The representation of structure in vision and language: outlines of papers to be discussed

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WEEK 1 *Introduction and motivation* [1]. Some thinkers (notably, Wittgenstein) postulated a link between the form of a proposition and its sense. We shall explore this idea, aiming at identifying possible parallels between the representation of object and scene structure in vision on the one hand, and the representation of syntactic and semantic structures in language on the other hand.

THEME 1: psychological and neuropsychological studies of the vision/language interface — week 2

WEEK 2

- *Analogical representation and language structure* [2]. "...40 subjects [were asked] to imagine visual scenes representing the meanings of simple utterances presented to them. The subjects then had to indicate the relative position, in each visual image, of two objects mentioned in each utterance. Series of utterances were presented differing syntactically (active or passive phrase) and semantically (specifying in different ways the spatial and temporal relations between the objects mentioned). The results of this mental imagery experiments indirectly support the hypothesis that syntactical structures can be represented in a nonlinguistic analogue medium."
- *Optic aphasia: a process of interaction between vision and language* [3]. "...First, evidence is reported showing that a verbal impairment specific to visually presented objects can be observed ...Secondly, a particular kind of visuo-verbal impairment is defined and called optic aphasia ... Thirdly, three hypotheses concerning the operation of the semantic system in normal subjects are derived from the evidence coming from this syndrome."
- *The language-to-object perception interface: evidence from neuropsychology* [4]. "If we consider objects, then the Gibsonian tradition teaches us that the richness of information available in the visual field is such that many of their properties may be inferred fairly directly from the visual array. Yet there are many other aspects of the visual world that cannot be inferred from the information in the visual field alone — the structural aspects of an object that are hidden from the present viewpoint, the potential behavior of an object and of the other objects likely to be found in its vicinity ...How are the processes involved in accessing these properties of an object when it is presented visually related to the way they are accessed when it is presented verbally?"

THEME 2: linguistic representation of visual space — weeks 3 through 6

WEEK 3 *How language structures space* [5]. "This chapter is concerned with the structure that is ascribed to space and the objects within it by linguistic 'fine structure,' that subdivision of language which provides a fundamental conceptual framework. The primary aim of the chapter is to characterize the general properties of this structuring and the linguistic-cognitive system in which it participates."

WEEK 4 *A spatial representation system in humans* [6]. "This target article reviews evidence for the functional equivalence of spatial representations of observed environments and environments described in discourse. It is argued that people possess a spatial representation system that constructs mental spatial models on the basis of perceptual and linguistic information. Evidence for a distinct spatial system is reviewed."

WEEK 5
- *On beyond zebra: the relation of linguistic and visual information* [7]. "This paper addresses the problem of how the forms of information derived by the visual system can be translated into forms useable by the language capacity, so that it is possible to talk about what one sees. The hypothesis explored here is that there is a translation between the 3D model of Marr's (1982) visual theory and the semantic-conceptual structure of Jackendoff's (1983) theory of natural language semantics."
- *"What" and "where" in spatial language and spatial cognition* [8]. "Fundamental to spatial knowledge in all species are the representations underlying object recognition, object search, and navigation through space. But what sets humans apart from other species is our ability to expres spatial experience through language. This target article explores the language of *objects* and *places*, asking what geometrical properties are preserved in the representations underlying object nouns and spatial prepositions in English."

WEEK 6 *Multiple geometric representations of objects in languages and language learners* [9]. "Central to our understanding of how young children learn to talk about space is the question of how they represent objects."

THEME 3: iconicity, cognitive grammar, and related issues — weeks 7 through 10

WEEK 7
- *Iconicity, isomorphism and non-arbitrary coding in syntax* [10]. "In surveying the history of our preoccupation with language as a code, one is struck by the fact that certain recurrent attitudes tend to cluster together in a way that is surely less than accidental, yet not quite logically necessary."
- *Metaphor-Icon Link in Poetic Texts: A Cognitive Approach to Iconicity* [11]. "This study attempts to clarify the interrelationship of the notions of metaphor and iconicity in the theory of cognitive metaphor ... In cognitive and semiotic terms, 'icons' and 'metaphors' share that property of signification 'motivated' by similarity. Connecting things of similarity is one of the basic operations of the human mind. The treatment of metaphor and iconicity in an interrelated fashion will provide a more cohesive and integrated explanation of various linguistic phenomena. The list of such phenomena includes word formation, word order, grammaticalisation, semantic change, poetic discourse, signed languages and

writing systems, as manifestations of the metaphor-icon link. This study shows that poetic texts, in particular, serve as an optimal example in this exploration because in poetic discourse, the metaphor-icon link is foregrounded rather than backgrounded as in ordinary discourse."

- *Homo Loquens* as 'sender-receiver' (i.e., *tranceiver*) and the *raison d'être* of sememic, lexemic and morphemic prefabs in natural language structures and language use [12]. "The paper enlarges the notion that syntax is full of 'freezes' and 'frames' (idioms, frozen phraseological units, etc.) by pointing out that natural languages show this feature of unpredictability on all levels. ... In syntax we find actually the 'greatest freedom,' but here, too, over and beyond bona fide idioms and phraseological units there are stereotypical forms ...".

WEEK 8 *Concept, Image, and Symbol: The Cognitive Basis of Grammar* [13] (selected chapters). "Langacker has collected, updated, and slightly revised 12 papers previously published in a variety of journals, explaining his theories of the symbolic nature of all valid grammatical elements and constructs, and the continuum of grammar and the lexicon. He applies the principles of cognitive grammar to a variety of languages and language groups, showing its use in both synchronic and diachronic analysis of such problems as locatives, passive voice, agreement, and the semantic characterization of basic grammatical classes."

WEEK 9 *Perceptual symbol systems* [14]. "Prior to the twentieth century, theories of cognition were inherently perceptual. Since then, developments in logic, statistics, and programming languages have inspired amodal theories of cognition that rest on fundamentally different principles than those underlying perception. In addition, perceptual theories of cognition have become widely viewed as untenable, because they are assumed to be recording systems, not conceptual systems. A modern theory of perceptual symbols is developed in the contexts of cognitive science and neuroscience. Six core properties establish a basic conceptual system: (1) Perceptual symbols are unconscious neural representations in perceptual systems, not conscious mental images . (2) Perceptual symbols are schematic, not holistic. (3) Perceptual symbols are multimodal, arising in the sensory modalities, movement, and introspection. (4) Perceptual symbols become integrated into systems that enable simulation competence, namely, the ability to simulate entities and events perceptually in their absence. (5) Frames underlie simulation competence and provide background knowledge for concepts. (6) Words and their syntactic frames become associated with simulation competences to allow linguistic control over the construction of perceptual simulations."

WEEK 10

- *Maps for verbs* [15]. "In this paper we present a dynamical representation sufficiently general and expressive to capture both the meaning of individual verbs and the more abstract commonality of sets of semantically related verbs. Our purpose is to develop a complete theory of language acquisition that can be implemented on a physical platform, such as a mobile robot. The representation of the semantics of a word or set of words is constructed incrementally based on what is happening in the agent's environment when the word or a member of the set of words is heard."
- *Mapping Conceptual Representations into Linguistic Representations: The Role of Attention in Grammar* [16]. "This paper presents a framework for investigating how conceptual representations of visual events are mapped into language. It outlines a model of event representations and how such representations are mapped into linguistic representations, details the role of cognitive processes of attention in such a model, and details an exprerimental method for investigating – both for particular languages and for typological comparison – how attention to component parts of events is mapped into language."

THEME 4: select computational approaches — weeks 11 through 12

WEEK 11 *The origins of syntax in visually grounded robotic agents* [17]. "Experiments are reported in which a group of software and/or robotic agents are able to develop a shared set of conventions with the multi-layered structure and complexity of natural languages. The languages are grounded in the environmental and bodily experiences as perceived by the agents. It is further shown how there can be a co-evolution of language and meaning and hence a progressive build up of cognitive competence."

WEEK 12 *Subsymbolic natural language processing: an integrated model of scripts, lexicon, and memory* [18] (precis). "Distributed neural networks have been very successful in modeling isolated cognitive phenomena, but complex high-level behavior has been amenable only to symbolic artificial intelligence techniques. Aiming to bridge this gap, this book describes DISCERN, a complete natural language processing system implemented entirely at the subsymbolic level. In DISCERN, distributed neural network models of parsing, generating, reasoning, lexical processing and episodic memory are integrated into a single system that learns to read, paraphrase, and answer questions about stereotypical narratives. Using DISCERN as an example, a general approach to building high-level cognitive models from distributed neural networks is introduced, and the special properties of such networks are shown to provide insight into human performance. In this approach, connectionist networks are not only plausible models of isolated cognitive phenomena, but also sufficient constituents for generating complex, high-level behavior."

WEEK 13 *Biological constraints and the representation of structure in vision and language* [19]. A review of [18]. "The computational building blocks of biological information processing systems are highly interconnected networks of simple units with graded overlapping receptive fields, arranged in maps. In view of this basic constraint, it is proposed that the present stage in the study of cognition should concentrate on gaining understanding of the cognitive system at the level of the distributed computational mechanism. The model of script understanding introduced in [18] appears promising, both because it treats seriously the question of architecture of the language processor, and because its architectural features resemble those used in modeling other cognitive modalities such as vision."

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