Chapter 3: Review of Existing Literature

Lateral Dominance

The process of lateralization begins as early as in the 21st month after birth as the left hemisphere begins to assume the sole responsibility for language in 97% of the population [Lenneberg (1967)] and it is formally established during 11th - 14th year. Lenneberg suggested that lateralization was generally irreversible except for the parts of the brain where it was not complete due to some childhood pathology. But there were a series of findings in the history of neurolinguistics which suggested the lateralization strategy of the human brain.

As early as 1836, a French neurologist Marc Dax pointed out that the right ‘hemiplegia’ [‘paralysis of one half of the body’ caused by left hemispheric brain damage as the left hemisphere controls the right side of the body) was linked to the loss of speech. This suggested that the left hemisphere also controlled speech. A French neurologist Paul Broca (1861) analyzed two post-mortem cases where the patients had severe speech deficits and he found out a significant damage to an area just in front of and slightly above the left ear. He then said that this area (now called Broca’s Area, i.e. lower area of the frontal lobe) is responsible for speech. Broca (1865) also reported that the loss of language after brain injury was far more common after left sided injury, supporting the left language lateralization theory.

Carl Wernicke (1874) presented two fluent aphasics’ cases where comprehension was impaired severely with unusual semantic features and “circumlocutions”, i.e. elaborate descriptions for a stimulus but never the stimulus, and the damaged area was the back and

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23 As quoted in Obler and Gjerlow (1999).
Fig. D: Lichtheim's model of language
top, i.e. superior-posterior, of temporal lobe now known as Wernicke's Area. Boston School supports the localizationists.

But not everybody liked the idea of localization. Hughlings Jackson (1878) was among those who differed ['Holist School', who were against the idea of language centre] and commented that there was a difference between “to locate the speech” and “to locate the damage” responsible for speech. Holists were also called “Connectionists” as they suggested how areas in the brain were connected, and thus language, according to them, was a complex activity dependent on different centres in the brain, which were responsible for different cognitive activities, such as memory, thinking, attention etc.

Other leaders of this school were Head and Goldstein. Goldstein (1948) commented that any brain damage would affect the process of thinking and thereby the language processing. Freud (1891) was a supporter of this school and held the view that there was just one aphasia and different symptoms in the types of aphasia could be explained by the proximity of the lesions from the motor/sensory areas.

Ludwig Lichtheim (1885) provided a “Connectionist” model for language and he stressed on the connection between the areas responsible for different cognitive abilities like comprehension, motor planning etc. Since he tried to postulate the centres for different linguistic processes, he no longer is regarded as a Connectionist in the sense of

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24 Norman Geschwind, Harold Goodglass and Edith Kaplan belong to this school “Aphasia Research Center, Boston”. Geschwind is generally credited with bringing the German neurolinguistic literature to the modern neurolinguistic thought.
25 Freud was 35 when he produced the monograph “On Aphasia” and he was influenced by the Darwinian theory of evolution and by the writings of Hughlings Jackson.
26 Freud’s view “On Aphasia” had very little of positive significance as he himself expressed his indebtedness to Jackson for his idea on aphasia. Head (1926) also ignored his name in his historical survey, Volume I.
27 The site of aphasia, according to him, was a “continuum cortical region which includes the space between the terminations of the optic and acoustic nerves and the area of the peripheral motor nerves” in the left hemisphere.
28 In neurolinguistics two major schools exist broadly – 1. Localizationists & 2. Holists. The Holist school includes the Connectionist approach. Obler & Gjerlow (1999) give a new label – “Interactionists” which again is included under the Holist umbrella. Earlier the Connectionists were associated with the Localizationists as they postulated language centres and arrows between them that connected them, e.g. Lichtheim (1885), but now they are called “Classical Connectionists”, who do not belong to Connectionism.
Holism. Rather his model is termed as a “Classical Connectionist” model which is associated with Localizationism.

Obler & Gjermøw (1999) supply a new label – “Interactionists”, which they hold synonymous somehow with the label of “Connectionists”. Interactionists hold the view that there are no areas in the brain “entirely ‘responsible’ for language, or even ‘dominant’ for language” against the areas with no language functions at all. The whole brain contributes to the language abilities.

Cognitive scientists working in the area of computational linguistics designed the model of brain processing along the Holist line of approach – Parallel Distributed Processing (PDP)\(^\text{29}\), which has three major principles –

1. The representation of information is distributed and not local;
2. Memory and knowledge for specific things are stored in the connection between units; &
3. Learning can occur with gradual changes in connection strength by experience.

The major components of this neurally inspired information processing model are – a set of processing units, a state of activation, an output function for each unit, a pattern of connectivity among these units, a propagation rule for propagating patterns of activities, an activation rule for combining the inputs, a learning rule whereby patterns of connectivity are modified by experience and an environment within which the system must operate [Rumelhart et al (1986)]. It says that even if there is a breakdown of one of the pathways or structure we still get some output devoid of the breakdown. We can witness the similar processes in the actual neural networks as despite the brain lesion we find some language output in an aphasic patient.

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\(^{29}\) A modern Connectionist Theory which says neither words nor sentences are actually instantiated in any given area of the brain, but they are energized to a threshold and the one that wins out by going over the threshold first is activated.
Exception (Anti-Lateralization) Studies & Reports

However, there have been some studies which do not conform to the theory of lateralization and which advocate the right hemispheric representation for language as well.

In order to stop the spreading of the infection in the cases of severe epilepsy, it sometimes becomes necessary to sever the major links between the two hemispheres. Gazzaniga et al (1967) & Gazzaniga (1983) studied these patients and found that both the hemispheres behaved like separate brains, each coping with the one half of the body independently. An object shown to left eye could also be named, so the right hemisphere also has some language capacity. But the point of the dispute was that in these Split-Brain cases, despite the cutting of the main connections, the back route still existed, which might be the cause of the right hemispheric language processing.

Milner et al (1964) claimed to have found 10 patients whose speech abilities were present in both the hemispheres. The Sodium Amytal test disturbed the speech irrespective of whichever carotid artery it was injected. Incidentally, all these patients were either left-handed or ambidextrous. Kinsbourne (1980) reported that even in the absence of the left hemisphere, patients were able to acquire a limited vocabulary and a certain comprehension; but they faced difficulty in speech production. Caplan (1987) found that the patients with right hemisphere damage have difficulty with intonation, and in understanding jokes and metaphors. But there have been loopholes in either the approach or methodology of the above mentioned studies.

Aphasia Batteries

There are no universally accepted definitions of syndromes arising from brain damage and no test is so productive an aid for the description or quantification of communication.

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30 In 'Commissurotomy' the main inter-hemispheric connections are severed. This was developed in the 1940s and 1950s to manage the infection of severe epilepsy.
31 Split Brain patients, who behave normally, with occasional reports of dissociation of behavior of the left and the right sides of the body.
disorders. Despite the presence of formal test batteries for the assessment of language disorders there are none which are broadly used and therefore they are insufficiently standardized. There are considerable similarities and significant differences among the different tests. Almost all the batteries operate on the four modalities of language – repetition, reading aloud, speaking and comprehension (both auditory and written) – and all provide information on the interpretation of the results but at the same time they differ in rationale, interpretation, scoring and comprehensiveness.

Examination for Aphasia by Eisenson (1954), is a medium length test divided into expressive and receptive functions. The premise is that aphasia is the impairment in the patient’s ability to handle situations involving internal and external symbol processing. The Language Modalities Test of Aphasia (LMTA) by Wepman & Jones (1961) and Minnesota Test for Differential Diagnosis of Aphasia (MTDDA) by Schuell (1965) were presented for general use and were similar in that aphasia is viewed as a unitary disorder which may be complicated by other communicative deficits. LMTA assesses calculation too in addition to the four modalities of language while MTDDA assesses auditory disturbances, visual and reading disturbances, speech and language disturbances and disturbances of numerical and arithmetic processes. The Porch Index of Communicative Abilities (PICA) by Porch (1967) takes less time to administer than many of the formal aphasia batteries and can be repeated with excellent test-retest reliability.

Boston Diagnostic Aphasia Examination (BDAE) by Goodglass & Kaplan (1983) provides the widest range of evaluation techniques and requires the knowledge of the system of aphasic syndromes (which is not totally accepted). Western Aphasia Battery (WAB) by Kertesz & Poole (1974) is a shorter language evaluation based on BDAE and varies from it in that results are expressed in quotients. These two test batteries mainly concentrate on auditory comprehension, repetition, reading aloud, writing to dictation and copying the written/printed text.

The Aphasia Language Performance Scales (ALPS) by Keenan & Brassell (1975) are time consuming and limited by space and environmental restrictions. The tests are
composed for four scales - listening, talking, reading and writing - purported to be independent of one another.

A syndrome need not have a coherent interpretation in terms of the underlying cognitive structures or processing, rather it is based on the statistical reliability of the co-occurrence of the symptoms. It is futile to know the syndrome in the experiments of cognitive neuropsychology and particularly in neurolinguistics. A syndrome may be clinically important and significant in the diagnosis of the patients and may further be useful in the prediction of the treatment course and its outcome. These can be of use again in neurological studies if they are informative with respect to physical proximity of the functional areas in the brain. In practice brain damage rarely impairs a single processing unit, while completely sparing other processing units of the whole system. Mostly the situations are typically complex. There cannot be a one-to-one relationship between cognitive damage and the anatomical impairment in the brain as there cannot be two similar cases of impairment and it is impossible to strictly demarcate the area for a certain cognitive ability. Therefore the issue of whether the local damage to a brain area selectively impairs a specific cognitive function is critical. So the notion of a syndrome has no potential for theoretical research in the domain of the cognitive neuropsychology and neurolinguistics, rather it can add to unjustified conflicts.

But using the tests of these standardized aphasia batteries becomes a problem in developing countries where the literacy rate is very low compared to the countries where these batteries are developed. Therefore using these for people across the board will result in massive errors which can always give wrong conclusions about the aphasia quotient which these batteries provide. And anyway, the rationale of these batteries can always be questioned in such studies - which do not need standardized batteries and their statistics for the analysis.
Morphological Representational Models & Deficit Studies: An Overview

I. Morphological Representation and Processing

Two competing models of morphological processing and lexical access have been in the debate –

a). Taft & Forster (1975)'s "Affix Stripping Model", according to which words are broken into their components, i.e. morphemes, for their processing in the mental lexicon. Each morpheme is individually listed in the lexicon.

1. Recognition of affix & Its removal for lexical search
2. Lexical search for the root
3. Recombination of root & affix after the recognition of the root

Taft (1979) reported that not only prefixed but suffixed words also undergo affix stripping analysis, but the question remained – 'what happens to the base which changes the shape after the affixation'. So the method is economical only for non-changing bases. Taft (1988) again reported that pseudo-prefixed words take longer to be recognized as they are initially misrecognised as 'prefix + stem'.

b). Butterworth (1983)'s "Full Listing Model" of lexical representation and processing which maintains that full words, not decomposed words, i.e. decomposed into roots and morphemes, are represented in the mental lexicon.

In between, several mixed and specific models have also been proposed. K. Patterson (1982) reported that morphemes, bound morphemes and complex forms [morpheme + bound morpheme / morpheme + (morpheme + bound morpheme)] are listed separately. Tyler & Wessels (1983) maintained the Full Listing hypothesis and said that words are represented as base morphemes with inflectional & derivational markers attached, as the
phonological change in the root after the affixation won’t allow the access to the root morpheme.

In Caramazza et al (1985) "Address Morphology Model", there are two access procedures for reading morphologically complex words – Morphological Parsing Address Procedure and Whole Word Address Procedure [both of these constitute "Lexical Address System"].

I
II
III
Output of real words activates pre assembled lexical forms pre-assembled whole word phonological form

Marslen-Wilson, Tyler, Waksler, and Older (1994) and later Wurm (1997)\textsuperscript{32} are of the opinion that decomposition of the words is more likely in the cases where the relationship between an affixed word and its root is semantically obvious. Ito, Sugioka, and Hagiwara (1996) maintained that only regular prefixes are attached and therefore decomposed by rule. Colé, Segui and Taft (1997) suggested a modification in the Full Listing Hypothesis that listing of the suffixed words and their roots would depend on the lexical frequency. Waksler (1999) argued for the “Dual Listing (Route) Model” of lexical representation [Pinker (1991), Frauenfelder & Schreuder (1992)] in which some whole words and some individual morphemes are listed. Penke, Janssen & Krause (1999) also argued for the Dualistic\textsuperscript{33} representation of inflections. They further suggested a modification in the model that ‘both regularity and irregularity are better

\textsuperscript{32} As quoted in Vannest & Boland (1999).

\textsuperscript{33} Dualistic models assume a qualitative distinction between affix based regular forms and stored irregular forms and any one of these can be selectively impaired in language disorders. The existence of a direct access route for whole word and that of a morphological decomposition route to deal with the problem of novel words and non-words for which there are no lexical entries – are assumed.
conceived as scalar' properties. This model is also compatible with the psycholinguistic implications of cross-linguistic evidences, since lexical items are fully listed in it.

Based on Kiparsky (1982)’s “Lexical Phonology and Morphology” (in which the difference of the levels of the attachment of the affixes is based on proximity to the root and interaction with the phonological processes and their productivity) Vannest & Boland (1999) suggested that the only productive, phonologically neutral, semantically transparent Level 2 suffixes are decomposed for analysis, but the words with idiosyncratic, structure changing, semantically invisible Level 1 affixes are not. Ullman (2001) argues for supporting the “Declarative/Procedural Model” of language after examining the psycholinguistic and neurolinguistic evidences. He presents a mental model of morphology and the computing components, which have distinct computational, cognitive and neural bases, including a memory system and a rule system.

The strong lexicalist hypothesis (for morphological representation) posits an existence of an autonomous morphological component consisting of a set of listed items and a set of word-formation rules and principles & both inflectional and derivational operations take place in this component. The internal organization of the mental lexicon is in terms of morphological families – the listing of the morphological related items could either be

34 Level 1 and Level 2 are parallel terms for Class I and Class II [Siegel (1979)] and the differentiation between these two is based on their phonological and morphological properties - that Class I [-ity, -ous, -ion, -ive etc] suffixes trigger and undergo phonological processes while Class II [-ness, -less, -hood, -ful etc] suffixes are inert and their respective word boundary notations are ‘+’ and ‘#’. According to Mohanan (1986), only Level I affixes can attach to bound stems.

35 The lexicon/grammar distinction in language is tied to the distinction between two well studied brain memory systems – Declarative memory and Procedural memory systems. Morphological transformations can be processed by either of the two brain systems. The declarative system underlies the learning and computation, i.e. retrieval, of at least those transformations that involve phonologically overt changes, but do not involve any overt morphological sequencing, e.g. dig-dug. The procedural system underlies the learning and computation of at least those transformations that are fully productive, i.e. local or global defaults, and that only involve morphological sequencing, e.g. laugh-laughed.
in a satellite like structure, i.e. items around a nucleus [Lukatela et al (1980)] or items under a head, possibly a root [Jarema & Kehayia (1992)].

Another influential model of language is proposed by Garrett (1975, 1992). This is based on her analysis of speech errors produced by normal speakers and a set of three distinct serially constructed levels of representations are posited prior to the generation of articulatory code.

1. **Message level**: Prelinguistic level of speaker’s intent.
2. **Functional level** [Lemma]: Semantic and thematic information without one-to-one correspondence to language surface structure. Here retrieval of lexical items takes place without the actual specification of a particular word.
3. **Positional level**: Output of syntactic and morphological processing resulting in language surface structure [formed by separate processing of phonological retrieval, assembly, and representation of lexical items specified at the functional level].

William Croft (1998) points out the notions of grammatical and semantic idiosyncrasies as the excluding factors for mental representation models. Dominiek Sandra (1998) in her reply to Croft (1998) raised a linguistic fallacy stating that linguists are more likely to express / confess a belief rather than to prove a point.

**Distributed Morphology** (DM) is a theory of the architecture of grammar proposed in Halle & Marantz (1993, 1994). Throughout early 1990s there have been contributions from several researchers in this area. There are three core properties: Late Insertion, Underspecification, and Syntactic Hierarchical Structure All the Way Down. In Late Insertion the basic hypothesis is that the phonological expression of syntactic terminals is in all cases provided only after syntax, i.e. in the mapping to Phonological Form (PF) and till then syntactic categories are purely abstract without any phonological content. After PF, these entries, called **Vocabulary Items**, are into the process called Spell-Out. Underspecification means that vocabulary items with PF may not be provided with the syntactic information, for example, about their position in a sentence. So a word with PF
doesn’t supply the morpho-syntactic features. Syntactic Hierarchical Structure All the Way Down entails that elements within syntax and within morphology have the same type of constituent structures such that they can be diagrammed through binary branching trees. DM is piece-based (model of morphology) in the sense that elements of both syntax and morphology are understood as discrete. There is no lexicon in DM in the sense of generative grammar of the 1970s and 1980s, e.g. the Lexicalist Hypothesis36 and this aspect of DM is an intriguing but a central component of the theory. The internal structure of items can be produced at the level of syntax and post-syntactically in a component called “Morphology”. Morpheme, a morpho-syntactic representation, refers to a syntactic/morphological terminal node and its content consists of syntactic and semantic features from Universal Grammar.

The different ‘parts of speech’ can be defined as a single f-morpheme type, called Root, in certain local relations with category-defining f-morphemes. For example, a ‘noun’ or a ‘nominalization’ is a Root whose nearest c-commanding f-morpheme is a Determiner. In DM, since “Dissociated Morphemes”37 can be inserted after Syntax, not every morpheme corresponds to a syntactic terminal. f-morphemes are typically not idioms38, but f-morphemes are always idioms. Spell-Out, also called Vocabulary Insertion, works differently depending on what type of morpheme is being spelled out, f-morphemes or l-morphemes. The distinction between inflectional and derivational morphology has no explicit status in DM. However, DM does distinguish between f-morphemes and l-morphemes (not all f-morphemes would normally be considered 'inflectional' however) as well as between syntactic and non-syntactic (dissociated) morphemes.

36 The Lexicalist Hypothesis states that the principles that regulate the internal structure of the words are different from those that govern syntactic structure/domain [Chomsky (1970); Jackendoff (1975) & Anderson (1988), as quoted in Katamba (1993)]. Unlike the lexical rules, the syntactic rules don’t change the word-classes and they have access to the output of both lexical and syntactic rules. Also the rules of syntax have no paradigms.

37 Morphemes such as ‘passive’ or ‘case’, which do not figure in syntax proper, can be inserted after syntax but before Spell-Out. These morphemes, which only indirectly reflect syntactic structures, are called “Dissociated” morphemes [Embick (1997)].

38 The term idiom is used to refer to any expression (even a single word or subpart of a word) the meaning of which is not wholly predictable from its morphosyntactic structural description.
"Word–Network Model" by Singh & Agnihotri (1997), focused on Hindi morphology, derives its spirit from the ‘dynamic European’ concept of the morpheme. They negate the distinction between inflection/derivation, productive/non-productive, clitic/non-clitic, concatenative/non-concatenative etc. and are of the opinion that only words should be the object of inquiry in any morphological operation. There is no segmentation operation to create any intermediate level between morphology and phonology. Therefore, morphophonology is not separable from morphology. They have denied the concepts of root, lexeme, morpheme etc. and considered only word and word-parts as the basic units of analysis, where word-part may or may not correspond to morpheme as their idea of the concept of morpheme is process-oriented [Kurylowicz (1960)] where the question of meaning is not relevant and therefore their word-parts, associated with specific Word-Formation Strategies (WFS), may or may not have meaning.

“Units smaller than the word are available to the speaker” but as “operational inputs” and not as lexical objects (lexemes, morphemes, roots etc.). These word-parts won’t have any lexical status outside the WFS in the lexicon. That is why these are specific to certain WFSs. This helps a speaker manipulate the formation of new non-actual words also besides the actual words. Since the Word–Network Model of morphology doesn’t rely on the morphological units smaller than words, the directionality constraint is not imposed and therefore a native speaker has the liberty to approach a given word in terms of word formation strategies and the assumption is always bidirectional – so there is nothing like rising from a simple to complex form, no concept of derived forms. Therefore, there are words which exist and there are WFSs which exist among the words. The strategy is not “linear” or “additive” – so the process could be “adjunction” from one end of but then it

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39 Word as the basic unit of morphological analysis and network is for the morphologically related words, including complex words.

40 The active part which participates in the process of word formation and the factor of meaning attached with the notion of the morpheme was not relevant, as said in Singh & Agnihotri (1997).

41 Morphological strategies or Word Formation strategies are used for the rules for the relatedness among the words in the lexicon. These allow a speaker to analyze a word morphologically he or she may not have analyzed before or to create a new word he or she may not have in the lexicon. These are adjunction, substitution and deletion.
would look "deletion" from the other end. Therefore there is no difference of level in
terms of access – all the related forms are equally accessible to the speaker. This model
completely dispenses with the notion of abstract forms in morphology, unlike the
American or Paninian school which assumes the abstract form, which is not a realized
form but an abstract form from which different forms of the paradigm are derived. It
talks of word-parts which also exist but not outside the WFSs as they won’t be having
any lexical status. But it accepts that they may or may not have meaning. They are not
independently placed and that is why not available to a speaker.

This model further suggests that learning a plural form will give access to its
corresponding singular, gender marked forms, cased forms and exposure to any verb is
enough to master the whole paradigm woven around this. The implications which these
proposals make are:

a) all related word-forms are placed in the lexicon and are connected to each other
via specific WFSs.
b) WFSs carry word-parts as operational agents
c) If one form is available to a speaker, he or she will know all the other related
forms, including the forms which change shape due to adjunction of word-parts.

In a morphological operation like

\[
\begin{align*}
  k^b a & \quad \longrightarrow \quad k^b \text{ana} \\
  \text{eat (verb)} & \quad \text{eatable (noun)}
\end{align*}
\]

According to Arnoff (1976), the noun is derived by a suffixation to the verb. According
to Kiparsky (1982), both forms are derived from a third unique abstract form, which
would be “k^b a” (distinct from the attested verb k^b a ) in the above operation. Singh and
Agnihotri (1997) do not consider the notion of abstract forms. According to them, since
the forms of the unique abstract roots are not legal in the language, no speaker will
recognize them. For them there are two basic bidirectional WFSs – adjunction and
substitution.

\[
\begin{align*}
  X & \quad \longrightarrow \quad X A \\
  X A' & \quad \longrightarrow \quad X A''
\end{align*}
\]
II. Morphological Deficit Studies: A Review

Neuropsychological studies support the hypothesis that morphology is represented autonomously, both at the level of word meaning and at the level of word form. In output processes, morphologically organized semantic information activates lexical representations of roots and affixes, which are composed before production. In input processes, the stimulus is parsed along the morphological dimension, to access root and affix lexical representations, which in turn activate morphologically organized semantic information. Inflectional and derivational morphology are represented independently in the lexicon. Inflected words are fully decomposed; derived words are decomposed into base form + inflection or the other contention is that they are represented in full wordforms.

Morphological paraphasias in language impairment are prominent in clinically defined disorders of sentence-production — agrammatism and paragrammatism. These impairments have been attributed to phonological factors [Kean (1977)], semantic factors [Warrington & Shallice (1984)]; Nehru et al (1999d&e); and Nehru & Ranjan (2001)], components of on-line sentence processing [Tyler et al (1990)], and disconnection within the grammar [Grodzinsky (1985, 1986)] etc.

Nehru et al (1999d) reported a polyglot female Broca’s aphasic having semantic error selectively on one language while it was preserved on other languages. The implications were indicative of two separate lexical processing representations. Nehru et al (1999 e) presented a clinically diagnosed Broca’s aphasic who exhibited highly selective semantic category deficit, couldn’t name vegetables, either naming them incorrectly or presenting names of fruits instead. Nehru & Ranjan (2001) presented a female Broca’s aphasic whose paraphasias were limited to the semantic field of the stimuli. The relationship

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42 A speech error associated with aphasia and dementia in which one open class substantive is substituted for another.
43 These are the symptoms of aphasia whereby function words and inflectional morphology are either omitted or substituted. Traditionally agrammatism and paragrammatism are used for omission and substitution respectively.
44 One of the pioneer dissociation-based studies showing category-specific dissociation within the non-living things – access to the category of musical instruments and gemstones was impaired.
between the stimuli and responses revealed semantic relationship of hyponymy, synonymy, antonymy etc.

All these proposals have got practical truth in them as has been witnessed in single word production tests in various language modalities while studying cases of language disorders. There is another type of morphological impairment – Comprehension Impairment, as there was failure in differentiating between forms which are morphologically related [Tyler et al (1990)].

The study of morphological impairments is important as it gives an opportunity to explore the cognitive mechanisms underlying lexical processing. A variety of morphological impairments have been reported in the past two decades by the researchers in the field. Miceli & Caramazza (1988) placed evidences for the lexical distinction between inflectional and derivational morphology in an Italian speaking patient. This inflection-derivation dissociation has also been exhibited in the impairments on polymorphic nouns in patients speaking Finnish, a highly inflected language [Laine et al (1994, 1995)], and Hindi speaking patients [Ranjan (1998); Nehru & Ranjan (1999 a&b)].

Ranjan (1998) reported cases of impaired inflectional morphology and spared derivational morphology. He also presented a dissociation between number and gender inflectional morphology on nouns in both single word and sentence processing. His cases included both Broca’s and Wernicke’s variety. Patient M.S. very selectively showed a dissociation within number inflectional morphology. Advancing on the claims about autonomous morpheme representation made by Nehru & Garg (1997) and Ranjan (1998), Nehru & Ranjan (1999 a&b) discussed two cases who showed dissociation between gender and number inflectional morphology and also within number and gender inflectional morphology.

Nehru & Garg (1997) reported a case in whom number was more impaired than gender. While talking of the nature of the morphological representation in Hindi, they commented on the number and gender inflectional markers and the degree to which these are prone to be impaired.

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Nehru et al (1999c) presented a 37 years old female patient who preserved the ‘-s’ morpheme as plurality marker but her ‘-s’ morpheme as present tense marker was impaired. The implication was an emphasis on autonomous morpheme representation. Ranjan et al (1998) presented another case of crossed aphasia who exhibited the dissociation between number and gender inflectional morphology.

Morphological paraphasias may result in potential word-forms but there are instances where the morphological paraphasias do not preserve lexicality at the level of morphotactics. But there is one lexicality constraint on morphological errors in spoken modality – morphological paraphasias conform to the phonotactics of the language in question [Grodzinsky (1990)]. The well-formedness of φ-inflection forms in a language will decide the nature of morphological errors – English, which has φ-inflected forms as valid forms, will have morphological deficits as affix-deletion errors [boys-boy-φ]. These deletion errors are absent in languages [Hebrew, Italian, Greek, Hindi etc] which lack φ-inflected forms and in which affix-less stems are not legal. Instead, inflectional substitutions were witnessed in Hebrew [Grodzinsky (1984)], Italian [Miceli et al (1983)], Greek [Kehayia (1990); Kehayia et al (1990)] and Hindi [Ranjan (1998), Nehru and Ranjan (1999 a&b)].

Andreewsky & Seron (1975) further examine the premise that an agrammatic’s speech is the output through a “syntactic filter” allowing “only nouns, verbs and adjectives to pass”. They tried to examine the nature of this filter in the processing of the grammatically ambiguous words. They displayed that the syntactic role of the words in a sentence is important and that oral reading is not simply a concatenation of isolated words but that a rather implicit context-sensitive analysis decides this production. Stanners et al (1979), using a priming method, found a distinction between derived forms and inflected forms and they concluded that only base forms of regularly inflected verbs are represented in the mental lexicon. Inflectional affixes are stripped from the stem in word recognition process. It doesn’t happen in the case of derivational affixes as
derived words are represented in their full forms in the mental lexicon [as quoted by Libben (1988)].

**Friederici et al (1982)** state the controversial nature of agrammatism that it is not only a "production deficit" but also an "impairment of comprehension". They examined 6 Broca's and 6 Wernicke's aphasics for testing the processing of the prepositions in different linguistic tasks (variety of emphasis on the use of syntactic knowledge). In the sentence completion tasks (where correct performance depended upon the knowledge of syntactic forms), the patients exhibited similar capacity in both production and comprehension. They thus supported the view that agrammatics generally lack the capacity to process syntax -- "sentence structure". **Bates et al (1987)** found that both Wernicke's aphasics and Broca's aphasics seemed to be significantly impaired in the production of grammatical morphology. Broca's aphasics were more likely to omit than substitute articles and their substitution error tended to derive from the avoidance of syntactic complexity. Wernicke's aphasics were more likely to substitute than omit articles and their substitution errors reflected their derailed efforts for more complex and morphologically marked constructions. This agrammatism/paragrammatism distinction doesn't work well for richly inflected languages (they investigated English, Italian and German speaking patients). **Goodglass et al (1993)** compared two speech elicitation techniques for their ability to characterize syntactic competence in aphasic patients. 7 Broca's aphasics and 7 paragrammatic conduction aphasics were evaluated on a free narrative story elicitation test and on a structured cross-modal morphology and syntax battery. Agrammatics showed inferior use of auxiliary verb inflection and passive word order. They suggested that the agrammatic production errors are independent of comprehension errors.

**Pierce (1982)** supported the view that aphasics have difficulty in comprehending the sentential information that relies on the processing of syntactic information. He further stated that aphasics tended to reduce the number of decoding strategies and over-apply a general strategy based on a canonical word order and present tense structure. Sentence comprehension impairment strongly implicate morphological deficits. **Pierce (1983)** further investigated that the syntactic processing was impaired in both the modalities –
listening and reading — and the aphasics applied a strategy based on a subject-verb-object present tense construction during both the modality tasks. Patient D.E. [Miceli & Caramazza (1988)] was found to be selectively impaired in processing inflections in normal speech comprehension.

In Grodzinsky (1984), the Hebrew speaking patients simply didn't omit the vocalic prosody that corresponds to the verb's inflection. But mere unpronounceability is not the criterion, as the permissible (phonemic) strings also are not considered in the lexicality constraint. Its nature regarding governing of aphasia production is yet to be investigated in details. Miceli et al (1984) reported double dissociation between production of nouns and verbs in agrammatic patients (verbs worst than nouns) and anomic patients (nouns worse than verbs).

Bhatnagar & Whitaker (1984) described a Hindi speaking aphasic who exhibited greater difficulty in producing inflectional bound morphemes than function words, while still retaining metalinguistic judgment to differentiate function words with semantic content, e.g. post-positions which mark case functions in Hindi. The patient, due to the impaired inflectional bound morpheme production, showed difficulty in the retrieval of the verbs also. Tyler et al (1990) reported a patient B.N. who exhibited a more pervasive morphological impairment and, in this, he showed insensitivity to both syntactic ill-formedness (based on the use of inappropriate inflected/derived forms) and lexical ill-formedness.

According to recent theories of sentence production [Garrett (1982)], agreement errors, i.e. morphological paraphasias can result from deficits to sentence processing mechanisms while single word processing remain unimpaired. Caplan (1994) suggested that the order of acquisition is usually the order of impairment. Jarema & Kehayia (1992) showed that morphological deficits can manifest at distinct levels of grammar selectively (rather than getting affected across the levels of grammar), i.e. lexical and

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46 They also reported that the internal morphological structure and idiosyncrasies of the lexical items also affected the aphasic's performance.
post-lexical levels. They were working on a presupposition (pre-investigated) that morphology can be selectively spared or impaired in aphasia. Vakareliyska (1993) provided evidences for the existence of an underlying sentence-initial subject slot for Bulgarin null-subject personal construction. The Bulgarian patient tended to insert a superfluous sentence initial pronominal subject in response to the sentences that contained no lexical subject.

Haarmann & Kolk (1992) studied patients of Broca’s and Wernicke’s aphasia and found evidences for the hypothesis that Broca’s aphasics and Wernicke’s aphasics show the same underlying impairment in the production of grammatical morphology. Also, there is no significant difference in the absolute level of performance of Broca’s aphasics and Wernicke’s aphasics. Furthermore, it was seen that they showed the same relative contribution of within and across-category substitution of free morphemes. But in the case of bound morphemes, Broca’s aphasics substituted within the category while Wernicke’s aphasics substituted across the category.

Luzzati and Bleser (1996) suggested that with respect to the inflectional morphology of simple and derived nouns, the morphological features of gender and number are almost fully preserved along with derivational suffixations. But at the level of syntactically generated phrases and choice of function words for the construction of prepositional compounds was severely impaired, pointing to a problem in morphosyntactic processing as a factor contributing to agrammatic speech production.

Bastiaanse (1995) reported a patient of Broca’s aphasia who had two distinct speech styles — one with mild syntactic deficits and other with severe morphological and syntactic deficits. His understanding of the problem is that the distinction between the syntactic and morphological agrammatism is due to an impaired choice of strategy, i.e. impairment to the “Grammatical Encoder” [Levelt (1989)]. Friederici et al (1992) investigated Broca’s aphasics and found that they were, like normal people, sensitive to the presence of contextually incorrect inflection but unlike them, they were not sensitive to the absence of an obligatory inflection even when its presence was syntactically highly
constrained. So they claimed that these aphasics were unable to process the full syntactic information encoded in the closed class elements, in an automatic and obligatory way. Friedmann and Grodzinsky (1997) presented a case of agrammatic production regarding verbal inflectional morphology. The patient showed a highly selective impairment of tense inflections, use of copula and embedded structures. They stated that agrammatism doesn’t mean the impairment of “all grammatical morphemes”, but rather the impairments are selective.

Badecker (1997) proposed that the impairment in the inflectional or derivational morphology of words may be either due to impaired morphological processing or due to whole-word processing failure. He proposed a dissociation between morphological processing and whole word processing systems and deduced that inflected forms induce a higher error rate than corresponding base forms. Blumstein (1997) suggested that since lexical access and word recognition processes are crucially involved in almost all aspects of language processing, so impairments in the processing components will affect all the components of linguistic grammar.

Benedet et al (1998) analyzed the use of equivalent grammatical structures in production and comprehension by agrammatic speakers of two languages — Spanish and English. They exhibited same relative order of difficulty. According to Sirigu et al (1998), the sentence and story grammar deficits involved distinct non-overlapping sites within the frontal lobes and they concluded that the sequence processing was specific to knowledge domains and involved different networks within the frontal lobes.

Ballard & Thompson (1999) applied single-case experimental design to examine — (1) the acquisition and generalization of complex sentence production in agrammatism and (2) the utility of syntactic theory in guiding hypotheses of treatment effects — using complex sentences — object clefts, object extracted matrix, embedded questions and embedded actives. They found out that etiology and size of lesion did not appear to account for the different behavioral patterns. They supported the linguistic specific
treatment (LST) which applies the syntactic theory to predict patterns of generalization as an effective treatment approach.

It is widely documented that the left hemisphere is dominant in all complex linguistic tasks, including the processing of inflectional morphology. Both in Italian and in other languages, patients with brain damage with a selective deficit in derivational morphology have never been reported. Marangolo et al (2003) presented the unusual case of two patients with very similar right-hemisphere lesions, who, in the absence of aphasic disorders, showed a selective inability in producing derivational morphology. Although both patients were unimpaired in producing verb infinitives, they showed a selective deficit in producing nouns derived from verbs. This difficulty was not present in deriving nouns from other grammatical categories, such as adjectives. Interestingly, both patients mostly substituted the derived noun with the past participle of the verb. This pattern of results documents for the first time a right-hemisphere contribution in the domain of derivational morphology.

Arabatzis & Edwards (2002) reported inflectional errors in a group of 8 English-speaking people with agrammatism. Subjects were required to provide inflected verbs in declarative sentences and construct negative sentences. The errors made by these speakers were considered in terms of whether they resemble the errors made by children at the Optional Infinitive Stage. Results confirmed that the errors differed from those made by children and that a different explanation was required. Explanations offered by Friedmann & Grodzinsky (2000) were considered inadequate in dealing with their data. They proposed that agrammatic speakers had problems with the implementation of grammar and particularly with syntactic processes such as feature-checking.

Alario et al (2003) reported the performance of two patients with lexico-semantic deficits following left MCA CVA who produce similar numbers of semantic paraphasias in naming tasks.

47 It is the stage in a child's development when the child's grammar accepts both the root infinitive and the inflected form, i.e. "she go" and "she goes" respectively.
Selective deficits in producing verbs relative to nouns in speech are well documented in neuropsychology and have been associated with left hemisphere frontal cortical lesions resulting from stroke and other neurological disorders. Shapiro et al (2001) demonstrated that grammatical categories have a neuro-anatomical basis and that the left prefrontal cortex is selectively engaged in processing verbs as grammatical objects. Hillis et al (2002) presented a longitudinal study of oral and written naming and comprehension of nouns and verbs in an individual, M.M.L., with nonfluent aphasia. She showed progressive deterioration of oral naming of verbs well before deterioration of written naming of verbs. The modality-specific nature of the observed verb production deficits ruled out a semantic locus for the grammatical class effects and provided a new source of evidence for the hypothesis that “there are distinct neural mechanisms for accessing lexical representations of nouns and verbs in language production”. Hillis et al (2003) reported a study of two cases of selectively impaired written naming of verbs after focal brain ischemia, and hypothesized that “parts of the left frontal lobe are crucial for representing and processing verbs”.

Miceli et al (2002), through an fMRI experiment, supported the neuropsychological studies about the correlation between left frontal lesions and damage to morphological processes in agrammatism, and the correlation between left temporal lesions and failure to access lexical representations in anomia. Taken together, these data suggest that grammatical gender is processed in a left fronto-temporal network. Shelton & Caramazza (1999) supported a componential organization of lexical knowledge – that the semantic component is independent of phonological and orthographic form knowledge, and the latter are independent of each other. Furthermore, the results do not support the hypothesis that word meaning is organized into modality-specific subcomponents.

Grodzinsky, Pinango, Zurif, and Drai (1999) argued that these conflicting results do not challenge the theory when the data are analyzed appropriately. They carried out a creative statistical analysis of the comprehension performance of published cases of Broca’s Aphasia and concluded that all these cases are in agreement with the predicted
The comprehension performance of a substantial number of the Broca's aphasics in their own sample does not conform to the pattern required. Caramazza et al (2001) contrary to Grodzinsky et al (1999)’s claim, i.e. Broca's aphasics have no difficulty understanding sentences in the active voice, but perform at chance level with passive voice constructions, stated that Broca's aphasia is not associated with a consistent single pattern of sentence comprehension performance, but allows for a number of distinct patterns in different patients.

Hillis et al (1999) reported the pattern of performance on language tasks by a neurologically impaired patient, RCM, who made semantic errors in writing to dictation and in written naming, but made very few errors at all (and no semantic errors) in spoken naming, oral reading, or spontaneous speech and the detailed analyses of RCM’s performance across lexical tasks, at two different time periods of recovery, provided evidence that “lexical orthographic representations can be either directly activated by lexical semantic representations, or activated by the interaction of lexical semantic and sublexical information from phonology-to-orthography conversion mechanisms”.

Single Case Studies & Underlying Principles

The basic, and established assumptions underlying all the neuropsychological and neurolinguistic investigations are Fractionation Assumption,48 49 (i.e. brain damage does not affect the system grossly but damages it in a predictable manner in the way

48 This assumption may create a problem for the cases of developmental aphasics in which a congenitally deficient brain may be organized along lines different from an intact brain. However in practice the developmental course observed under pathology typically resembles the normal process even though the ultimate achievements are often below those of normal children [Levy & Kavé (1999)].

49 Grodzinsky (1986), in parallel, argues for the constraint of breakdown-compatibility which says that the predictions should comply with the breakdown patterns
system is organized) and Transparency Assumption\(^50\) (i.e. an individual's performance is transparent, therefore one can hypothesize about the underlying process from the observations of the individual). Grodzinsky (1986) proposed a breakdown-compatibility constraint on the fractionation hypothesis which said that the prediction made by a theory should be compatible with the breakdown patterns and therefore, a complete profile of the subject's behaviour need not be accounted for. But this hypothesis is not suited to developmental disorders as it is possible that in such cases, the brain may congenitally be deficient in way of organization, unlike a normal brain. But Leonard (1997) reported that despite the low level achievements, the affected children exhibited the course of development like normal children.

The role of the notion of syndrome carries no potential for theoretical research in cognition, it can just raise controversies. Single case studies follow this anti-syndromic approach. McCloskey & Caramazza (1988) claimed that not only are these single case studies justifiable, but that they are the only source of valid inferences about the structure of normal cognitive system.

There has been a debate regarding single case vs. group-studies over the past two decades. There are strong claims for single case method that single case-studies are justifiable and are the only source of valid inferences about the structure of the normal cognitive system\(^51\). Neither the anatomical impairments nor the cognitive-linguistic impairments are same for two patients, hence no group study is justified in such cases. In group patient research, the group must be defined by reference to psychologically defensible dimensions and the Fractionation Assumption must be supported empirically to ensure that the group is homogeneous with respect to the components of processing that might be impaired in each member of the group. In a single-case approach, we look for a 'functional lesion, i.e. lesion to a component of cognitive architecture, and then a comprehensive analysis of a single patient's status in the required area gives us the nature of the lesion. Moreover, the variables observed in the group of patients are no great in

\(^{50}\) Caramazza (1984), McCloskey & Caramazza (1988)

number to justify the groupings and the extensive variability displayed by the patients, which reflect meaningful and very specific patterns of dissociations, would be lost in case they are grouped together in the name of agrammatism [Miceli et al (1989)]. So there are two related problems – mean scores may not match the performance of any individual patient in the study and summary statistics often cover-up extreme scores and other minority patterns that would have affected the interpretations if those could have been detected [Caplan (1988), Caramazza (1986), Newcombe & Marshall (1988)]. Averaging over the findings in a group of the patients increases the probability of chance and therefore the preferred methodology should be multiple single-case studies rather than group studies. Single-case study approach has the obvious advantage of satisfying the sufficiency condition⁵² - a patient is studied in details and thus considerable constraints on the interpretation of the patterns of the impairments are provided. Goodglass & Wingfield (1998) gave a practical basis for the single-case/individual study methodology that because of counterintuitive dissociative phenomenon, cases of theoretical interest were relatively rare and furthermore, the individual case studies of such patients often precede the creation of custom-designed test materials.

The fact that findings from the comprehension analysis of a single patient’s performance may not be generalisable to other patients is unimportant as the research is not aimed at the characterization of patients in general. The goal is to determine, for any patient, if there is an appropriate modification of the cognitive system - not to account for the observed behaviour of the patients.

Principles underlying single case approach will be fractionation assumption, dissociation and double dissociation. Since mental processes are not directly observable and their existence and function must be inferred from the manner in which task performances

⁵² Within the transparency assumption, Caramazza (1984) proposes a methodological principle/constraint, i.e. sufficiency condition, ‘the use of pathological cases to study the normal processing requires an exhaustive analysis of their performance’. The justification provided for this is that the interpretation and co-occurrence & dissociation of symptoms [reflecting impairments of specific processing components as well as interpretation of individual symptoms themselves] requires that we have sufficient information to [relatively] unambiguously determine that the observed performance can be assumed to result from the disruption of the hypothesized processing component.
change from treatment to treatment involving different levels of an experimental variable and different forms of brain damage, so there is a methodological problem for cognitive psychology and cognitive neuropsychology. The goal of cognitive psychology and cognitive neuropsychology is to identify, enumerate and characterize the fundamental processes underlying human behaviour and dissociation and double dissociation are useful tools, if not the magical, for determining the existence of the mental processes – a criterion for localizing mental function in the human brain (Teuber 1955). Single dissociation is when a patient or a group of patients show different performances (in terms of accuracy and latency) in two different tasks and a double dissociation is when another patient or a group of patients shows the opposite pattern of performances on the same two tasks, in addition to a single dissociation. Dunn & Kirsner (2003) are critical of the reliance the researchers show over it in the area of cognitive psychology and cognitive neuropsychology and they are of the opinion that it only refers to differences between the tasks but doesn’t imply that “all dissociated performances are theoretically relevant, theoretically transparent & constitute authentic dissociations” and therefore fully operational definitions of normal performance, impaired performance and dissociation are needed in the condition when a patient’s performances are compared to control samples. The process of single dissociation ['presence of a symptom A and the absence of a symptom B'] and double dissociation ['presence of a symptom A and absence of a symptom B & presence of a symptom B and absence of a symptom A'] are of great importance in adopting the single-case methodology. This way psychological distinction or independence of the cognitive system can be derived. The presence of the single dissociation strongly suggests and the double dissociation confirms the psychological distinction of a cognitive structure.

 Alan Baddeley (2003) points out the problem in the methodics of double dissociation that it presupposes the system as a dichotomic one, i.e. “a two-by-two design with ... two patients and two conditions”. But despite this limitation, he considers it a useful tool. If correlation could be good as a tool, double dissociations certainly remain a “very powerful weapon” as they place stronger constraints. On the other hand, double dissociation challenges the skeptics to come up with better accounts (if, according to
them, dissociations do not necessarily imply that systems are those proposed by the theorists). A classic example is of a patient who showed impaired long-term memory while short-term memory was preserved [Baddeley & Warrington (1970)] while another patient who exhibited a preserved long-term memory with impaired short-term memory [Shallice & Warrington (1970)]. These two studies were able to refute the hypothesis that long-term memory is dependent on short-term memory [Atkinson & Shiffrin' (1968)]. Thus, double dissociation remains a very useful tool to understand cognitive systems.