in the memory for a short period of time.

George Miller (1956) in his paper '*The Magical Number Seven, Plus Or Minus Two*' states: people can remember **approximately 5 to 9 bits of information** for short periods of time. He calls this bits '**chunks**'. To form these chunks, first a reader needs to analyze them into units.

Then, Working memory provides a **temporary space** to retain this information (which is known as **Working Memory Span**).

It plays a key role in discourse processing, as it provides a platform for all the ongoing computations that perform different operations while processing a sentence (such as pre-lexical recognition, lexical access, integrating lexical units into syntactic structures...).

Working memory helps in obtaining the basic building blocks of sentence meaning.

# Understanding Discourse:

## Working Memory

When all the individual sentences are processed, a reader now needs to retain and integrate them. Then, he associates that information with extra-linguistic information. All this is stored in **Long Term Memory**. It helps in putting individual sentences to use.

While the information goes to long term memory, three things happen (**Sachs, 1967**):

1. Information about individual lexical items and clause structure is lost. **Only meaning is retained.**
2. **Individual sentences are lost.** Only their integrated meaning is retained. (People recall the gist, not the surface form.)
3. **Inferences are added to** the representations or meanings.

Individual sentences are used to create more **global representation** of meaning.

Human memory works fine in **integrating and synthesizing** the information, but not at keeping individual bits of information.

**Exception:** When sentences carry high interactive content or great interpersonal import, even the syntax is retained.

Ex: *“Can’t you do anything right?”*

Ex: *“After all this time?” “Always!”*



# Understanding Discourse:

## Anaphoric References

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**Anaphor**= An anaphor is a linguistic device that refers to **someone or something that has been mentioned in the previous context**. An anaphor can be either a pronoun or a definite noun phrase (a noun phrase introduced by a definite article).

Ex:

*'John went for a ride across the woods. He has been doing it every Sunday. He also visits a Church after he is done. Meeting with family and friends in the evening really cherishes him.'*

**Co-referencing** = Locating a referent/ antecedent for the anaphor. It is an important task in Discourse Processing. It helps him build a connected, semantically and pragmatically coherent mental representation.

# Understanding Discourse: Anaphoric References

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How does a reader resolve an Anaphor?

To resolve an anaphor, a reader uses both linguistic and non-linguistic knowledge.

*'John and Mary went for a ride across the woods. He has been doing it every Sunday. She wanted to visit a Saint Anthony's Church instead. It is famous for its ambience and musicals'*

A reader pays attention to the **Discourse Focus**. It is achieved by:

1. **Recency** (He → John) (She → Mary)
2. **Long-term focus** throughout the text. (instead= instead of riding)
3. **Main Characters**: here, John and Mary
4. **Proper Names**: here, John and Mary, Saint Anthony's
5. **Position in a prior sentence**: especially, the subject in the previous sentence.

# Understanding Discourse: Inferencing Process

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**Inferencing**= Drawing the information from the text which is not explicitly stated, but is derived from the knowledge of the listener and the information coded in his mental representations.

The formation and storage of inferences is a central feature of discourse processing. Inferencing is '**core of the understanding process**' (Robert Schank, 1976).

Ex: *'My daughter just got married!'* *'Do you like him?'* (him= son-in-law)

Ex: *'We went to a wedding.'* *'The woman wore white.'* (woman= bride)

A reader adopts a **Minimalist view** while Inferencing. This suggests that very few inferences are drawn during the actual process of interpretation. These inferences are constructed by *automated mental processes*. According to this view, inferences will be drawn under only two limited conditions:

1. If there is a need to **establish a cohesion** between two adjacent parts, and
2. If the information is **quicky and easily** available.

# Understanding Discourse: Inferencing Process

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- A reader uses logic, sociocultural norms, and the real-world knowledge of the interlocutors to infer the meaning. These are known as ‘**Scripts**’ (Schank and Abelson, 1977).

Scripts= general scenarios.

The more closer people are socially and culturally, the more ‘shared scripts’ they have.

- Inferencing helps a reader to integrate the upcoming new information into his growing mental representation, i.e., **Global Discourse Structure**.
- It is done more successfully if a reader is **familiar** with the topic.

# Understanding Discourse: Inferencing Process

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Some types of inferences:

1. **Causal:** *The delicate bowl fell off the shelf.* **Inference:** *It broke.*
2. **Bridging:** *Timmy was riding his bike. He came home covered with scrapes and bruises.* **Inference:** *Timmy fell off his bike.*
3. **Instrument:** *The woman stirred her coffee.* **Inference:** *She used a spoon.*
4. **Elaborative:** *Dave ate four pounds of crab.* **Inference:** *Dave likes crab.*
5. **Goal:** *Susan left early for the birthday party. She stopped at the mall on the way.* **Inference:** *Susan wanted to buy a present.*

The general consensus is that bridging inferences are routinely drawn, elaborative inferences are rarely drawn, and causal and instrument inferences are drawn under very limited circumstances.

# Discourse Processing: Theories / Models

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There are primarily three prominent theories or models of Discourse Processing:

- 1) Walter Kintsch's **Construction-Integration Theory**
- 2) Morton Ann Gernbacher's **Structure Building Framework**
- 3) Rolf Zwaan's **Event Indexing Model**

# Discourse Processing

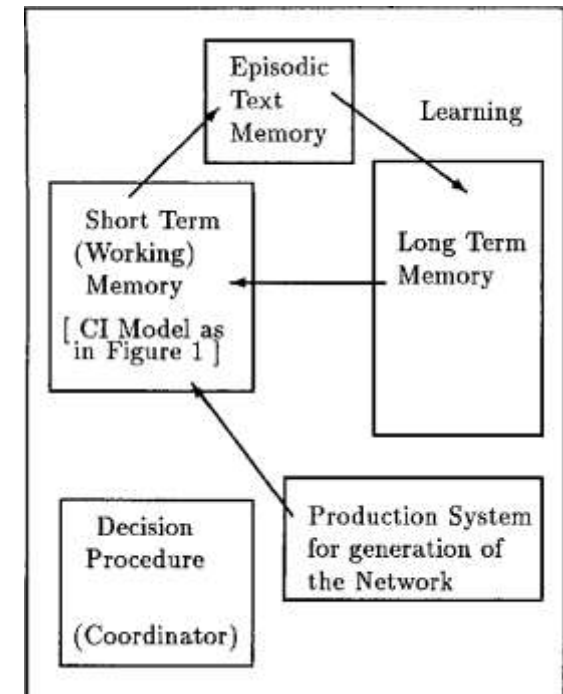
## Walter Kintsch's Construction-Integration Model (1998)

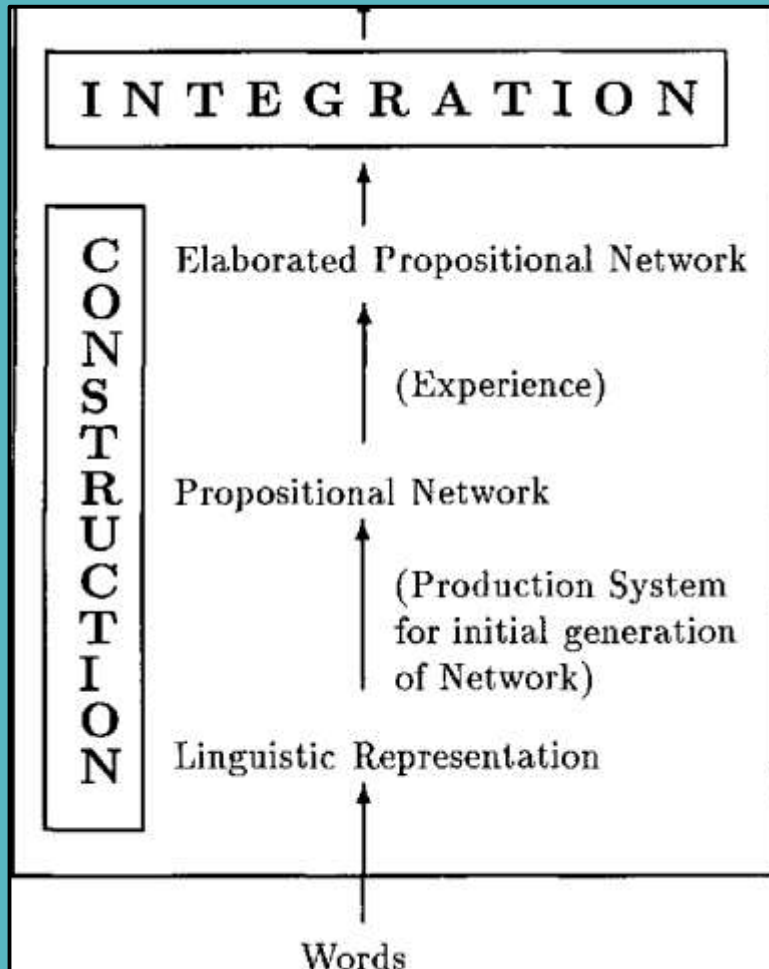
### Construction-Integration Theory

According to this theory, a reader interprets a text by building three distinct kind of mental representations.

1. Surface Model
2. Text Base
3. Situation Model

A reader creates a set of productions that manipulates the content of working memory and builds a coherent, structured model representations that can be stored in a stable form in the comprehender's long-term memory.





## Construction-Integration Theory

**Surface Model** captures the exact words in the text along with their syntax. It is the *least abstract* mental representation.

To build the second model, a reader takes the inputs from the Surface Model, does some work on that input, and outputs a set of propositions that the surface model represents.

The mental representation that describes the propositions represented by the text is called **text-base**. It is *close* to verbatim form of text itself but it does not include the precise wording of the original text- some surface information is lost. It *may* include some information that was not explicitly mentioned in the text.

At the *highest level of abstraction*, readers build a **situation model**. It describes the ideas/ events that the text is about. It is a mental simulation that captures a number of different features of the real or imaginary world. It contains information directly stated in the text + inferred information.

Proposition= a predicate and its arguments (verb and actors)  
Proposition= the smallest unit of meaning that has truth value.



The ultimate goal of the Construction-Integration system is to build a Situation Model that can describe the relevant aspects of what a text is about. At this state, the model uses the **general world knowledge**.

### Experimental Research:

Participants never made mistakes about the Situation Model, they made some mistakes about the specific Propositions in the story, and they often made mistakes about the specific wording of the story. (The surface form representation is fairly weak and decays very rapidly.)

## Construction-Integration Theory

Thus, a text is processed in cycles.

**Construction:** In each cycle, comprehenders input a few propositions' worth of text. Knowledge associated with the inputted text becomes automatically activated.

**Integration:** In this phase comprehenders connect new propositions to previously processed propositions, draw inferences, and update their situation model. Situation model contains '**Tokens**' or *Mental Place-holders*: for characters, objects, and concepts previously introduced by the speaker.

The situation model is the strongest and longest lasting representation, the text-base is the next strongest, and the surface form is the weakest and shortest lived.

# Discourse Processing

## Morton Ann Gernbacher's Structure Building Framework



Professor at the University of Wisconsin-Madison, USA

## Structure Building Framework

Model:

1. To understand a story, readers lay a foundation. The **foundation** is based on the information that arrives first. Just like when we build a house, laying a foundation is the first thing.
2. Two additional processes are used to continue building the structure: **mapping and shifting**. The mapping process connects the incoming information to the foundation as long as it is relevant, and coherent with the earlier information. If not, then the **readers build a new substructure by process of shifting. The branching substructures terminate at the foundation.**

Thus, foundation and appropriate number of connected substructures- represent any mental representation of a story/ picture.

The model applies to both verbal and non-verbal (pictures etc.) materials.

According to Gernbacher, the processes that are responsible for Discourse Processing are also responsible for other cognitive tasks.

## Structure Building Framework

### Summary:

The structure building framework says that we use **general purpose cognitive mechanisms** to process and understand discourse. Comprehenders begin by **laying a foundation**, and then they either **map** incoming information onto the current structure, or they **shift and build** a new substructure.

# Discourse Processing

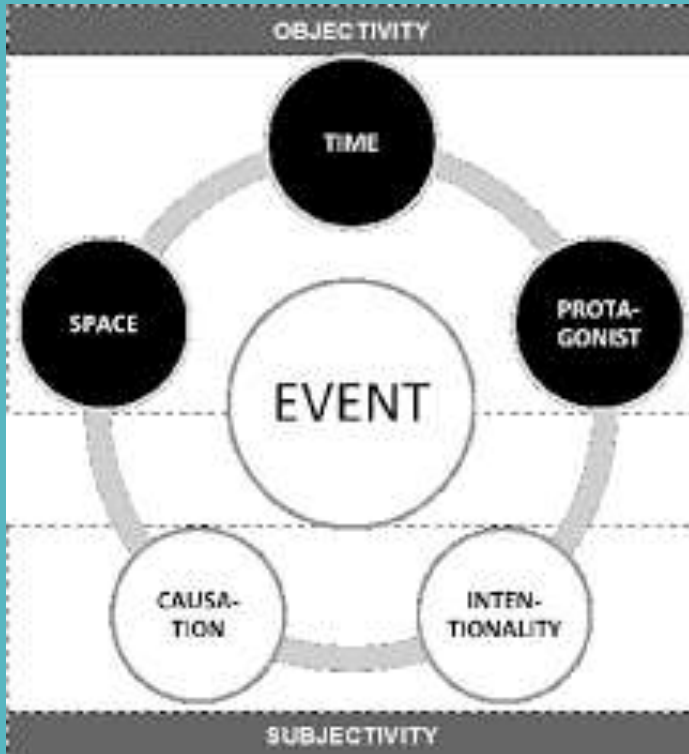
## Rolf Zwaan's Event Indexing Model

### Event Indexing Model:

According to this model, the purpose of the discourse comprehension system is to understand the “goals and actions of protagonists and events that unfold in the real world or some fictional world.”

To represent these story elements, five core aspects of stories are tracked, and each **event** in the story is **indexed** (or tagged) according to each of the five core features:

1. The time frame over which the event occurs (**time**),
2. The characters that are involved in the event (**protagonists**),
3. The causal connection of the current event to preceding and following events (**causation**),
4. The spatial location(s) where the events occur (**space**), and
5. How the event relates to a protagonist's goals (**motivation**).



## Event Indexing Model:

Similar to the structure building framework, the EIM conceptualizes *events as activated memory nodes*.

The representation of a story consists of a *set of memory nodes* and the *connections* between them.

Each *memory node* is coded for the five features, and as each new piece of the text is processed, it is evaluated as to how it relates to previously activated memory nodes.

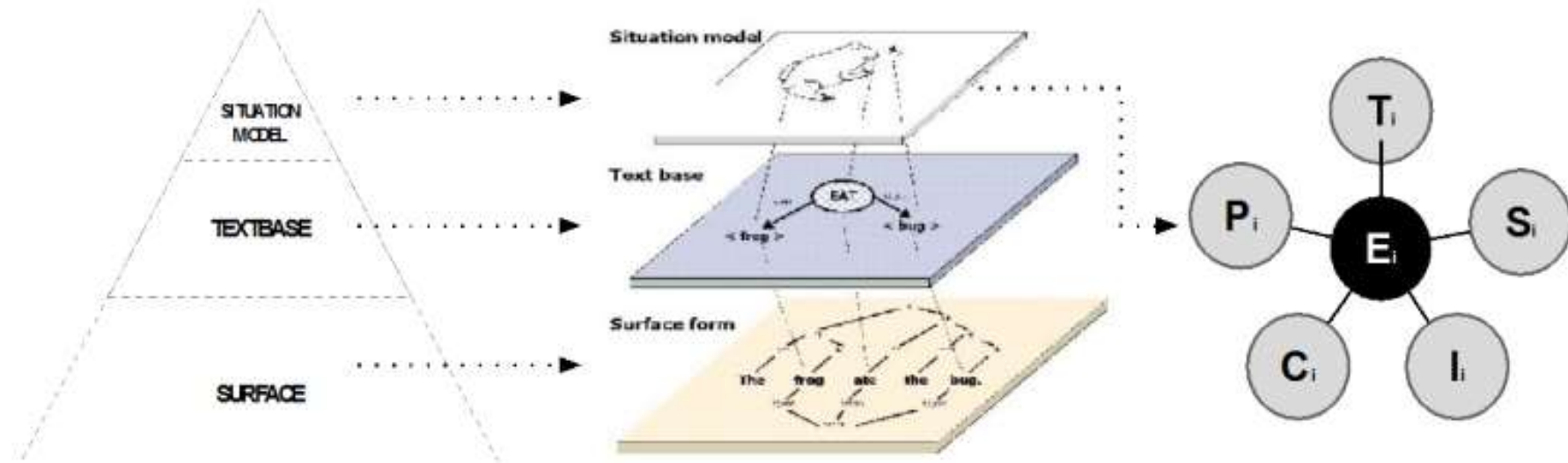
So, each time a new piece of text is processed, the *comprehender updates the situation model* to reflect the information provided by the text. Different pieces of text can require updating of different features of the event index.

Some researchers have therefore proposed that a critical element of discourse coherence and discourse understanding is the discovery of the *causal structure* of the story.

## Event Indexing Model:

Some cues that a reader uses:

- **Virtual proximity:** Objects that are in close virtual proximity to a currently focused character have a higher degree of activation.
- **Temporal Iconicity:** A reader indexes the events in order that they are described.
- **Mental Flip:** If Temporal Iconicity is violated, a reader flips the order of the events mentally. It uses working memory processes.
- **Emotional States:** A reader also indexes emotional states and personalities of the characters and uses them to infer characters' responses in the next events.
- **Tracking Goals:** A reader tracks multiple goals of multiple characters in narratives. This is a sophisticated process. A character is always a central to the narrative. A reader also recognizes when the goals of different characters are in conflict.
- **Causal Connections:** A reader applies a causal connections between propositions. It is the glue that binds the pieces of a narrative together. Also known as, *cohesion*. It contributes to textual *coherence*.



*Figure 1: Multi-layer and multi-dimensional mental representation of text comprehension Three layers of multi-dimensional mental representation during human comprehension and the situation model (Dijk et al., 1983; R. A. Zwaan & Radvansky, 1998)*

Yujie Wang, Daminda Alahakoon, and Daswin De Silva , 2018

# Discourse Processing: Neural Basis

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## Some Evidence:

1. More coherent text produces different brain wave activity than less coherent texts.
2. Left hemisphere: what sentences mean (semantics), right hemisphere: establishing a coherence between sentences, drawing inferences (coherence).
3. Right-hemisphere is more activated when text lacks cues for coherence. (Right Superior Temporal Lobe)
4. Left-hemisphere is also involved in describing causal connections, especially when it requires a bridging inference.



## Key Takeaway:

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- Models of Discourse Processing:
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## Reading Material: (Same as Module 1)

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Extra information (Not covered in the class): <https://www.slideserve.com/cato/discourse-processing>