

# Empirical Study of the Form and Function of Linguistic Elements

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## Introduction

This empirical study will use human subjects to assess the form and function of linguistic elements. The study consists of three parts. In Part 1, subjects will be presented with sentences and expressions and asked to identify (by circling and connecting together circles) meaningful groups of words within the sentences and expressions. The goal of Part 1 is to identify the structure of simple sentences and expressions based on the identification of meaningful groups. In Part 2, subjects will be presented with sentences and expressions and asked to rank the words in terms of their contribution to the overall meaning of the sentence or expression. The goal of Part 2 is to identify the head, or most important word or words, of each sentence or expression. In Part 3, subjects will be presented with sentences and expressions with one word already circled and asked to identify the Part of Speech (POS) of the circled word. The goal of Part 3 is to see what impact the linguistic context of a word has on its POS.

## Background

Ball (2007) presents an approach to language processing during comprehension based on the *activation, selection and integration of constructions* corresponding to the linguistic input. The notion of constructions comes from an emerging linguistic theory called *Construction Grammar* (Fillmore, 1988; Goldberg, 1995). “Constructions are stored pairings of form and function, including morphemes, words, idioms, partially lexically filled and fully general linguistic patterns...any linguistic pattern is recognized as a construction as long as some aspect of its form and function is not strictly predictable from its component parts” and even fully predictable constructions may be stored “as long as they occur with sufficient frequency” (Goldberg, 2003:219). A classic example of a construction is the *transitive verb clause* consisting of a *subject, verb* and an *object* as exemplified by “the man<sub>subject</sub> hit<sub>verb</sub> the ball<sub>object</sub>”. A less common construction is the *caused-motion* construction as exemplified by “she<sub>subject</sub> sneezed<sub>intrans-verb</sub> the napkin<sub>object</sub> off the table<sub>direction</sub>” (Goldberg, 1995). The caused-motion construction is interesting in that a verb which is normally *intransitive* as exemplified by “she sneezed” occurs with an object “the napkin” and directional prepositional phrase “off the table”. Many normally intransitive verbs can occur in this construction. (An alternative viewpoint is that the caused-motion construction is integrated with a distinct intransitive verb construction in

this example.) Although Construction Grammar began with the exploration of many unusual constructions like “X can’t do Y let alone Z” and “the harder I X, the worse I Y”, it has come to be recognized that the basic principles of Construction Grammar apply to common constructions as well. In fact, a basic claim of Construction Grammar is that “the network of constructions captures our knowledge of language *in toto* – in other words, it’s constructions all the way down” (Goldberg, 2003).

A basic result of the analysis in Ball (submitted) is that there are multiple possible representations that can be constructed during the processing of even very simple English sentences and expressions. Multiple constructions are likely to be activated by each lexical item in an input text. If all these constructions are selected for integration, the result is a complex network of integrated constructions corresponding to the linguistic input. There are at least two ways in which these representations can be simplified: 1) not all the activated constructions are selected for integration, and 2) selected constructions are not integrated to the full extent possible. A primary goal of this research is to see if there is empirical evidence for the proposed constructions and the representations that result from their activation, selection and integration. A secondary goal is to compare the structural predictions of Double R Grammar—the theory of linguistic representation underlying the processing mechanism proposed in Ball (submitted)—with other linguistic formalisms.

A key claim of Double R Grammar is that the basic structure of nominals and clauses is bi-polar consisting of a referential and a relational pole (Ball, 2005). Many other linguistic formalisms (e.g. X-Bar Theory, Dependency Grammar, Head-Drive Phrase Structure Grammar (HPSG)) assume a uni-polar structure (HPSG does allow for some structures which are not uni-polar). Empirical evidence for two separate word clusters (or groups), one centered around a referential specifier and the other centered around a relational head would provide support for Double R Grammar’s bi-polar theory and against uni-polar theories.

## **Methodological Issues**

It is widely accepted within the psycholinguistic community that knowledge of language is largely implicit and not open to conscious reflection. As a result, most empirical studies try to tap into language knowledge without requiring subjects to explicitly reflect on the linguistic task. It is probably true that our ability to process language is largely encoded in procedural memory which is not accessible to conscious reflection (cf. Anderson and Lebiere, 1998). However, if humans create linguistic representations during processing and these linguistic representations are stored in declarative memory in some symbolic form, then they should be accessible. Humans do have implicit declarative knowledge of language which may be ineffable, but that implicit knowledge pertains largely to the statistical regularities that humans acquire as a result of the rational analysis of linguistic input (Anderson, 1990). These statistical regularities may be viewed as subsymbolic or connectionist in nature. But to the extent that discrete symbols corresponding to linguistic categories exist, subjects should have some explicit

knowledge of them. The linguistic categories may not be nameable, but they should be empirically identifiable.

An important argument for the implicit nature of linguistic knowledge follows from the theoretical position put forward in Generative Grammar (Chomsky, 1965) that there is an encapsulated autonomous syntax module which is responsible for the creation of syntactic representations that are impervious to higher level cognition. Much recent psycholinguistic research challenges the existence of this autonomous syntax module. If syntactic representations are generated at all, they are closely tied to and heavily influenced by other components of cognition. For example, recent studies which present linguistic expressions and pictorial scenes side by side (cf. Henderson & Ferreira, 2004) reveal immediate effects of the pictorial scene on linguistic processing and vice versa. Identification of a referring expression in the linguistic input is followed immediately by an eye movement to the relevant icon in the pictorial scene, even when there are distracter icons closely related to the icon actually described in the referring expression. Further, syntactic ambiguities are immediately resolved in the presence of pictorial scenes which serve to disambiguate the linguistic expression. For example, in the expression “put the apple on the towel in the box”, if the pictorial scene shows an apple on a towel, then subjects will fixate this image immediately after processing “on the towel” indicating that “on the towel” modifies “the apple” despite the fact that “put” has a strong preference for a locative argument and “on the towel” could be functioning as this argument instead of modifying “the apple”. If on the other hand, the pictorial scene contains a towel represented separately from an apple, subjects will immediately fixate the image of the towel after processing “on the towel” indicating treatment of “on the towel” as a locative argument (Tanenhaus et al., 2004).

A related argument for the implicit nature of linguistic representations is based on the distinction between *competence* and *performance*. Humans are assumed to have linguistic knowledge that is clouded by performance limitations. Although ordinary speech is highly ungrammatical by formal linguistic standards, it is assumed that this lack of grammaticality is a performance limitation. Ignoring performance limitations and focusing on underlying competence, humans are assumed to create syntactic structures that are highly structured and fully grammatical. The actual utterances are a poor indication of this underlying linguistic knowledge and hence the underlying structures must be implicit. Townsend and Bever (2001) attempt to reconcile actual linguistic performance with the creation of complex syntactic structures in their *Late Assignment of Syntax* (LAST) theory of sentence comprehension. According to their theory, sentences are initially processed using habits and heuristics, many of which rely on semantic knowledge. This initial processing results in a *pseudo-parse*. Only if there is sufficient time do humans create more complex syntactic representations for sentences using an algorithmic process involving application of syntactic rules. The catch phrase for their theory is that “we understand everything twice”. The LAST theory is to some extent a reversal of a large body of psycholinguistic research which is based on the assumption that syntactic representations are created first and subsequently drive semantic interpretation of sentences. That reversal is driven by psychological evidence that humans do not form complex syntactic representations—at least not initially or under extreme

time constraints. Ferreira (2003) takes the LAST theory one step further, providing evidence that humans do not perform a second-stage algorithmic parse even under ideal conditions. According to Ferreira, “the experiments would seem to give every opportunity for the second-stage, algorithmic parse to run to completion and to win out over the pseudo-parse.” Yet the results demonstrate “less than perfect comprehension” even though “sentences are presented without background noise, the input is perceptually clear, often the participant controls the pace at which the sentence is presented..., and most critically, the goal of the participant is specifically to understand the sentence so as to perform well on a relatively public comprehension task”. If no complex syntactic representation is created either before or after the pseudo-parse, then the pseudo-parse is the only representation and the distinction between competence and performance loses its force.

The assumption that humans construct a globally coherent syntactic representation, at least in the absence of time constraints, runs counter to working memory limitations. The capacity of working memory is not large enough to support global access to all the elements of a complex linguistic structure at once. Syntactic structures, to the extent they exist at all, must be constructed from the integration of local structures which are small enough to be brought together in working memory. Dynamic systems theory has taught us that it is possible to generate complex behaviors and representations from the local interaction of simple behaviors, viewed globally. Although the global behavior is often highly coherent, there is no guarantee that these local interactions will result in globally consistent behavior, with chaotic states often resulting. Adding in memory constraints to a dynamic system should only increase the likelihood of globally inconsistent behaviors. Evidence that humans construct locally coherent representations which may not be globally coherent is presented in Christianson et al. (2001). Subjects presented with the sentence “While Anna bathed the baby played in the crib” answered “yes” to the follow-up question “Did Anna bathe the baby?” a majority of the time! This response is locally coherent with “Anna bathed the baby”, but globally incoherent with the full sentence. This response should not occur if subjects retain only a globally coherent representation.

In their book “Simpler Syntax”, Culicover and Jackendoff (2005) argue for a generative semantic component closely aligned with the generative syntactic component put forward in Generative Grammar—extensively reducing the scope of the syntactic component in the process. Even if there remains a “simpler” generative syntactic component which is impervious to higher level cognition (and therefore very difficult to falsify), presumably the generative semantic component involves higher level cognitive mechanisms and representations which are more accessible and may be explicit. However, the generative semantic component in Culicover and Jackendoff is a conceptual, non-linguistic component and it is unclear how the ability of subjects to group words into meaningful units—an explicitly linguistic and semantic task—relates to their conceptual semantic component. Do subjects analyze linguistic expressions into conceptual representations and then use the conceptual representations to somehow do the linguistic grouping? Presumably they don’t use the purely syntactic representations generated by the syntactic component, since this is an explicitly semantic task, and the syntactic component has historically been assumed to be impervious to semantic influences.

In Double R Grammar, linguistic representations are explicitly semantic. There is no distinction between syntactic and semantic representations of linguistic knowledge. Linguistic representations map to non-linguistic representations of the objects and situations to which they can be used to refer and with which they are symbolically associated. Non-linguistic representations are perceptually-based abstractions of non-linguistic input. There is no purely conceptual, modality independent realm of representation as Culicover and Jackendoff propose. Representations may be highly abstract, but they are perceptually grounded, perceptual symbol systems (Barsalou, 1999). The explicit and semantic nature of linguistic representations makes it reasonable to ask subjects to group words into meaningful units.

Subjects explicitly know what “the man bit the dog” means. They explicitly know what it means for “the man” to occur before “bit” and “the dog” to occur after “bit”. They may or may not explicitly know that “the man” is the *subject* of the clause and the *agent* of the action “bit”, but they should have little difficulty identifying “the man” as the *biter* even though this is an implausible sentence. English often encodes knowledge of semantic roles at the lexically specific level of *biter* or *bitten* (e.g. “who bit whom”) and this knowledge is explicitly available. More abstract labels like subject and agent which generalize over relational elements like “bit” may be more difficult to access and use, although humans should have little difficulty grouping subjects and agents together.

The speed with which we speak and understand spoken English requires that knowledge of English be encoded into chunks that are large enough to support realtime production and comprehension. Smaller chunks of knowledge are still typically accessible, but the amount of processing required to assemble them in realtime is prohibitive. There isn't time to identify words by sequentially scanning the individual letters in the word. There isn't time to work out the meaning of “kicked the bucket” from the meaning of the words “kicked” “the” and “bucket” followed by some metaphorical interpretation process. If we don't already know what “kicked the bucket” means, we will fail to understand this idiom when we hear it, unless some external cue provides sufficient context. The rapidity of the process of spoken language production and comprehension is not an argument against explicit knowledge of language. It is an argument for larger chunks of explicit linguistic knowledge. Recognized as a unit, the form and meaning of the subelements of these larger chunks may remain largely implicit. Trying to identify the number of “f”s in a text containing multiple “ofs” turns out to be quite hard. The word “of” is so strongly encoded as a unit, that it is difficult to perceive the “f” in it. In this sense, the “f” in the word “of” is implicit. We somehow recognize “of” without awareness that it contains an “f”. The fact that the word “nonetheless” contains the three words “none”, “the” and “less” is also largely implicit for native speakers of English. Until non-native speakers of English learn to recognize “nonetheless” as a unit, they will have more difficulty recognizing this word than native speakers. Once learned as a unit, the subelements become implicit. Implicitness is largely a result of overlearning and the creation and prominence of larger linguistic units, not the result of an autonomous language module that is impervious to higher-level cognition.

This empirical study is founded on the idea that it is OK to directly ask subjects about their higher-level linguistic knowledge. Explicitly asking subjects about their declarative knowledge is the norm in psychological studies, not the exception. For example, many studies ask subjects to rate the semantic similarity of words. It seems a small step to ask subjects to group words together into meaningful units. Asking subjects to label words and groups is a bigger step, but many native speakers of English receive extensive training in grammar and it is a reasonable assumption that they use this explicit knowledge in generating and understanding language.

Many linguists are good at learning new languages because they can take advantage of the extensive grammatical knowledge they have acquired during their linguistic studies. If they know that “the” combines with a noun to form a noun phrase that can refer to an object, then when they encounter a new word that is categorized as a noun, they know that it can occur with “the”—or whatever the equivalent in some other language is. Without this explicit grammatical knowledge, they must learn how to use the word by example and from context. This is a much slower process, but it is still explicit. Although slower to learn by example, once learned, the examples are available for interpreting new linguistic inputs via automated declarative lookup, whereas applying the knowledge that nouns combine with “the” requires associating a word to the category noun before combining the noun with “the”. It is easier and quicker to understand the meaning of “the dog” if an exemplar exists in memory, than it is to associate the word “dog” with a category that combines with “the” to form a linguistic unit whose meaning can be determined. In languages like Spanish where there is gender agreement between determiners and nouns (e.g. *el perro* – the dog vs. *la gallina* – the chicken), it is even more useful to learn determiners and nouns as a unit. Knowledge of linguistic categories can facilitate language learning, but given the rapidity of speech, declarative lookup of prestored linguistic chunks is the primary mechanism of speech. Acquisition of these prestored chunks (or constructions) is a slow, experiential-based learning process that continues over a lifetime. Language acquisition is not essentially complete at an early age when the “rules” of grammar are learned. Although impressive, the language skills of young children are far below those of adults in both lexical content and grammatical range. It took a trip to Memphis for me to learn the meaning of the lyric “got my feet ten feet off of Beale” in the song “Walking in Memphis” which I had previously heard a large number of times. (Beale is a street in Memphis which is full of music venues.) While this is an example of a lack of word knowledge, examples of the learning of new constructions are also readily available. As an adolescent I used the word “alot” in my writing until my grammar teacher corrected my mistake. Although “a lot” functions like an adverb, it has the form of a noun phrase (a multiword unit). In order to improve my comprehension of Spanish, I recently purchased a dictionary of Spanish idioms. What was surprising to me, was how many of the English language equivalents I was unfamiliar with. A sampling includes “turn one’s brain” as in “the atrocities the young soldier witnessed in Viet Nam eventually turned his brain”, “cheek by jowl” as in “the duke’s family now live in a cottage in the village, cheek by jowl with the estate workers” and “a flying visit” as in “she paid her parents a flying visit before returning to university”. On the other hand, in a dictionary of over 9000 idioms, most were very familiar as in “get (something) off one’s chest”, “split hairs” and “wear one’s heart on

one's sleeve". A characteristic of many constructions is that they extend the range of grammatical structures available in a language. "The harder I try, to worse I get" does not have the normal form of a sentence. Knowledge of normal sentence structure will not allow one to use this construction appropriately. These examples blur the line between lexicon and grammar and suggest that it takes a lifetime to learn a language.

Creating a coherent text is a cognitively intensive task requiring access to and use of much explicit linguistic knowledge. Only in the most time restricted linguistic tasks can an argument be made that explicit knowledge of language is extremely limited. Speech generation and understanding is very time restricted. But speech generation is typically characterized by extensive use of formulaic expressions, disfluencies, restarts, non sequiturs, redundancies and outright contradictions. It seems clear that speech is not generated by traversing a well-formed syntactic representation and pronouncing the lexical items at the leaves of the tree. With respect to speech understanding, hearers are very unlikely to be able to create full syntactic representations of the kind espoused in Generative Grammar given the extremely noisy nature of the spoken input and extreme time constraints. At best, a partial structural representation—structural pieces corresponding to well learned constructions activated by the input—is likely to be created. The activation of these constructions is largely automatic and based on spreading activation from the spoken input (Kintsch, 1998; Anderson, 1983). To the extent that hearers are able to construct more complete representations, doing so is likely to involve a selection and integration process operating over the structural pieces activated by the spoken input and constrained by the rapidity of speech (not a separate algorithmic process operating on distinct syntactic representations as suggested by Townsend and Bever, 2001). In reading, where the subject has control over time, more integrated representations are possible and constructions which encode knowledge about different, and often competing, dimensions of meaning may be integrated. In writing, more coherent text is the likely result of bringing explicit knowledge of language to bear. Humans have and use explicit linguistic knowledge in generating and understanding text. It's OK to examine that knowledge empirically.

The key methodological consideration addressed in this section is whether or not it is, in principle, reasonable to directly ask subjects to introspect about their linguistic knowledge. While introspection was outlawed in Behaviorist studies, the advent of Cognitive Psychology has reestablished introspection as a viable experimental technique—when used cautiously (Levelt, 1972). To the extent that humans construct symbolic, declarative representations of linguistic input, they should be able to introspect on the nature and form of these representations. In the cautious use of introspection, a host of additional methodological considerations come in to play. Among the most important is the need to develop an experimental method which elicits linguistic knowledge from subjects without biasing them in their responses. To avoid biasing subjects in study 1, the instructions for forming groups will not use real words which could bias subjects to group similarly to the instructions. And subjects with a possible linguistic bias will not be used. As to whether or not grouping is a viable methodological approach, Levelt (1972) claims that "one type of [linguistic] intuition...word group cohesion...is...a strong candidate for reliable judgments". Sentences used in an earlier

study by Levelt (1970) will be used in this study as a way of validating the grouping methodology. In study 2, it is probably inappropriate to ask subjects to circle the head of each sentence or expression. The notion of what a head is, is what we are trying to get at. However, subjects are unlikely to be familiar with this label and may not be able to use it appropriately. Instead, they will be asked to rank order the words in each expression, assigning 1 (or first prize) to the word or words which contribute most to the overall meaning, assigning 2 (or second prize) to the word or words which contribute next most to the overall meaning and so on until each word is assigned a ranking. The default assumption is that the word assigned a ranking of 1 is the most important word or head. More than one word can be assigned the same ranking, making it possible for a sentence or expression to have multiple heads. This method is related to a method used in an earlier study by Loosen (1972) in which subjects were asked to underline the 1 to 3 words which contribute most to the meaning of a sentence or expression. In study 3, the question of whether or not subjects can be given a listing of Parts of Speech without biasing their responses needs to be resolved.

### Study 1: Identifying Meaningful Units via Grouping and Connecting

The goal of this study is the identification of meaningful units and the determination of the basic structure of clauses (roughly synonymous with sentence) and nominal and verbal expressions. Subjects will be presented with expressions of various forms within a PowerPoint presentation and will be asked to group the words in the expressions into groups by circling them using the PowerPoint “oval”. Once circled, a group may be combined with other words or groups to form a larger group. And circles may be connected using the PowerPoint “connector” when there is intervening linguistic input that is not part of the group. The instructions for this task will use perceptually arranged collections of dots and squares to suggest how groups can be formed. For example, the collection of dots



Can be viewed as two distinct groups which can be circled as follows:



Another example,



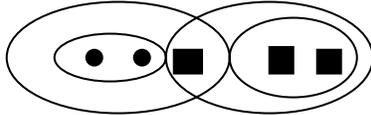
might be grouped as follows:



An example with two perceptual types



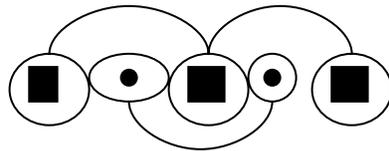
might be grouped as follows



A final perceptual example



might be grouped as follows:

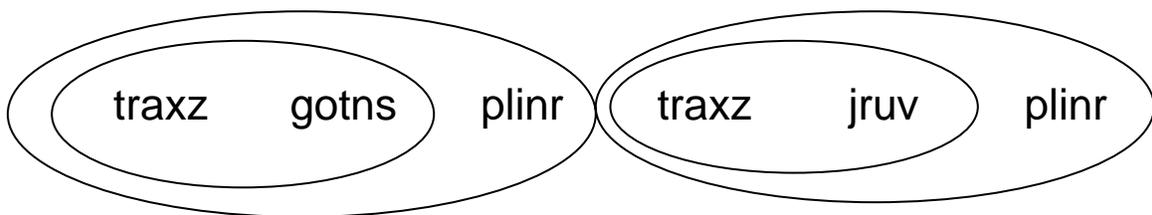


using connectors to group discontinuous elements.

An example using non-words

traxz    gotns    plinr    traxz    jruv    plinr

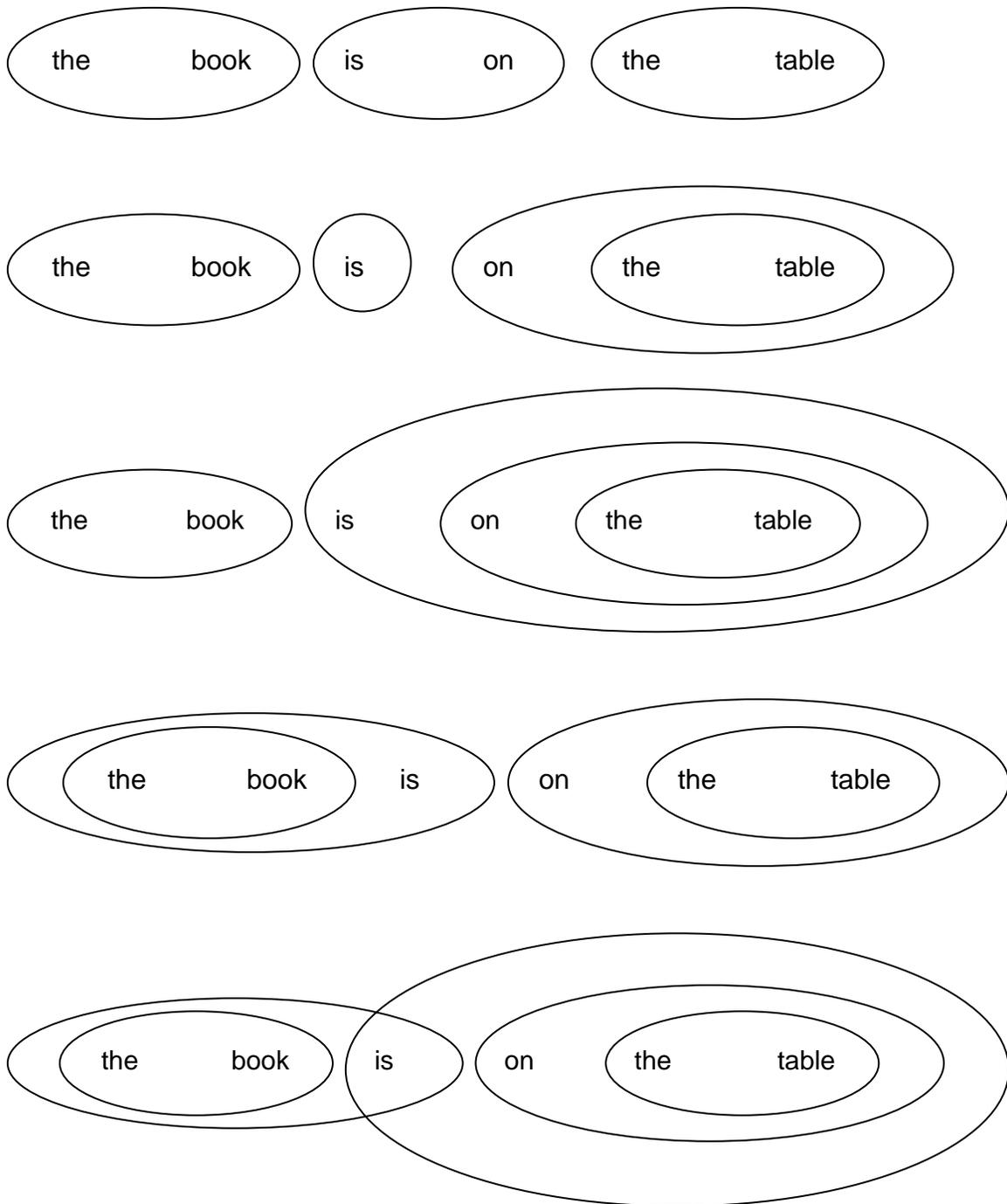
might be grouped as



The actual grouping task will involve expressions like

the        book        is        on        the        table

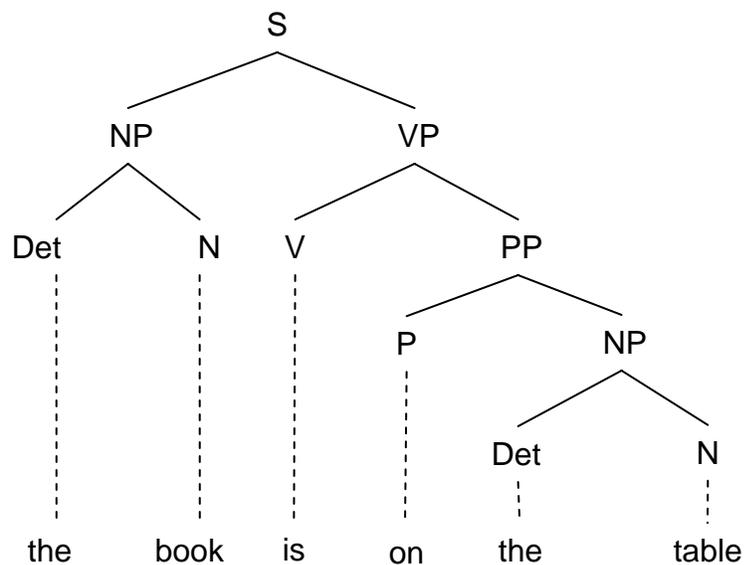
for which at least the following groupings are possible:



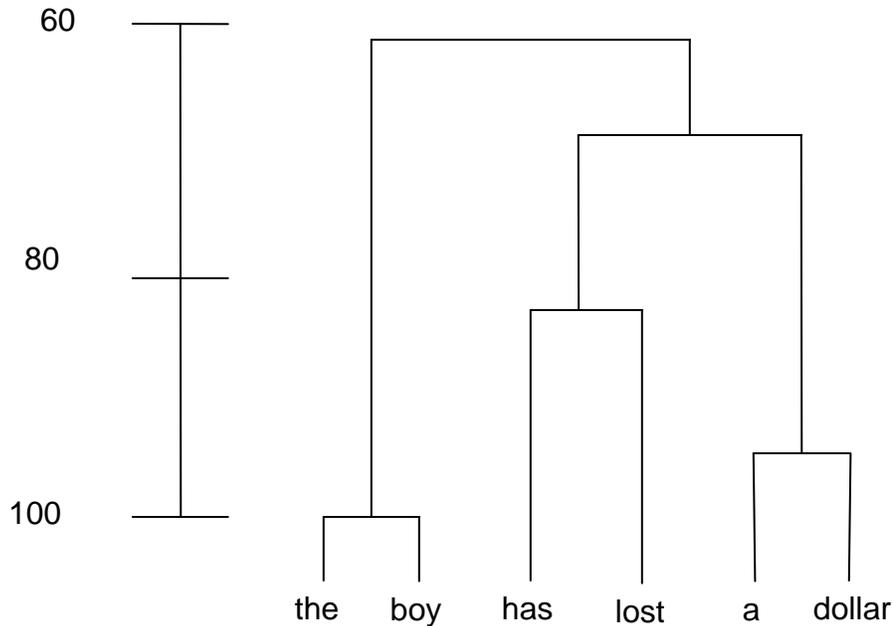
Each of these groupings is consistent with the predictions of a different theory of the basic structure of a clause or sentence. The first grouping is consistent with Double R Grammar with “is” and “on” combining to form a *predicator* and “the” and “book” and “the” and “table” combining to form the *subject* and *object* complements which combine with the predicator to form a clause. The second grouping corresponds to the Subject-Verb-Adverbial representation of Quirk et al. (1985) with “is” functioning as the Verb and “on the table” functioning as an *Adverbial* (i.e. a non-optional prepositional phrase occurring after the Verb). Huddleston & Pullum (2002) present a similar representation

differing only in the substitution of the term *predicate complement* for Adverbial. The third grouping corresponds to the division of a sentence into a noun phrase “the book” followed by a verb phrase “is on the table” as proposed in early Generative Grammar. This representation is also consistent with Double R Grammar under the assumption that “on the table” forms a referential unit corresponding to a location that combines with “is” to form a *predicate*. The fourth grouping corresponds to Halliday & Matthiessen’s (2004) distinction between the *mood* (i.e. subject plus finite operator) and *residue* elements of a clause viewed as a *medium of exchange* (one of three different perspectives on the clause in Halliday’s version of Functional Grammar). This grouping is also consistent with Double R Grammar under the assumption that the subject functions as a *reference point* that combines with the auxiliary verb functioning as a *reference marker* before combining with “on the table” functioning as a *predication*. The fifth grouping is consistent with more recent versions of Generative Grammar under the assumption that the relationship between “the book” and “is” is that “the book” is the *specifier* of “is” whereas the relationship between “is” and “on the table” is that “on the table” is a *complement* of “is”.

In earlier versions of Generative Grammar, it was claimed that the sentence is always composed of a Noun Phrase (NP) followed by a Verb Phrase (VP).



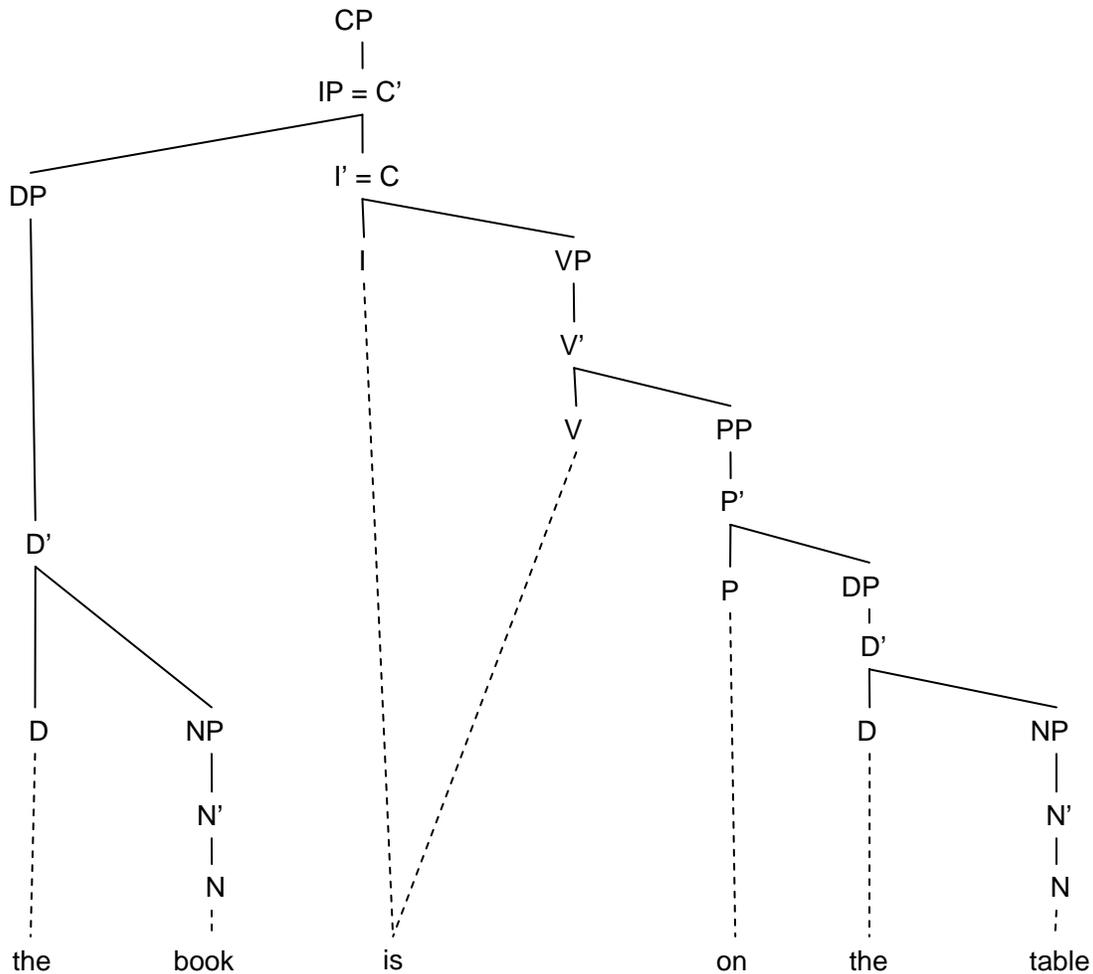
In a precursor to this study, Levelt (1970) conducted an experiment in which he asked subjects to rate the similarity of word triads occurring in a sentence. These similarity results were subjected to a hierarchical clustering analysis resulting in the following pattern for the sentence “the boy has lost a dollar” (the scale reflects the relative frequency of “more related” in triadic comparisons):



This pattern is consistent with the division of a sentence into an *NP* “the ball” and a *VP* “has lost a dollar” consisting of a *verb group* “has lost” and an *NP* “a dollar”. It should be noted that hierarchical clustering does not label clusters and the functional labels *subject* corresponding to “the ball” and *predicate* corresponding to “has lost a dollar”—with the subfunctions *predicator* “has lost” and *object* “a dollar”—are also consistent with the results. There are several reasons Levelt’s results should be revisited. The hierarchical clustering mechanism enforces a binary structure. The fact that the object *NP* combines with the verb before the subject *NP* indicates a somewhat closer similarity between object and verb (relative frequency around 65). However, hierarchical clustering sums over all dimensions of meaning at once. It may be that the saliency of the subject relative to the object results in this structure even though relational meaning is also encoded in sentences. There may be tiers of meaning that can be teased apart given appropriate experimental techniques which do not force a single binary structure on a sentence. Further, although this basic transitive sentence appears to have an *NP VP* structure based on hierarchical clustering, there are likely to be other sentence forms for which the hierarchical clustering technique leads to alternative structures. For example, the sentence “what is he hitting” is unlikely to show an *NP VP* structure using similarity assessment and hierarchical clustering techniques. And there may even be simple transitive verb sentences which lead to alternative clusterings as in “the boy’s lost a dollar” where the cliticization of “is” with “the boy” should favor clustering “the boy’s” together. In fact, Levelt (1970) found that in the Dutch sentence “Jan eet appels en Piet eet peren” (John eats apples and Peter eats pears), the subjects, “Jan” and “Piet”, combined with the verb “eet” before the objects, “appels” and “peren”. This is a clear violation of the basic *NP VP* structure for Dutch sentences. Based on a suggestion from Tom Bever, Levelt notes that “middle verbs (like “eat”)...tend to be more related to the subject than to the object of the sentence, whereas full transitives (like “hit”) more frequently cluster with the object of the sentence”. However, no empirical support for this hypothesis is provided.

It should be noted that the NP VP structure is no longer accepted as the basic sentence form in Generative Grammar—having been replaced by X-Bar theory and the Functional Head Hypothesis (see below). It is a basic assumption of X-Bar theory based variants of Generative Grammar that the complement “a dollar” combines with the main verb “lost” before combining with the auxiliary verb “has”. The shift from having the auxiliary verb “has” combine with “lost” to having “has” combine with “lost a dollar” is inconsistent with the results of Levelt (1970). Even more serious, the combining of “Jan”, the subject, with “eet”, the verb, before “appels”, the object, is inconsistent with all variations of Generative Grammar. The empirical results of Levelt (1970) have had little influence on the direction of Generative Grammar, which is theoretically well shielded from such empirical findings. However, the linguistic climate is changing and linguistic theories without solid empirical foundation will face increasing opposition.

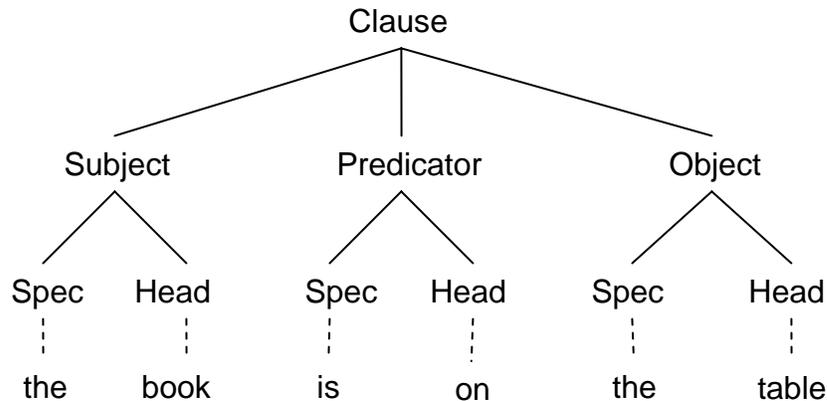
The introduction of X-Bar theory modified the basic sentence structure by claiming that all phrasal expressions were *endocentric* projections from a *head* whose part of speech was one of Noun, Verb, Adjective or Preposition (generalized by X)—giving NP, VP, Adjective Phrase (AP) and Preposition Phrase (PP) (generalized by XP). X-Bar theory also introduced a level of representation in between the word and phrase level. The head combines with one (or perhaps more) complements to form an intermediate representation (called X-Bar or X'), which combines with an optional specifier to form a phrase level representation (called X-Double Bar or X'' or XP). Initially, sentences retained the *exocentric* NP VP structure (i.e. neither NP nor VP is the head of a sentence). Subsequently, the *Functional Head Hypothesis* led to the introduction of functional heads (i.e. “functional” here is a reference to function words being heads) allowing for phrasal expressions to be headed by function word categories like Determiner, Inflection (or Tense), and Complementizer—giving Determiner Phrase (DP), Inflection Phrase (IP) and Complementizer Phrase (CP). With the introduction of function word heads, and under the assumption that sentences are headed by a Complementizer (i.e. a word that allows a sentence to function as a complement in a larger structure), it became possible to bring sentences under the X-Bar Schema. The basic structure of a sentence in Generative Grammar is now seen as something like



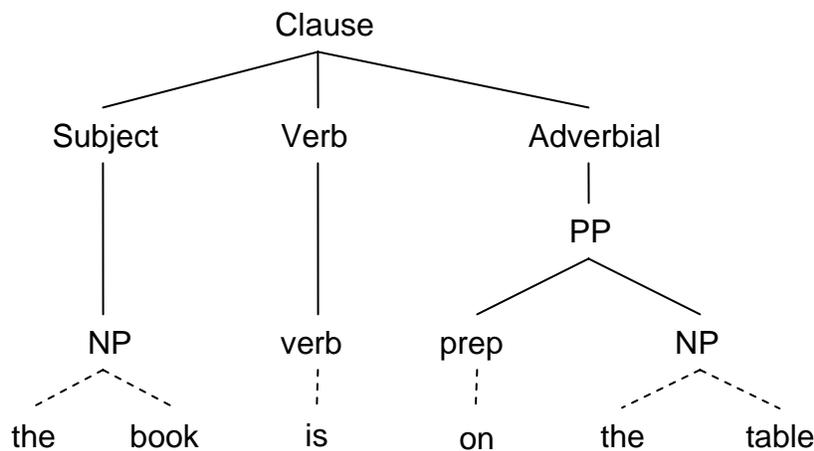
Although not explicitly represented, the DP “the book” is the specifier of IP, the PP “on the table” is a complement of V, the VP “be on the table” is a complement of I. I’ and C are unified to allow “is” to head IP as well as CP. This is made necessary by the lack of an explicit complementizer in main clauses. In subordinate clauses like “that he likes you” in “that he likes you is nice” which contain the explicit complementizer “that”, IP may function as a complement to CP with “that” functioning as the head of CP. All other specifier and complement positions are empty. The word “is” is divided into its inflection (I) or tense and the bare form “be” (V).

It is a basic claim of Double R Grammar that the structure of expressions reflects the encoding of referential and relational meaning. Grammatical units which reflect these two dimensions of meaning should be empirically identifiable. These grammatical units are functional in nature and need not correspond to the syntactic units identified in Generative Grammar. The basic referential relationship is between a specifier which marks definiteness or tense in support of reference and a head which determines the type of object or situation the expression can be used to refer to. For example, in “the dog” and “is happy”, “the” and “is” are the specifiers and “dog” and “happy” are the heads. The basic relational relationship is between an expression describing a relation and the expressions describing the participants in the relation. For example, in “the book is on the

table”, the word “on” describes a relationship between two participants described by “the book” and “the table”. Three possible representations have been identified which are consistent with different aspects of Double R Grammar. The first representation identifies the subject and object participants and the relation between them expressed as a *predicator* (i.e. predicate specifier + relational head). This representation is consistent with Quirk et al.’s (1985) basic SVO schema for a clause, with Predicator corresponding to their V function (note: V is a grammatical function and not a part of speech in the SVO schema).

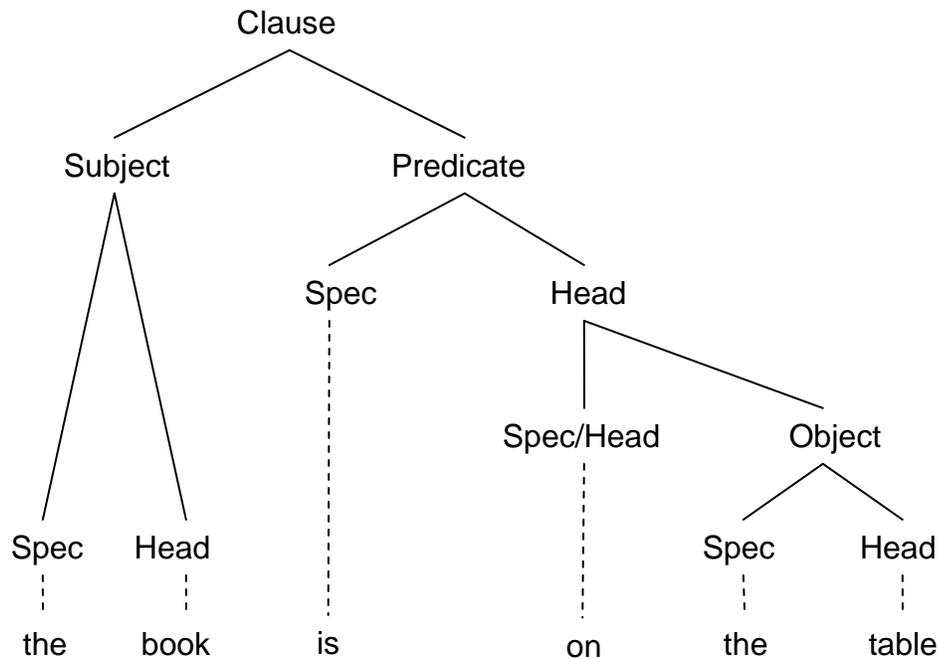


However, Quirk et al. would not categorize “the book is on the table” as an example of the SVO schema. Instead, they would categorize “is” as the V and “on the table” as an *Adverbial* consistent with the SVA schema.



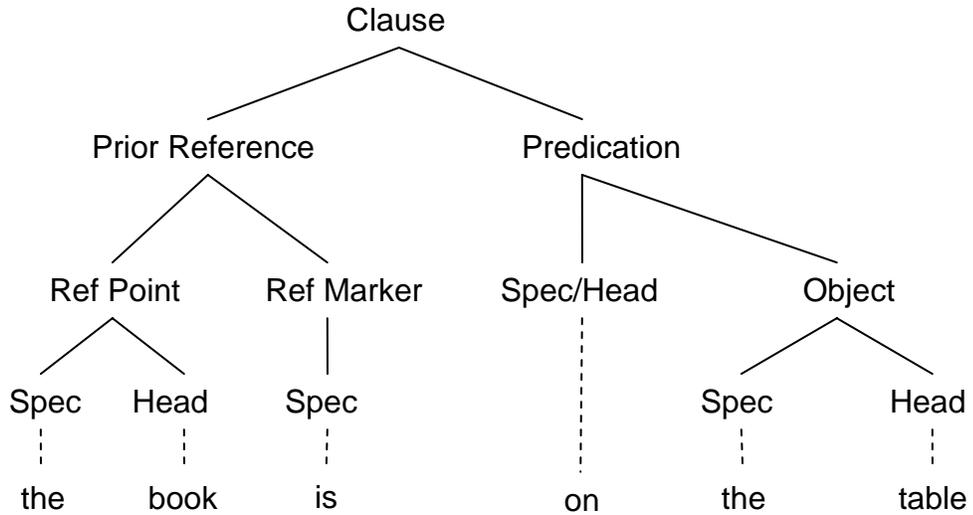
According to Quirk et al., every (full) clause has a verb functioning as the Verb (either a main verb or an auxiliary verb). Prepositional phrases like “on the table” function as Adverbials with the auxiliary verb functioning as the Verb.

The second Double R Grammar based representation allows for the location referring expression “on the table” to form a grammatical unit which functions as the relational head and combines with the predicate specifier to form a *predicate*. In this representation, relational meaning is subordinated to the referential status of “on the table”.



The primary structural difference between this representation and that of Quirk et al. is the combining of “is” with “on the table” to form a predicate. The key question is whether the basic structure of the clause “the book is on the table” is Subject-Predicator-Object, Subject-Verb-Adverbial or Subject-Predicate.

The third Double R Grammar based representation provides an external perspective on the clause, tying the clause to the previous discourse via use of a *reference point* and *reference marker* which combines to form the *prior reference* or *given* information of the clause. This prior reference combines with the *predication* “on the table” that introduces *new* information with respect to the prior reference. The predication is composed of the relational element “on” and the object “the table”. The relational element is lacking an indication of tense. This representation is more strongly suggested by expressions like “the book’s on the table” where the auxiliary verb cliticizes on the subject, indicating the formation of a grammatical unit.

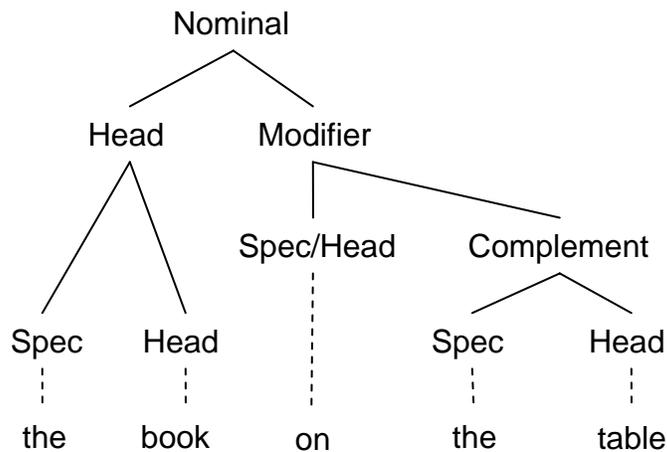


This representation is consistent with Halliday and Matthiessen’s (2004) *clause as exchange* dimension of meaning in which the subject “the book” and finite element “is” combine to constitute the *mood* and “on the table” constituting the *residue*.

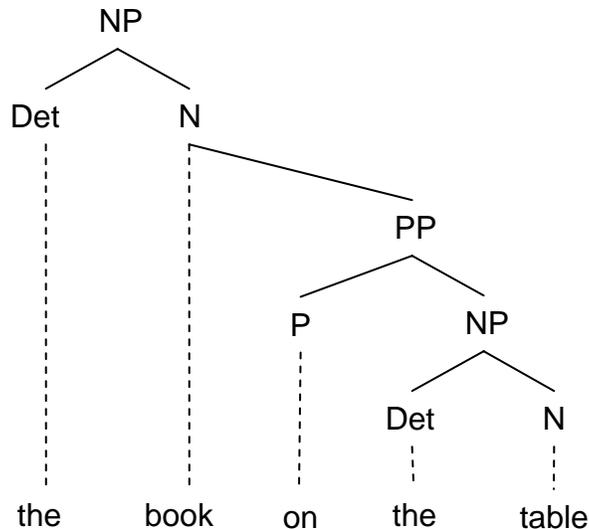
Besides trying to identify the basic clausal structures, elements of nominal structure will also be empirically tested. In the expression

The book on the table

Double R Grammar predicts a grouping of “the book” and a grouping of “on the table” and within “on the table” a grouping of “the table”. This grouping is consistent with the basic relational meaning of “on” with relates two participants “the book” and “the table”, but with the location referring expression “on the table” functioning as a modifier of “the book”.



Many other linguistic formalisms treat “on the table” as a modifier of “book” forming the group “book on the table” with the determiner “the” combining with “book on the table” to form a Noun Phrase.



The problem with this representation is that the representation of relational meaning is not at all transparent. “Book” by itself does not constitute a participant (i.e. it is not a referring expression). There do appear to be expressions in which the head noun may be modified by a prepositional phrase. For example, in “the present queen of England” “queen of England” may form a constituent that is modified by “present”. From a relational perspective, this constituent is dispreferred since “queen” does not constitute a referring expression, whereas England does. However, modification of non-referring nominal heads is allowed in expressions like “the red book” where “red” modifies the head “book”, and the possibility of post-head modification of nominal heads is not excluded, just assumed to be dispreferred in the default case (lacking empirical evidence to the contrary). When both a pre-head and a post-head modifier are present, the semantics of the expression may suggest post-head modification of just the head. Compare “the teetering book on the edge of the table” vs. “the red book on the table”. In the first expression, it is being on the edge of the table that makes the book teeter, whereas in the second expression, the book is red independently of being on the table. Empirical investigation is needed to determine how humans prefer to group modifiers in such expressions.

A key element of this study is to assess to what degree there is empirical evidence for a bi-polar structure of nominals and clauses. Do subjects create distinct groupings of words centered on specifiers and heads? For example, in the nominal “the first three red books” do subjects group “first” with “the” (specifier) separately from grouping “red” with “books” (head). If so, does “three” get grouped with “red books” or “the first”? Likewise, in the sentence “he could not have been running rapidly” do subjects group “not” with “could” (specifier) independently of grouping “rapidly” with “running” (head). If so, how do they group “have” and “been” with respect to “could not” and “running rapidly”? The

positing of a bi-polar structure distinguishes Double R Grammar from many other linguistic formalisms. In a traditional grammar based uni-polar analysis of “the first three red books”, “red” is grouped with “books”, “three” is grouped with “red books”, “first” is grouped with “three red books” and “the” is grouped with “the first three red books”. “The”, “first”, “three” and “red” function as modifiers of “books” and the expression as a whole retains an endocentric structure. A uni-polar clustering consistent with Generative Grammar (post X-Bar theory and the functional head hypothesis) would have “the” functioning as the head of a DP (determiner phrase) with “first three red books” functioning as an NP complement. Within this NP complement, “red” would function as a modifier (or adjunct) of “books” and I am unsure of the status of “first” and “three”.

It should be noted that there is no assumption that human subjects have explicit knowledge of the functional labels used in the representations shown above. The functional labels are provided for expository convenience. However, it is assumed that subjects will be able to group words into meaningful units even if they can’t label the units. Subjects may also have limited knowledge of Part of Speech (POS) labels like N (noun), V (verb), Adj (adjective), Adv (adverb) and P (preposition). They are unlikely to know the POS labels for functional categories like D (Determiner), I (Inflection), C (Complementizer). They may or may not have knowledge of the POS labels pronoun, proper noun, and article. They may or may not have knowledge of common phrasal categories like NP (Noun Phrase) and PP (Prepositional Phrase). They are unlikely to have labels for other phrasal categories. It is an open question whether or not POS labels should be provided for Part 3 of this experiment.

## **Study 2: Identifying Heads**

In this part of the study, subjects will be presented with sentences and expressions and asked to rank order the words in the sentence or expression based on how much the words contribute to the overall meaning of the sentence or expression. The word or words which contribute most to the overall meaning will be ranked 1 (first prize). The word or words which contribute second most will be ranked 2 (second prize). Subjects will continue in this manner until every word is given a ranking. The default assumption is that the word with the highest ranking functions as the *head* of the sentence or expression. Subjects will be allowed to give the same rank to more than one word, making it possible for them to identify more than one head.

The methodological approach adopted in this study is not without precedent. Levelt and Kempen (1975) cite a study by Loosen (1972) in which “he presented subjects with written (Dutch) sentences and asked them to underline one to three words that they considered most essential for the meaning of the sentence.” Loosen computed the relative frequency that two words were underlined together and submitted the resulting matrix to hierarchical clustering analysis.

The concept of a *head* has achieved an importance in modern linguistic theory that may be unrivaled. It is the basis of X-Bar Theory, a key component of Generative Grammar; it gives its name to Head-Driven Phrase Structure Grammar (HPSG); and most other

linguistic theories have adopted some notion of headedness. A key difference between the comprehensive grammar of English put forward by Huddleston and Pullum (2002) and the equally comprehensive grammar of Quirk et al. (1985) is the adoption and use of functional categories like *head*, *modifier* and *determiner*, with head leading the list. In adopting these lower level functional categories, Huddleston and Pullum push functional categories down into the description of phrases which are described in non-functional terms in Quirk et al.

Although *head* is an important linguistic concept, the actual use of this concept is highly controversial. In Generative Grammar, *head* is an essentially syntactic notion. The head is the element of a phrase that projects the syntactic type of the phrase. A noun heads a noun phrase; a verb heads a verb phrase, etc. The introduction of function word heads like Inflection and Complementizer in Generative Grammar is consistent with the syntactic basis of headedness and enables the extension of X-Bar Theory to a much broader range of syntactic structures. However, many linguistic theories assume that the concept *head* is a functional and semantic notion, not a purely syntactic notion. Roughly, the head is the semantically most significant element of a phrase. The head is the word which contributes most to the overall meaning of the phrase. Function word heads are inconsistent with this basic semantic definition of heads. Their introduction in Generative Grammar leads McCawley to lament that "...all sorts of things...get represented as heads of things they aren't heads of" (in Cheng and Sybesma, 1998). Abney (1987) is widely cited for pushing the concept of function word heads in Generative Grammar. In a later work, Abney (1991) introduces the concept of *semantic heads* to overcome some of the limitations of *syntactic heads* (especially function word heads). Informally, he defines semantic heads as "Intuitively, the s-head [semantic head] of a phrase is the most prominent word in the phrase. For example, the verb is the s-head of a sentence, the noun is the s-head of a noun phrase or prepositional phrase...The s-head is not necessarily the same as the syntactic head...an abstract element Infl, not the verb, is taken to be the head of the sentence, and the complementizer (C) is often taken to be the head of an embedded sentence (CP)".

In Double R Grammar, function word heads are categorized as specifiers, not heads. Specifiers contribute important information about the referential status of phrases, but heads are the key determinants of what phrases can be used to refer to. Abney's notion of a semantic head is close to the notion of head in Double R Grammar with one obvious exception being Abney's treatment of nouns as s-heading prepositional phrases (e.g. "table" in "on the table" is an s-head). Double R Grammar assumes that prepositions head prepositional phrases. This assumption will be empirically tested in this study.

The goal of this part of the experiment is to see to what extent there is empirical support for a semantic notion of headedness. What element of phrases and sentences will subjects identify as the word or words which contribute most to the overall meaning of the phrase and sentence, and what are the implications of this for Double R Grammar and competing linguistic theories.

It is a claim of Double R Grammar that the word “happy” in the sentence “John is happy” functions as the head. Most other functionally oriented linguistic theories treat “is” as the head on the assumption that sentences are headed by verbs. This leaves “happy” to function as a complement. But if “happy” is the semantically most significant element of “John is happy” then its treatment as a complement is problematic. Complements contribute important information to sentences, but that information is subordinate to the information provided by heads. Is the sentence “John is happy” essentially about “being”? Or is it essentially about “being happy” or “happiness”? Double R Grammar assumes the latter. If “happy” is empirically determined to be the word which contributes most to the overall meaning of “John is happy”, then the treatment of “happy” as the head is supported and its treatment as a complement is called into question. The treatment of “happy” as a complement is suggested by sentences like “John seems happy” with the more complex verb “seems”. It is difficult to argue that “seems” provides a purely referential function. There is more semantic content to semi-auxiliaries like “seems” than there is to regular auxiliaries like “is”. It is an empirical question whether or not subjects will choose “seems” or “happy” as the semantically most significant element of “John seems happy”. If they prefer “happy”, then this provides support for “seems” providing both a specifying and modifying function, a combination not heretofore considered in Double R Grammar. If they prefer “seems”, then “happy” is not functioning as the head. Instead it may be functioning as a *predicate modifier* or a *complement*. If it is functioning as a predicate modifier, then “happy” combines with “seems” to form a complex *predicator* “seems happy” with “seems” functioning as the head and “happy” functioning as a modifier. If “happy” is functioning as a complement, then it may also function as a complement in “John is happy”—the position adopted by Quirk et al. and Huddleston and Pullum. However, it is also possible that “happy” may function as the head in “John is happy” and a complement in “John seems happy”. If so, then, empirically, subjects should have different preferences for selection of the most significant word across these two examples. Assuming a preference for treating “seems” as the head of “John seems happy”, the status of “happy” as either a predicate modifier or complement remains to be teased apart.

It is possible that subjects will treat the subject of a clause and not the verb (or other relation) as the head. In the sentence “John ate” they may assign a ranking of 1 to “John” and a ranking of 2 to “ate”. If so, this will be an indication that the subject is considered the central element of a sentence, with the predicate—which functions to say something about the subject—being less central. From this perspective, the predicate is a modifier of the subject, not the head of a clause. In a typological analysis, Hawkins (1974) suggests that the head-modifier relationship is more universal than the function-argument relationship. Such a result would provide support for Hawkins’ analysis with respect to English. Although, this result can be handled with some modification to Double R Grammar, it is not predicted and not expected. The sentence “John ate” refers to a situation of eating in which John is a participant. Although John is an important element of the sentence, the reference of the sentence to an eating situation suggests that “ate” and not “John” is the most important element or head. The head is not the word in the sentence or expression which is most contentful, it is the word that determines what the sentence or expression may be used to refer to.

It is a basic claim of Double R Grammar that “on” in the “the book is on the table” is the head of the sentence in accord with the fact that the sentence as a whole refers to a situation which describes a relationship of *being on* between *a book* and *a table*. The word “on” contributes most to the overall meaning of the sentence. However, the preposition “on” is often treated as a minor function word without much meaningful content and it will be competing with the contentful words “book” and “table” for the status of head. As a result, this sentence will provide a strong test of the notion of headedness put forward in Double R Grammar.

It is not expected that subjects will select auxiliary verbs like “is” in “the book is on the table” as the most meaningful word. If they do, this would constitute evidence against a basic principle of Double R Grammar. On the other hand, failure of subjects to select “is” does not constitute evidence against the *Functional Head Hypothesis* of Generative Grammar. The empirical task of identifying the semantically most significant word in a sentence is not one that Generative Grammarians would accept as being relevant to their syntactic theory. On the other hand, expressions like “The book, on the table, no way!” (should) present a challenge for Generative Grammar in that there is no verb whatsoever in the expression. Such expressions are the cornerstone of Construction Grammar which embraces atypical constructions, but they are often eschewed as peripheral and unrevealing in Generative Grammar.

Expressions like “a bunch of bananas” present an interesting test of headedness. It is generally accepted that the head of a subject nominal agrees with the verb (or auxiliary verb) in normal sentences. If “bunch” is the head of “a bunch of bananas” then “a bunch of bananas is on the table” is the normal form of agreement. However, “bunch” is a semantically bleached word and “bananas” is semantically explicit. If “bananas” is the semantically most significant word, and hence the head, then “a bunch of bananas are on the table” is the normal form with “bananas” functioning as the head despite its position as the complement of the preposition “of”. If “bananas” is the head, then “bunch of” takes on a modifying function and subjects may group “bunch of” together to indicate this functionality, despite the fact that “of bananas” is a perfectly normal prepositional phrase. It would be especially interesting if subjects showed differences in head selection and grouping preferences based on the difference in agreement between “a bunch of bananas is on the table” and “a bunch of bananas are on the table”!

The claim that all phrases necessarily have a head is controversial. For example, Huddleston and Pullum (2002) argue that expressions involving conjunctions like “the bread and butter” are unheaded. Langacker (1991) argues that expressions like “the red” in “the red is nice” are unheaded, with the head of the expression being implicit when not explicitly lexicalized by “one” as in “the red one”. In Construction Grammar, various unheaded constructions like “the harder I try, the worse I get” have also been proposed. The claim is that there is no overall head in this construction, although the components of the construction “the harder I try” and “the worse I get” may have the heads “harder” and “worse”. It is generally assumed in Double R Grammar that most expressions have heads. In “the bread and butter”, “bread” and “butter” likely function as conjoined heads. In “the

red”, the adjective “red” can function as the head in the absence of a noun or “one” as the head. In “the red one”, “one” is the head despite its minimal meaningful content since it supports reference to a generic object. The construction “the harder I try, the worse I get” may legitimately be headless at the level of the overall construction. Although not part of this study, some empirical mechanism for determining whether or not there are unheaded constructions is desirable.

### Study 3: Parts of Speech

In this part of the study, subjects will be asked to determine the part of speech of words in various contexts. It is a basic claim of Double R Grammar that nouns, verbs and adjectives can occur in different contexts without changing their part of speech. For example, in

1. He is **running**
2. The **running** animal
3. The **running** of the animals
4. **Running** laps is fun

the word “running” occurs in five different grammatical contexts. In many grammatical approaches, “running” would be considered a verb (participle) in 1, an adjective in 2, a noun in 3, and a gerund in 4. Borer (2004) makes the strong claim that substantive words in the mental lexicon are not encoded with part of speech information. Instead, part of speech is determined by the syntactic structures in which they participate. Borer argues for a return to a syntax based representation of linguistic knowledge with a corresponding reduction in the importance of lexical knowledge (an anti-lexicalist position). In contrast, Double R Grammar claims that words encode base part of speech information in the mental lexicon, but that words can function in multiple grammatical contexts. In the examples above, “running” is a verb that is functioning as the head of a clause in 1, a nominal head modifier in 2 and the head of a nominal in 3. The function of words is distinct from their base part of speech and grammatical approaches which conflate part of speech and grammatical function are unable to capture this distinction.

The key issue addressed in this study is what constitutes a lexical entry in the mental lexicon. Unlike Borer, most language researchers assume that part of speech information is a key element of lexical entries in the mental lexicon (cf. Levelt, 1989). If the word “running” is a verb in 1, an adjective in 2 and a noun in 3, then three separate entries in the mental lexicon are implied. On the other hand, if the word “running” is a verb (participle) in all three examples, then a single entry in the mental lexicon will suffice. Allowing words to have multiple parts of speech based on the syntactic structures they may occur in results in a rabid proliferation of lexical entries (e.g. most nouns can be adjectives, most adjectives can be nouns, most verbs can be adjectives and nouns) unless a position like that of Borer (no part of speech information independent of syntactic context) or Double R Grammar (determinate part of speech subject to various grammatical construals) is adopted. One advantage of the Double R Grammar position is that it supports a notional (i.e. meaningful) basis for part of speech determination. Words

have a part of speech based on their most common use, with that use reflecting the meaning of the word. Alternative uses result from grammatical construal processes that impose different perspectives on the base meaning of the word. For example, Talmy (2003) discusses the grammatical process of reification of action words like “call”. The difference in meaning between “called” in “John called me” and “call” in “John gave me a call” is the result of this grammatical process which allows “call” to be used objectively. Dixon (2005) presents a linguistic study of what he calls the “give a verb, have a verb and take a verb constructions”. According to Dixon, of the 700 most common verbs, “about one-quarter of them can occur in at least one of the constructions”. As part of this study, examples of these constructions will be presented and subjects will be asked to identify the part of speech of the “verb” element of the construction.

An important goal of this study is to show that the basic linguistic technique of using syntactic location to determine part of speech is seriously flawed. Words have a part of speech based on their common use, but words may be used in grammatical contexts which provide alternative construals. Syntactic construal is the parallel of morphological construal. Morphologically, a verb can be converted into a noun via addition of “-al” as in “arousal” which is derived from the verb “to arouse” (or “construal” from “to construe”). In morphology, there is no claim that “arouse” is a noun because it occurs in “arousal”. But this is effectively what is claimed in syntactic approaches which insist that the head of a noun phrase is necessarily a noun. If the head of a noun phrase retains its base part of speech in an expression like “the running of the bulls”, then morphology and syntax are brought into closer alignment. The head or stem contributes the main semantic content and the grammatical or morphological context determines how the head or stem is used or construed.

If a word is used in an alternative construal frequently enough, it may come to have a separate entry in the mental lexicon. In fact, the base construal of a word is to some extent language dependent. A word that is a noun in one language may be an adjective in another. A word that is a verb in one language may be an adjective in another. These differences are meaningful and relate to the base lexical construal of the word in the language.

A possible addition to this study is to have subjects group individual words based on their meaning in order to elicit knowledge of part of speech categories without requiring knowledge of part of speech category labels. If the groups created separate into well established part of speech categories, this would provide evidence that subjects have knowledge of parts of speech and treat part of speech categories as meaningful (and not purely syntactic) categories. Perhaps subjects could be given a list of part of speech categories and asked to label the groups after the fact.

The results of this study will have important implications for uni-polar theories of linguistic structure. If the head of a noun phrase like “running” in “the running of the bulls” is treated as a verb and not a noun by subjects—despite the linguistic context—then the most important principle of X-Bar Theory—that heads project the types of the phrases they occur in—will be called into question. More generally, linguistic formalisms

that assume a strong, endocentric relationship between heads and phrases, including Dependency Grammar, HPSG, and Generative Grammar will need to reconsider this basic theoretical position.

## **Conclusions**

The results of this empirical study will have important implications for Double R Theory. If subjects are unable to perform the tasks presented in the experiment, or can only perform them with great difficulty, this will be an indication that they do not have explicit knowledge of the representations that they create during language comprehension. Since Double R Theory assumes the creation of explicit declarative memory representations that can be retrieved and reflected on, this important aspect of the theory would be called into question. If subjects are able to perform the tasks, but do not create groupings that align with the predictions of Double R Grammar, then the system of representation will be called into question. If the preferences of subjects for selecting the most significant word in a sentence or expression do not align with the predictions of Double R Grammar, then this aspect of the theory will have to be revisited. If subjects consistently label the part of speech of words based on the syntactic context in which they occur and not based on the morphological form and/or meaning of the word, then this part of the theory will be challenged.

The validity of the empirical results as a test of Double R Theory and other linguistic formalisms depends on whether or not the experimental paradigm is itself valid. I have tried to argue that the paradigm is valid. This is an important question and the validity of the paradigm will no doubt be vigorously challenged. If it does stand up to scientific scrutiny, then it will open up a new realm of empirical investigation (or at least reinvigorate an earlier paradigm) within psycholinguistics. I am optimistic that this will prove to be the case. There are many potential avenues of investigation using this paradigm that could be explored. I do not personally expect to control or even lead that research. The creation of a PowerPoint version of the experiment is intended to keep the paradigm as simple as possible while supporting its on line use and easy propagation to other research labs. A simple paper and pencil version of the experiment would have the advantage of not requiring subjects to know about PowerPoint graphing capabilities, but would require more manual intervention by experimenters and would be more difficult to distribute. Programmatic versions would allow for more regimented control and manipulation of experimental inputs and facilitate analysis, but would be more difficult to propagate to other research organizations and would be more difficult to develop and modify.

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