

On the intellectual roots of functionalism in linguistics

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1. Antiquity

In Biology, the mother of all functionalist disciplines, one can trace two traditional lines of adaptive-functional thought. The first, global or macro functionalism, is the Darwinian discussion of **adaptive selection**, whereby organisms or populations adapt to their external environmental (Darwin 1859), or to their self-created niche (Waddington 1942, 1953; Odling-Smee *et al.* 2003). In this sense, one may consider language as an adaptation selected for a particular niche in which communication enhanced sociality and conferred various adaptive-reproductive advantages (Darwin 1871; Washburn and Lancaster 1968; Lieberman 1984 Greenfield 1991; Dunbar 1992, 1998; Knight 1998; Számádó and Sathmáry 2006; Tomasello *et al.* 2005; Bickerton 2005, Givón 2009; *inter alia*).

The second line, concerning the **functional motivation** for the structure of individual bodily organs, harkens back to Aristotle, the founder of empirical biology. Two structuralist schools dominated Greek biological thought prior to Aristotle's, both seeking to understand bio-organisms like inorganic matter. Empedocles proposed to explain organisms by their **component elements**, while Democritus opted for understanding them through their **component parts**-- their structure.

In *De Partibus Animalium*, Aristotle first argued against Empedocles' elemental approach, pointing out the relevance of histological and anatomical macro-structure:

(1) "...But if men and animals are natural phenomena, then natural philosophers must take into consideration not merely the ultimate substances of which they are made, but also flesh, bone, blood and all the other homogeneous parts; not only these but also the heterogenous parts, such as face, hand, foot..." (McKeon ed. 1941, p. 647)

Aristotle next noted the inadequacy of Democritus' structuralism:

(2) "...Does, then, configuration and color constitute the essence of the various animals and their several parts?... No hand of bronze or wood or stone constituted in any but the appropriate way can possibly be a hand in more than a name. For like a physician in a painting, or like a flute in a sculpture, it will be unable to do the *office* [= function] which that name implies..." (*ibid.*, p. 647; italics & bracketed translations added)

Next, Aristotle offered his functionalist touchstone--the teleological interpretation of living organisms, using the analogy of usable artifacts:

(3) "...What, however, I would ask, are the forces by which the hand or the body was fashioned into its shape? The woodcarver will perhaps say, by the axe and auger; the physiologist, by air and earth. Of these two answers, the artificer's is the better, but it is nevertheless insufficient. For it is not enough for him to say that by the stroke of his tool this part was formed into a concavity, that into a flat surface; but he must state the *reasons* why he struck his blow in such a way as to affect this, and what his final *object* [= purpose] was..." (*ibid.*, pp. 647-648; italics added)

Finally, Aristotle outlined the governing principle of functionalism, the isomorphic mapping between form and function:

(4) "...if a piece of wood is to be split with an axe, the axe must of necessity be hard; and, if hard, it must of necessity be made of bronze or iron. Now exactly in the same way the body, which like the axe is an *instrument*--for both the

body as a whole and its several parts individually have definite operations for which they are made; just in the same way, I say, the body if it is to do its *work* [= function], must of necessity be of such and such character..." (*ibid.*, p. 650; italics and brackets added)

Ever since Aristotle, **structuralism**--the idea that structure is autonomous, arbitrary and requires no 'external' explanation; or worse, that structure somehow explains itself--has been a dead issue in biology, a discipline where common-sense functionalism is taken for granted like mother's milk. Thus, from a contemporary introductory anatomy text:

(5) "...anatomy is the science that deals with the structure of the body... physiology is defined as the science of function. Anatomy and physiology have more meaning when studied together..." (Crouch 1978, pp. 9-10)

Paradoxically, Aristotle, following Epicure, is the father of structuralism in linguistics, as may be seen in the opening paragraph of *De Interpretatione*:

(6) "Now spoken sounds [=words] are symbols of affections of the soul [=thoughts], and written marks are symbols of spoken sounds. And just as written marks are not the same for all men [=are language specific], neither are spoken sounds. But what these are in the first place signs of--affections of the soul --are the same for all [=are universal]; and what are these affections are likenesses of -- actual things--are also the same for all men..." (J.L. Ackrill ed. 1963; bracketed translation added)

From Aristotle's **empiricist** perspective, thoughts ('affections of the soul') reflect external reality ('actual thing's) faithfully, iconically ('are likenesses of'). What is more, this reflecting relation is universal ('the same for all men'). In contrast, linguistic expressions ('words') bear an arbitrary relation to ('are symbols of') thoughts. And this relation is not universal ('not the same for all men').

Paradoxically again, Aristotle wound up hedging his bets about language. In his treatment of grammar in *The Categories*, and in various other works on logic (*Prior Analytic*, *Posterior Analytic*), an **isomorphism**--functionally motivated relation--is postulated between grammatical categories and sentences, on the one hand, and logical meaning.

A similar hedging of bets is found in Plato's *Cratylus* dialog (Hamilton and Cairns eds 1961), where Cratylus argues for the Aristotle/Epicure arbitrariness position (*nomos*), while Socrates argues for a motivated, natural, isomorphic relation (*physis*); and further, that language is an *organ* dedicated to the expression of meaning.

Socrates' (i.e. Plato's) naturalness position was extended to grammatical analysis in the works of the Alexandrine philosopher Marcus Terrenius Varro (116-26 BC) and the Roman philosopher Apollonius Dyscolus (80-160 AD). This extension merged Plato's 'naturalness' position concerning the compositionality of lexical words with Aristotle's functionalist analysis of grammatical categories (Itkonen 2010).

2. Middle Ages to the 19th Century

Most later Platonists opted for Socrates' naturalism and universality. And indeed, from early on there tended to be a less-than-perfect clustering of approaches to language along the philosophical dichotomy of Aristotelian **empiricism** vs. Platonic **rationalism**:

(7)	domain	functionalism	structuralism
	=====	=====	=====
	epistemology:	rationalism	empiricism
	motivation:	naturalness	arbitrariness
	universals:	universality	diversity
	mind:	mentalism	externalism
	ontogeny:	innateness	input-dependence
	diachrony:	emergence	???
	evolution:	evolution	???

That the clustering in (7) was imperfect was obvious from two glaring exceptions. The first goes back to Aristotle: Medieval Latin grammarians/logicians, the *Modistae*, subscribed to St. Thomas Aquinas' Aristotelian empiricism, but also to the logical functionalism and universalism of *The Categories* (e.g. St. Anselm's *De Grammatico*; also Boethius of Dacia, Sigerus de Cortraco; William Ockham; see discussion in Itkonen 2010).

Subsequently, the *Port Royal* French grammarians (Arnauld 1662; Lancelot & Arnauld 1660) reverted, via Descartes, to Platonic rationalism, thus conforming better to the clustering in (7). The second exception is Chomsky (see below).

3. The 19th Century

In philosophy, there was a subtle sea change at the end of the 18th Century, with Kant and the emergence of the **pragmatic middle-ground** between the two extreme schools of epistemology. Its impact was not immediate, and the birth of linguistics proper in the early 19th Century took place in a context of a continuing Platonic/rationalist perspective and an implicit functionalism. However, the 19th Century contributed three important ingredients to the mix in (7). The first came with linguistics itself--**diachrony**. The other two emerged through contact with other disciplines: First, the expansion of Platonic mentalism from logic and meaning to a broader concept of **cognition** under the impact of nascent psychology. And second, the addition of **evolution** under the impact of Darwinian biology. The most conspicuous exponents of this enriched mix were W. von Humboldt (1836) and Hermann Paul (1890). Their perspective carried over into the 20th Century with illustrious exponents such as Otto Jespersen (1921, 1924) and Edward Sapir (1921), as well as the oft-forgotten functionalism of George Zipf (1935), who seems to have retained a great reservoir of common sense about language:

(8) "...language is primarily a representation of experience. It may represent [it] as a report of direct perceptual experience... Or it may represent tendencies to act...[thus] potential activity, such as oration to persuade others to modify their behavior in accord with the wishes of the speaker... A function of the linguistic representation is to restore equilibrium. The equilibrium may be of two types: (a) inter-personal and (b) intra-personal..." (Zipf 1935, pp. 294-295)

4. Structuralism

The rise of structuralism in the social sciences in the early 20th Century is sometimes seen as a reaction to so-called naive functionalism of the late 19th Century Romantics. The real impetus, however, was again external, coming from a radical brand of empiricism-- **Logical Positivism** in philosophy. To the infant disciplines of psychology, anthropology and linguistics, two towering exponents of Logical Positivism, Bertrand Russell (Russell 1956) and Rudolph Carnap (Carnap 1963) offered the deceptive analogy of physics, inadvertently reaching back to pre-Aristotelian biology.

In tracing the roots of 20th Century structuralism to Positivist philosophy, one must recall that the ultimate descent of Positivism in the philosophy of science goes back to

Aristotle's objectivist epistemology. This is fairly transparent in, e.g., Rudolph Carnap's later reflection upon the physicalism of the Vienna Circle:

(9) "...The thesis of physicalism, as originally accepted in the Vienna Circle, says roughly: Every concept of the language of science can be explicitly defined in terms of observables; therefore every sentence of the language of science is translatable into a sentence concerning observable properties..." (Carnap 1963, p. 59)

Bertrand Russell's objectivism, couched in somewhat forbidding terms, is evident in his discussion of the relation between particular entities and the universal concept to which they give rise:

(10) "...We may then define a *particular* in our fourth sense as an entity that cannot be in or belong to more than one place at any particular time, and a *universal* as an entity that either cannot be in or belong to any place, or can be in or belong to many places at once...Owing to the admission of universals in our fourth sense, we can make an

absolute division between percepts and concepts. The universal whiteness is a *concept*, whereas a particular white patch is a *percept*....Such *general qualities* as whiteness never exist in time, whereas the things that do exist in time are all particular [percepts]..." (*Relations of universals & particulars*; in Russell 1956, p. 122)

The core notions of functionalism, *purpose* or *function*, are invisible teleological constructs that defy translation into Carnap's 'language of science'; as are psychological concepts such as *meaning*, *intent*, *mind*, *knowledge* or *belief*. The critical element that makes something a biological code, or in C.S. Peirce's (1934, 1940) words "something by knowing of which one knows something more", is the signal's association with some purpose or function. This is where the world of living organisms stands in stark contrast to the pre- biological universe of physics and chemistry, where teleological notions are senseless, except perhaps in reference to the Divine. To quote the physicist I. Rabi:

(11) "...My view of physics is that you make discoveries but, in a certain sense, you never really understand them. You learn how to manipulate them, but you never really understand them. "Understanding" would mean relating them to something else--to something more profound..." (Rabi 1975, p. 96)

Aristotle's doctrine of the arbitrariness of the linguistic sign--thus the arbitrariness of cross-language diversity--pertained explicitly only to the semiotic relation between concepts and sounds or letters, i.e. the lexicon. But latter-day structuralists unreflectively extended the doctrine to grammar. In the intellectual climate fostered by Logical Positivism, F. de Saussure (1915) elaborated the three central dogmas of structuralism:

! **arbitrariness**: The detachment of the visible signal from invisible mental-- purposive--correlates

! **idealization**: The reification of the underlying system--*langue*--as against the manifest behavior--*parole*.**[FN 1]**

! **segregation**: The detachment of synchrony (product) from diachrony (process). Leonard Bloomfield, the father of American structuralism, owed his conception of meaning to the empiricism of behaviorist psychology:**[FN 2]**

(12) "...We must study people's habits of language -- the way they talk -- without bothering about mental processes that we may conceive to underlie or accompany habits. We must dodge the issue by a fundamental assumption, leaving it to a separate investigation, in which our results will figure as data along the results of other social sciences..." (Bloomfield 1922, p. 142)

(13) "...In order to give a scientifically accurate definition of meaning for every form of the language, one should have to have a scientifically accurate knowledge of everything in the speaker's world... In practice, we define the meaning of a linguistic form, whenever we can, in terms of some other science..." (Bloomfield 1933, pp. 139-140)

In the same vein, Bloomfield's rejection of universals and theory harkens back to Aristotle's and Saussure's arbitrariness:

(14) "...North of Mexico alone there are dozens of totally unrelated groups of languages, presenting the most varied types of structures. In the stress of recording utterly strange forms of speech, one soon learns that philosophical presuppositions were only a hindrance... The only useful generalizations about language are inductive generalizations..." (1933, pp. 19-20).

5. Chomsky

Noam Chomsky's theoretical perspective displays a baffling melange functionalist and structuralist features. On the one hand, Chomsky's structuralist provenance is clearly evident in his subscription to Saussure's **arbitrariness** ('autonomous syntax'), **idealization** ('competence') and **segregation** (irrelevance of diachrony). In ch. 1 of *Aspects* (1965), idealization is introduced as follows:

(15) "...Linguistic theory is concerned primarily with an idealized speaker-listener, in a completely homogeneous speech-community, who knows its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitation, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language to actual

performance...This seems to me to have been the position of the founders of modern general linguistics, and no cogent reason for modifying it has been offered. In the study of actual linguistic performance, we must consider the interaction of a variety of factors, of which the underlying *competence* of the speaker-hearer is only one. In this respect, the study of language is no different from empirical investigation of other complex phenomena..." (Chomsky 1965, pp. 3-4; italics added)

There is nothing *in principle* inimical to functionalism in idealization--provided it is strictly **methodological**. Data is always simplified during analysis. Theory is always more abstract than the data it purports to organize and explain. However, once cognition was relegated to the realm of 'performance', and with disinterest in change and variation, 'competence' became a theoretical prime, the endgame of both description and theory. Underscoring the connection between idealization and structuralism is Chomsky's (1961) description of grammar as a formal algorithmic machine:

- (16) "...By "grammar of the language L " I will mean a device of some sort (that is, a set of rules) that provides, at least, a complete specification of an infinite set of grammatical sentences of L and their structural description. In addition to making precise the notion "structural description", the theory of grammar should meet requirements of the following kind. It should make available:
- (1) (a) a class of possible grammars $G_1, G_2...$ (b) a class of possible sentences $S_1, S_2...$
 (c) a function f such that $f(i, j)$ is a set of structural descriptions of the sentence S_i that are provided by the grammar G_j , (d) a function $m(i)$ which evaluates G_i ,
 (e) a function g such that $g(i, n)$ is the description of a finite automaton that takes sentences of (b) as input and gives structural descriptions assigned to these sentences by $G_i...$ " (*On the notion 'rule of grammar'*, 1961, p. 6)

This **formalism** has remained a foundational leitmotif, running through multiple reincarnations of Generative Grammar. Over the years, it has grown ever more extreme, as Chomsky eventually (1992) dispensed with the last vestiges of concrete syntactic structures altogether:[FN 3]

- (17) "...[Early generative grammar proposed that] each language is a rich and intricate system of rules that are, typically, construction-particular and language-particular... The principles-and-parameters approach that has developed in recent years, and that I assume here, breaks radically with this tradition... The notion of grammatical construction is eliminated, and with it, construction-particular rules. Constructions such as verb phrase, relative clause, passive, etc., are taken to be *taxonomic artifacts*, collection of phenomena explained through the interaction of the principles of UG, with the values of parameters fixed..." (Chomsky 1992, p. 3; bracketed material and italics added)

By the time *Aspects* (1965) came along, the feature mix of Generative Grammar has become rather heterogenous. First, the transformational relation between 'deep' and 'surface' structures has always hinged on **meaning** (propositional semantics). This was obscured by Harris' (1965) terminology ('co-occurrence'), but was explicitly embraced in ch. 2 of *Aspects*, and is only marginally compatible with structuralism (or empiricism).

Next came the assumption of Cartesian **mentalism** (1965, ch. 1, 1966, 1968). But this clashed head on with 'competence', which ruled psychology out of bounds. The mentalism Chomsky envisioned thus turned out to be so abstract and formal so as to have relatively little to do with empirically-studied mental representation and mental processing.

Next Chomsky (1959, 1965 ch. 1, 1966, 1968) came up with an extreme **innatist** account of language acquisition, again a move toward Cartesian Platonism. This was confounded, however, by Chomsky's puzzling resistance to a biologically-plausible account of language **evolution**, coupled with a life-long insistence on Cartesian **exceptionalism** (1968; see also Hauser *et al.* 2002).[FN 4]

Lastly, there is the puzzling contradiction between the implicit functionalism of ch.2 of *Aspects*, where 'deep structure' is said to be isomorphic to propositional semantics ('logical structure'), and ch. 3, where the communicative correlates of transformations are ignored ('transformations don't change meaning'), or dismissed as 'stylistic options'. Chapter

2 was the real launching pad of the **Generative Semantics** rebellion (Ross and Lakoff 1967). And the frustration of chapter 3's mid-stream retreat to structuralism forced many of us to undertake the empirical study of the communicative underpinnings of syntax (Hooper and Thompson 1973; Givón 1979, ed. 1979; Hopper ed. 1982; *inter*

6
alia).

The schizophrenic legacy of *Aspects* has haunted subsequent functionalist work for years to come, with persistent focus on the relation between grammar and propositional meaning, to the exclusion of communicative pragmatics (Chafe 1970; Lakoff 1970; Dik 1978; Foley and van Valin 1984; Langacker 1987, 1991; *inter alia*).

6. The pragmatic synthesis

Many could claim credit for the functionalist rebellion of the 1970s. My own take may sound a bit perverse, but I think the rebellion started with Chomsky himself, in *Aspects* (1965) and even before. Chomsky had managed, rather explicitly, to build so many apparent contradictions into his position, it was almost impossible to ignore them:

- ! Universality without the study of language diversity?
- ! Mentalism without psychology ('performance')?
- ! Logic/semantics without communication/discourse?
- ! Innateness without evolution?
- ! The centrality of acquisition without real child language data?
- ! Native speaker's intuition without spontaneous speech data?
- ! Ordered rules that mimicked diachrony, but Saussurean segregation?

In 1965-1967, each one of us focused on one--or at best a few--of these contradiction. But sooner or later it became clear that the emperor was stark raving naked.

The functionalism that emerged out of the anti-Generative rebellion of the late 1960s assembled its intellectual baggage gradually, piecemeal and often retroactively. The philosophical background, whether acknowledged or not, was the re-emergence of the Kantian-Peircean **pragmatic middle ground** between the two reductionist schools of epistemology, empiricism and rationalism. This went with a corresponding middle ground between extreme inductivism and extreme deductivism in the philosophy of science (Hanson

1958). As Chomsky (1959, 1966) had it, there was no such middle ground. But a closer examination reveals a persistent pragmatic middle in both epistemology and methodology. Consequently, many of the stark dichotomies in (7) turned out to be empirically untenable. A more fine-grained approach to language, incorporating elements of both extremes, could now emerge. The main strands of this approach may be given as follows.[FN 5]

a. Communicative (discourse) function

Ch. 3 of *Aspects* was a clear challenge to functionalists--they had to demonstrate that transformations *were* communicatively motivated. That is, that surface-structure variation among clause types was not a mere matter of 'stylistics' (Hooper and Thompson 1973). What was needed, above all, were structure-independent criteria--or empirical tests--for hypotheses about the communicative function of syntactic structures. The initial step here was to study the **text-distribution** of morpho-syntactic structures (Chafe ed. 1980, 1994; Givón 1979, ed. 1983). But this was only a first step toward a more direct experimental, cognitive validation of the notion 'communicative function'.

b. Iconicity

A relatively short-lived boom in iconicity studies, inspired by Peirce (1934, 1940), took place in the 1980s, purporting to demonstrate the non-arbitrariness of grammar (Haiman 1985, ed. 1985). Unfortunately the notion of 'iconicity' involved in the discussion never transcended the relatively concrete pictorial level. Underlying cognitive, neurological and bio-evolutionary mechanism were seldom invoked, in spite of the near-certainty that pictorial iconicity was the surface product of complex emergence (Givón 1995).

c. Universality cum variation

Here, under the clear influence of Joseph Greenberg, a convergence took place between the extreme Bloomfieldian/Aristotelian approach of unconstrained diversity and the extreme Chomskian approach of abstract universality. Both were recognized as necessary ingredient in a mature, empirical perspective, whereby universality did not contrast with diversity but rather predicted and constrained it. And further, the emphasis now shifted from formal to substantive universals, thus to the interplay between purely-structural (linguistic) and substantive (cognitive, neurological, biological) universals. And finally, universals were increasingly ascribed to the process of emergence (Heine and Kuteva 2007; Givón 2009).

d. Cognition and neurology

The relation between language and cognition ought to have become, at least in principle, a crucial ingredient of the pragmatic synthesis of the 1970s; first in relation to lexical-semantic memory (Atkinson and Shiffrin 1968; Swinney 1979; Spitzer 1999, *inter alia*); then in relation to working memory and attention (Carpenter and Just 1988; Just and Carpenter 1992; Garthercole and Baddeley 1993; *inter alia*); but perhaps most crucially in relation to episodic memory and discourse processing (Kintsch & van Dijk 1978; Loftus 1980; Anderson *et al.* 1983; Gernsbacher 1990, ed. 1994; Kintsch 1992, 1994; Ericsson and Kintsch 1995; *inter alia*).[FN 6]

In the same vein, understanding the neurology of visual information processing (Ungerleider and Mishkin 1982; Squire 1987; Squire and Zola-Morgan 1991), and of the attentional and working-memory systems (Schneider and Chein 2005; Posner and Fan 2008), is crucial to an eventual account of language processing and language evolution (Givón 1995, ch. 9). Of most immediate relevance are the neurology of lexical semantics (Peterson *et al.* 1988; Raichle *et al.* 1993; Snyder *et al.* 1995; Posner and Pavese 1997; Abdulaev and Posner 1997; Caramazza 2000; Martin and Chao 2001; Bookheimer 2002; Pulvermuller 2003; Badre and Wagner 2007; *inter alia*) and the processing of simple and complex clauses (Friederici 2009; Friederici and Frisch 2000; Friederici *et al.* 2006a, 2006b; Grodzinsky and Friederici 2006; Pulvermuller 2003; *inter alia*).[FN 7]

e. Diachrony & grammaticalization

The resurgent interest in diachronic syntax and grammaticalization in the 1970's (Givón 1971, 1979; Li ed. 1977; Heine *et al.* 1991; Heine and Traugott eds 1991; Heine and Kuteva 2007; Hopper and Traugott 1993; Bybee *et al.* 1994; *inter alia*) represented an integral strand in the functionalist tapestry and a return to F. Bopp and H. Paul. The resurgence of diachrony dovetailed with the interest in typological diversity and universals, and in the diachronic underpinnings of synchronic typology (Givón 2002, 2009). It also dovetailed--Labov (1994) notwithstanding--with the functional motivation for change and emergence, an issue that is central to bio-evolution (see below).

f. Child language acquisition

The rise of the middle-ground pragmatic approach to child language acquisition was another important strand in the functionalist tapestry. Rather than an automatic consequence of innate, abstract universal parameters, the ontogeny of language was now seen as an **interaction** between multiple innate factors--neuro-cognition, communication, learning strategies, maturational sequences--and the care-giver's socio-affective, communicative and linguistic input (Ervin-Tripp 1970; Scollon 1976; Bates 1976; Bates *et al.* 1979; Bates and MacWhinney 1979; Ochs and Schieffelin eds. 1979; MacWhinney ed. 1999). Rather than an instantaneous single process, language acquisition turned out to be a gradual multi-stage emergence (Carter 1974; Bloom 1970/1973; Bowerman 1973; Bates *et al.* 1975).

7. The bio-evolutionary connection

The third trajectory of emergence, evolution, is fully compatible with functionalism in linguistics, meshing well with core preoccupation such as variation-and-change and the functional-adaptive motivation (Heine and Kuteva 2007; Givón 2002, 2009). Diachrony seems at first blush to be unprecedented in biology, as against ontogeny and phylogeny. However, language diachrony turns out to recapitulate many of the general features of biological evolution. This may be summed up in the following observations (Givón 2009, ch. 3):

! Today's micro-variation within the species/language engenders, at least potentially, tomorrow's macro-variation across species/languages.

! Conversely, today's starkly diverse extant species, genera, families, and phyla in biology, or starkly diverse languages, dialects and families, can be traced back to earlier variation at lower taxonomic levels (sub-species, sub-dialects).

! Consequently, gradual step-by-step *micro-variation* can yield, over time, stark and seemingly unbridgeable gaps of *macro-variation* among extant species or languages.

! The process of change itself, the invisible teleological hand that guides the ever-shifting but still roughly-isomorphic matching of structures and functions, is driven by adaptive selection, i.e. by functional-adaptive pressures.

! The overlaying of adaptively-driven changes in temporal order can lead, over time, to considerable

restructuring and arbitrariness of structure-function mapping, thus to seemingly non-adaptive *relic features* ('excess structure', 'spandrels').

! Universal principles do not control observed surface features directly, but rather control the developmental processes that, in turn, give rise to observed surface features.

In addition, six general principles seem to characterize both language diachrony and biological evolution:

- ! Graduality of change
- ! Adaptive-selectional motivation
- ! Functional change and ambiguity before structural change and specialization
- ! Terminal addition of new structures to older ones
- ! Local causation (but global consequences).
- ! Uni-directionality of change

To drive these points home, here are a few salient quotes from the evolutionary biologists E. Mayr and D. Futuyma. First, concerning Platonic idealization:

"...Plato's concept of the *eidōs* is the philosophical codification of this form of thinking. According to this concept the vast observed variability of the world has no more reality than the shadows of an object on a cave wall...Fixed, unchangeable "ideas" underlying the observed variability are the only things that are permanent and real. Owing to its belief in essences this philosophy is also referred to as *essentialism*...[which] dominated the natural sciences until well into the nineteenth century. The concepts of unchanging essences and of complete discontinuity between every *eidōs* (type) and all others make genuine evolutionary thinking well-nigh impossible..." (Mayr 1969, p. 4)

"...variation is at the heart of the scientific study of the living world. As long as *essentialism*, the outlook that ignores variation in its focus on fixed essences, held sway, the possibility of evolutionary change could hardly be conceived, for variation is both the product and the foundation of evolution. Few other sciences take variation as a primary focus of study as does evolutionary biology..." (Futuyma 1986, p. 82)

The profound difference between biological and pre-biological science, what Aristotle insisted on in the 4th Century BC, indeed hinges on **variation**. That is:

"...Until a few years ago, when an evolutionist or a systematist opened the book on the philosophy of science, and read about the basic concepts, methods and objectives of science, he was bound to be distressed to discover how little all this had to do with his own particular endeavor. The reason for this incongruity is that these books were written either by logicians or physicists. These authors did not realize that the physical sciences are a very specialized branch of science. Its ideal is to explain everything under a few general laws and to subordinate all diversity under a limited number of broadly-based generalizations[...] Perhaps the outstanding aspect of the physical sciences is the identity of the entities with which it deals. A sodium atom is a sodium atom no matter where you encounter it and what its chemical history might have been. It always has exactly the same properties. The same is true for the elementary particles, the protons, electrons, mesons, etc., or for the aggregates of atoms, the molecules. It is the sameness of these entities that permits the determination of extremely precise constants for all the properties of these constituents as well as their inclusion in general laws.

How different is the material of the systematist and evolutionist! Its outstanding characteristic is uniqueness. No two individuals in a sexually reproducing population are the same (not even identical twins), no two populations of the same species, no two species, no two higher taxa[...]..." (Mayr 1976, pp. 408-409)

Both variation and its limits are adaptively motivated, exhibiting a fluid trade-off relation. Excessively-constrained variation deprives a population of evolutionary dynamism, as innovative adaptive solutions to potential novel conditions are diluted and re-absorbed into the common gene pool. Unconstrained variation leads to reproductive isolation and speciation, whereby the creative adaptive innovations of dynamic outlier populations cease to contribute to the common gene-pool (Bonner 1988).

The source of variation in biological populations is both genetic (genotypic) and non- genetic (phenotypic, behavioral). While both can be adaptive, it is only genetic variation that has direct evolutionary consequences. However, the adaptive interaction of genes with the environment--natural selection--is mediated by the phenotypic structural and behavioral traits controlled by them. As a result, non-genetic variation does partake in the actual mechanism of adaptive selection. In this way, synchronic variation in the phenotypic behavior, thus the adaptive experimentation of individuals, contributes, in a fashion reminiscent of the Lamarckian program, to the eventual direction of adaptive evolution. Or, as Ernst Mays puts it:

"...Many if not most acquisitions of new structures in the course of evolution can be ascribed to selection forces exerted by newly-acquired behaviors (Mayr 1960). Behavior, thus, plays an important role as the pacemaker of evolutionary change. Most adaptive radiations were apparently caused by behavioral shifts..." (Mayr 1982, p. 612)

Synchronic variation *within* a biological population is at the very heart of the mechanism of evolutionary change, whereby such micro-variation can become, in time, macro-variation *across* distinct populations. In linguistics, this is akin to saying that today's synchronic variants are but the potential reservoir of tomorrow's diachronic changes, the *Labov Principle* (Givón 2009, ch. 3).

An important line of research that is highly relevant to the evolution of language may be found in **primatology** and **animal ethology** (deWaal 1982, 2001; Cheney and Seyfarth 1990, 2007; Hrdy 2009; Tomasello and Call 1997, Tomasello *et al.* 2005; Boesch and Boesch-Achermann 2000; Crockford and Boesch 2002, 2005; *inter alia*). While not pointing directly at language, this magnificent body of work lays out the parameters of gradual socio-cultural evolution in primates, hominids and *homo sapiens*, which is in turn the real context for the evolution of human communication.

Recent works in **evolutionary psychology** (E.O. Wilson 1975, 1978; Barkow *et al.* eds 1992; Geary 2005; *inter alia*) and **evolutionary anthropology** (Hamilton 1964; Trivers 1971; Axelrod 1984; Richerson *et al.* 2003; Richerson and Boyd 2005; Orbell *et al.* 2004; Marlowe 2005, 2010; *inter alia*) point in the very same direction--toward the integration of the study of mind, culture and bio-evolution.

The intellectual integration of the human sciences with evolutionary biology has been facilitated by evolutionary biologists, in their growing recognition of the pivotal role that everyday adaptive behavior plays in guiding both ontogeny and phylogeny. This essentially-Lamackian intellectual program is founded upon clear non-Lamackian mechanism, integrating life-time behavioral change (diachrony), maturational development (ontogeny) and genetic change (evolution) into a single evolutionary perspective (Waddington 1942, 1953; Mayr 1976; Fernald and White 2000; West-Eberhard 2004; *inter alia*). In this connection, it is worth quoting two evolutionary biologists studying the evolution of social fish:

"...Behavior can and does influence specific aspects of brain structure and function over *three different time frames*. A causal link is easy to establish on an *evolutionary time scale* because selective forces of the ecological niche of the animal typically are reflected in the body shape, sensory and motor systems, and behavior. Similarly, on a *developmental time scale*, behavior acts in concert with the environment to establish structural changes in the brain that influence an organism throughout its lifetime. Surprisingly, there currently is evidence that in *real time*, *social behavior* also causes changes in the brain in adult animals..." (Fernald and White 2000, p. 1193; emphases added)

Linguistics, much like its sister human sciences psychology and anthropology, emerged out of a long humanistic tradition that tended to discount the biological foundations of mind, language and culture, with occasional visionaries like Herman Paul and George Zipf notwithstanding. The profound move in the sister disciplines towards re-integrating the sciences of life within a bio-evolutionary perspective is an open invitation to join the consortium. An intellectual framework is now in place whereby linguistics may take its rightful place along its sister discipline that study live organisms--biology, psychology and anthropology. With its integrative impulse, this *research programme* harkens all the way back to Aristotle, and thus closes an ancient circle.

Notes

*

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1

Saussure's idealized *langue* harkens back to Plato's *eidon* ('essence'; see Bostock 1994; Williams 1994).

2

Bloomfield got his behaviorism from his Chicago colleague Weiss, thus indirectly from Watson. He and his structuralist followers never adopted the Platonic/Saussurean idealization, an anathema to empiricists.

3

In the same vein, the rules of grammar were boiled down to a single abstract one, 'merge' (Rizzi 2009; Bickerton 2009).

4

The logical contradiction here is quite glaring, since innateness implies genetic coding, which is itself the cumulative product of adaptive-selected evolution. Many functionalists purport to accept language evolution but reject innateness, the converse of Chomsky's contradiction.

5

Few of the participants in the functionalist renaissance of the 1970s explicitly acknowledge all these strands. They nonetheless hang together coherently as a broad *research programme*.

6

Unfortunately, the vast majority of self-designated functionalists, of whatever sect, tend to expostulate about cognition without studying the cognitive literature.

7

While of great relevance in principle, current experimental work in neuro-linguistics suffers from two related, self-imposed methodological strictures: (a) Single-word or single-clause language stimuli, which remain largely out of the functional range of grammar; and (b) excessive focus on grammaticality judgements, ignoring the adaptive role of grammar in communication.

References

- Abdulaev, Y. and M.I. Posner (1997) "Time-course of activating brain areas in generating verbal associations", *Psychological Science*, 8.1.
- Anderson, A., S.C. Garrod and A.J. Sanford (1983) "The accessibility of pronominal antecedents as a function of episodic shift in narrative text", *Quarterly J. of Experimental Psych.*, 35A
- Anselm, St. *De Grammatico*, in D.P. Henry (1964) *The De Grammatico of St. Anselm*, Notre Dame, IN: University of Notre Dame Press
- Aristotle, *De Partibus Animalium*, in McKeon (ed. 1941) Aristotle, *The Categories*, in McKeon (ed. 1941)
- Arnauld, A. (1662) *La Logique, ou l'Art de Panser*, tr. in J. Dixon and P. James (1964) *The Art of Thinking*, Indianapolis: Bobbs-Merrill
- Atkinson, R.C. and R.M. Shiffrin (1968) "Human memory: A proposed system and its control processes", in K.W. Spence and T. Spence (eds) *The Psychology of Learning and Motivation*, vol. 2, NY: Academic Press
- Axelrod, R. (1984) *The Evolution of Cooperation*, NY: Basic Book
- Badre, D. and A.D. Wagner (2007) "The left ventrolateral prefrontal cortex and the cognitive control of memory", *Neuropsychologia*, 45
- Barkow, J.H., L. Cosmides and J. Tooby (eds 1992) *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, Oxford: Oxford University Press
- Bates, E. (1976) *Language in Context: The Acquisition of Pragmatics*, NY: Academic Press
- Bates, E. L. Benigni, I. Bretherton, L. Camioni and V. Voltera (1979) *The Emergence of Symbols: Cognition and Communication in Infancy*, NY: Academic Press
- Bates, E., L. Camioni and V. Voltera (1975) "The acquisition of performatives prior to speech", *Bobbs-Merrill Quarterly*, 21
- Bates, E. and B. MacWhinney (1979) "A functional approach to the acquisition of grammar", in E. Ochs and B.V. Schieffelin (eds 1979)
- Bickerton, D. (2005) "The origin of language in niche construction", University of Hawaii, Honolulu (ms)
- Bickerton, D. (2009) "Recursion: Core of complexity or artifact of analysis?", in T. Givón and M. Shibatani (eds 2009)
- Bloom, L. (1970/1973) *One Word at a Time: The Use of Single-Word Utterances Before Syntax*, The Hague: Mouton
- Bloomfield, L. (1922) "Review of Sapir's Language", *The Classical Weekly*, 18
- Bloomfield, L. (1933) *Language*, NY: Holt, Rinehart and Winston
- Boesch, C. and H. Boesch-Achermann (2000) *The Chimpanzees of Tai Forest: Behavioral Ecology and Evolution*, Oxford: Oxford University Press
- Bonner, J.T. (1988) *The Evolution of Complexity in Animals*, Princeton: Princeton University Press
- Bookheimer, S. (2002) "Functional MRI of language: New approaches to understanding the cortical organization of semantic processing", *Ann. Rev. of Neuroscience*, 25
- Bostock, D. (1994) "Plato on understanding language", in S. Everson (ed. 1994) Bowerman, M. (1973) *Early Syntactic Development*, Cambridge: Cambridge University Press
- Bybee, J., W. Pagliuka and R. Perkins (1994) *The Evolution of Grammar: Tense, Aspect and Modality in the Languages of the World*, Chicago: University of Chicago Press
- Caramazza, A. (2000) "The organization of conceptual knowledge in the brain", in M. Gazzaniga (ed.) *The New Cognitive Science*, 2nd edition, Cambridge, MA: MIT Press
- Carnap, R. (1963) *The Philosophy of Rudolph Carnap*, ed. by P.A. Schillp, LaSalle, IL: Open Court
- Carpenter, P. and M. Just (1988) "The role of working memory in language comprehension", in D. Klahr and D. Kotovsky (eds) *Complex Information Processing: The Impact of Herbert Simon*, Hillsdale, NJ: Erlbaum
- Carter, A. (1974) *Communication in the Sensory-Motor Period*, PhD dissertation, UC at Berkeley (ms)
- Chafe, W. (1970) *Meaning and the Structure of Language*, Chicago: University of Chicago Press
- Chafe, W. (ed. 1980) *The Pear Stories*, Norwood, NJ: Ablex
- Chafe, W. (1994) *Discourse, Consciousness and Time: The Displacement of Conscious Experience in Speaking and Writing*, Chicago: University of Chicago Press
- Cheney, D. and R. Seyfarth (1990) *How Monkeys See the World*, Chicago: University of Chicago Press

- Cheney, D. and R. Seyfarth (2007) *Baboon Metaphysics*, Chicago: University of Chicago Press
- Chomsky, N. (1959) "Review of B.F. Skinner's *Verbal Behavior*", *Language*, 35
- Chomsky, N. (1961) "On the notion 'rule of grammar'", in *The Structure of Language and its Mathematical Aspects*, Providence RI: American Mathematical Society
- Chomsky, N. (1965) *Aspects of the Theory of Syntax*, Cambridge, MA: MIT Press
- Chomsky, N. (1966) *Cartesian Linguistics*, NY: Harper and Row
- Chomsky, N. (1968/1972) *Language and Mind*, NY: Harcourt, Brace, Jovanovich
- Chomsky, N. (1992) "A minimalist program for linguistic theory", *MIT Occasional Papers in Linguistics*, Cambridge, MA: MIT
- Crockford, C. and C. Boesch (2003) "Context specific calls in wild chimpanzees, *pan troglodytus verus*: Analysis of barks", *Animal Behavior*, 66
- Crockford, C. and C. Boesch (2005) "Call combinations in wild chimpanzees", *Behaviour*, 142
- Crouch, J.E. (1978) *Functional Human Anatomy*, 3rd edition, Philadelphia: Lea and Fabiger
- Darwin, C. (1859) *On the Origin of Species by Means of Natural Selection*, London: John Murray
- Darwin, C. (1871) *The Descent of Man and Selection in Relation to Sex*, London: John Murray
- deWaal, F. (1982) *Chimpanzee Politics: Power and Sex among the Apes*, London: Unwin/Counterpoint
- deWaal, F. (2001) *The Ape and the Sushi Master*, NY: Basic Books
- Dik, S. (1978) *Functional Grammar*, Amsterdam: North Holland
- Dunbar, R. (1992) "Co-evolution of cortex size, group size and language", *Brain and Behavior Science*, 16.4
- Dunbar, R. (1998) "Theory of mind and the evolution of language", in J. R. Hurford *et al.* (eds 1998)
- Ericsson, A. and W. Kintsch (1995) "Long term working memory", *Psych. Review*, 102.2
- Ervin-Tripp, S. (1970) "Discourse agreement: How children answer question", in J.R. Hays (ed.) *Cognition and the Development of Language*, NY: Wiley
- Everson, S. (ed. 1994) *Language, Companion to Ancient Thought*, 3, Cambridge: Cambridge University Press
- Fernald, R.D. and S.A. White (2000) "Social control of brain: From behavior to genes", in M. Gazzaniga (ed.) *The New Cognitive Neuroscience*, Cambridge, MA: MIT Press
- Foley, W. and R. van Valin (1984) *Functional Syntax and Universal Grammar*, Cambridge: Cambridge University Press
- Friederici, A. (2009) "Brain circuits of syntax", in D. Bickerton and E. Szathmáry (eds) *Biological Foundations and Origin of Syntax*, Cambridge, MA: MIT Press
- Friederici, A. and S. Frisch (2000) "Verb-argument structure processing: The role of verb-specific and argument-specific information", *J. of Memory and Language*, 43
- Friederici, A., J. Bahlmann, S. Heim, R.I. Schubotz and A. Anwander (2006a) "The brain differentiates human and non-human grammar: Functional localization and structural connectivity", *Proc. Nat. Acad. of Sci., USA*, 103
- Friederici, A., C.J. Fiebach, M. Schlesewsky, I. Bornkessel and D.Y. von Cramon (2006b), "Processing linguistic complexity and grammaticality in the left frontal cortex", *Cerebral Cortex*, 16
- Futuyma, D. (1986) *Evolutionary Biology*, 2nd edition, Sunderland, MA: Sinauer
- Gathercole, S.E. and A.D. Baddeley (1993) *Working Memory and Language*, Hillsdale, NJ: Erlbaum
- Gear, D.C. (2005) *The Origin of Mind: The Evolution of Brain, Cognition and General Intelligence*, Washington, DC: American Psychological Association
- Gernsbacher, M.A. (1990) *Language Comprehension as Structure Building*, Hillsdale, NJ: Erlbaum
- Gernsbacher, M.A. (ed. 1994) *Handbook of Psycholinguistics*, NY: Academic Press
- Givón, T. (1971) "Historical syntax and synchronic morphology: An archaeologist's field trip", *CLS #7*, Chicago: University of Chicago, Chicago Linguistics Society
- Givón, T. (1979) *On Understanding Grammar*, NY: Academic Press
- Givón, T. (ed. 1979) *Discourse and Syntax, Syntax and Semantics* 12, NY: Academic Press
- Givón, T. (ed. 1983) *Topic Continuity in Discourse*, TSL #3, Amsterdam: J. Benjamins
- Givón, T. (1995) *Functionalism and Grammar*, Amsterdam: J. Benjamins
- Givón, T. (2002) *Bio-Linguistics: The Santa Barbara Lectures*, Amsterdam: J. Benjamins
- Givón, T. (2009) *The Genesis of Syntactic Complexity: Diachrony, Ontogeny, Neuro-Cognition, Evolution*, Amsterdam: J. Benjamins
- Givón, T. and M. Shibatani (eds 2009) *Syntactic Complexity*, TSL #85, Amsterdam: J. Benjamins
- Greenfield, P.M. (1991) "Language, tools and brain: The ontogeny and phylogeny of hierarchically organized sequential behavior", *Brain and Behavior Sciences*, 14.4
- Grodzinsky, Y. and A. Friederici (2006) "Neuroimaging of syntax and syntactic processing", *Current Opinion in Neurobiology*, 16
- Haiman, J. (1985) *Natural Syntax*, Cambridge: Cambridge University Press
- Haiman, J. (ed. 1985) *Iconicity in Syntax*, TSL #6, Amsterdam: J. Benjamins

- Hamilton, E. and H. Cairns (eds 1961) *Plato: The Collected Dialogues*, Princeton: Princeton University Press
- Hamilton, W.D. (1964) "The genetical evolution of social behavior", I, II, *J. of Theoretical Biology*, 7 (July)
- Hanson, R.N. (1958) *Patterns of Discovery*, Cambridge: Cambridge University Press
- Harris, Z. "Co-occurrence and transformations in linguistic structure", *Language*, 33.3
- Hauser, M., N. Chomsky and W.T. Fitch (2002) "The faculty of language: What it is, who has it, how did it evolve", *Science*, 298, Nov. 2002
- Heine, B., U. Claudi and F. Hünemeyer (1991) *Grammaticalization: A Conceptual Framework*, Chicago: University of Chicago Press
- Heine, B. and T. Kuteva (2007) *The Genesis of Grammar*, Oxford: Oxford University Press
- Heine, B. and E. Traugott (eds 1991) *Approaches to Grammaticalization*, TSL #19 (2 vols), Amsterdam: J. Benjamins
- Hooper, J. and S. Thompson (1973) "On the application of root transformations", *Linguistic Inquiry*, 4
- Hopper, P. (ed. 1982) *Tense and Aspect: Between Semantics and Pragmatics*, TSL #1, Amsterdam: J. Benjamins
- Hopper, P. and E. Traugott (1993) *Grammaticalization*, Cambridge: Cambridge University Press
- Hrdy, S.B. (2009) *Mothers and Others*, Cambridge, MA: Harvard University Press
- Humboldt, W. von (1836) *Linguistic Variation and Intellectual Development*, tr. by G.C. Buck, Coral Gables, FL: University of Florida press [1961]
- Hurford, J.R. M. Studdard-Kennedy and C. Knight (eds 1998) *Approaches to the Evolution of Language*, Cambridge: Cambridge University Press
- Itkonen, E. (2010) "Philosophy of Linguistics", *Oxford Encyclopedia of Philosophy of Science*, Oxford: Oxford University Press (in press)
- Jespersen, O. (1921) *Language: Its Nature, Development and Origin*, NY: Modern Library
- Jespersen, O. (1924) *The Philosophy of Grammar*, NY/London: W.W. Norton & Co. [1965]
- Just, M. and P. Carpenter (1992) "A capacity theory of comprehension: Individual differences in working memory", *Psych. Review*, 99.1
- Kintsch, W. (1992) "How readers construct situation models of stories: The role of syntactic cues and causal inference", in A.F. Healy, S. Kosslyn and R.M. Shiffrin (eds) *Essays in Honor of William K. Estes*, Hillsdale, NJ: Erlbaum
- Kintsch, W. (1994) "The psychology of discourse processing", in M.A. Gernbacher (ed. 1994)
- Kintsch, W. and T. van Dijk (1978) "Toward a model of text comprehension and production", *Psych. Review*, 85
- Knight, C. (1998) "Ritual/speech co-evolution: A solution to the problem of deception", in J.R. Hurford *et al.* (eds 1998)
- Labov, W. (1975) "Empirical foundations of linguistic theory", in R. Austerlitz (ed.) *The Scope of American Linguistics*, Lisse: Peter de Ridder
- Labov, W. (1994) *Principles of Linguistic Change, vol. 1: Internal Factors*, Oxford: Basil Blackwell
- Lakoff, G. (1970) "Linguistics and natural logic", *Studies in Generative Semantics*, 2, Ann Arbor, MI: University of Michigan
- Langacker, R. (1987) *Foundations of Cognitive Grammar*, vol. I, Stanford: Stanford University Press
- Langacker, R. (1991) *Foundations of Cognitive Grammar*, vol. II, Stanford: Stanford University Press
- Li, C.N. (ed 1977) *Mechanism of Syntactic Change*, Austin: University of Texas Press
- Lieberman, P. (1984) *The Biology and Evolution of Language*, Cambridge, MA: Harvard University Press
- Loftus, E. (1980) *Eyewitness Testimony*, Cambridge: Harvard University Press
- MacWhinney, B. (ed. 1999) *The Emergence of Language*, Mahwah, NJ: Erlbaum
- Marlowe, F. (2005) "Hunter-Gatherer and Human Evolution", *Evolutionary Anthropology*, 14
- Marlowe, F. (2010) *The Hadza*, Berkeley: University of California Press
- Martin, A. and L.L. Chao (2001) "Semantic memory and the brain: Structure and processes", *Current Opinion in Neurobiology*, 11
- Mayr, E. (1969) *Populations, Species and Evolution*, Cambridge, MA: Harvard University Press
- Mayr, E. (1976) *Evolution and the Diversity of Life*, Cambridge, MA: Harvard University Press

- Mayr, E. (1982) *The Growth of Biological Thought*, Cambridge, MA: Harvard University Press
- McKeon, R. (ed. 1941) *The Basic Works of Aristotle*, NY: Random House [22nd edition] Lancelot, C. and A. Arnould *et al.* (1660) *Grammaire Générale et Raisonnée*,
- Ochs, E. and B. Schieffelin (eds 1979) *Developmental Pragmatics*, NY: Academic Press
- Odling-Smee, F.J., K.N. Leland and M.D. Feldman (2003) *Niche Construction: The Neglected Process in Evolution*, Monographs in Population Biology #37, Princeton: Princeton University Press
- Orbell, J., T. Morikawa, J. Hartwig, J. Hanley and N. Allen (2004) "Machiavellian intelligence and the evolution of cooperative disposition", *American Political Science Review*, 98.1
- Peirce, C.S. (1934) *Collected Writings*, vol. V, Cambridge, MA: Harvard University Press
- Peirce, C.S. (1940) *The Philosophy of Peirce*, d. by J. Buchler, NY: Harcourt, Brace
- Paul, H. (1890) *Principles of the History of Language*, Tr. by H.A. Strong, London: Swann, Sonnenschein & Co.
- Petersen, S.A., P.T. Fox, M.I. Posner, M. Mintun and M.E. Raichle (1988) "Positron emission tomographic studies of the cortical anatomy of single words", *J. of Cognitive Neuroscience*, 1.2
- Plato, *Cratylus*, in E. Hamilton and H. Cairns (eds 1961)
- Posner, M.I. and J. Fan (2008) "Attention as an organ system", in J. Pomerantz (ed.) *Neurobiology of Perception and Communication: From Synapses to Society*, 4th De Lange Symposium, Cambridge: Cambridge University Press
- Posner, M.I. and A. Pavese (1997) "Anatomy of word and sentence meaning", in M. Posner and M. Raichle (orgs) *Colloquium on Neuroimaging of Human Brain Functions*, UC Irvine (ms)
- Pulvermuller, F. (2003) *The Neuroscience of Language*, Cambridge: Cambridge University Press
- Rabi, I. I. (1975) interview in *The New Yorker*, Oct. 20, 1975
- Raichle, M.E., J.A. Fietz, T.O. Videen, M.K. McLeod, J. Pardo, P.T. Fox and S.E. Petersen (1993) "Practice-related changes in the human brain functional anatomy during non- motor learning", *Cerebral Cortex*, (ms)
- Richerson, P.J., R. Boyd and J. Henrich (2003) "Cultural evolution of human cooperation", in P. Hammerstein (ed.), *Genetic and Cultural Evolution of Cooperation*, Boston: MIT Press
- Richerson, P.J. and R. Boyd (2005) *Not by Genes Alone: How Culture Transformed Human Evolution*, Chicago: University of Chicago Press
- Rizzi, L. (2009) "Recent advances in syntactic theory", in D. Bickerton and E. Szathmáry (eds) *Biological Foundation and Origin of Syntax*, Cambridge, MA: MIT Press
- Ross, J.R. and G. Lakoff (1967) "Is deep structure necessary?", *First La Jolla Conference on Linguistics Theory* (ms)
- Russell, B. (1956) *Logic and Knowledge*, selected essays, 1901-1950, ed. E.C. Marsh, London: Rutledge
- Sapir, E. (1921) *Language*, NY: Harcourt, Brace & World [1929]
- Saussure, F. de (1915) *Course in General Linguistics*, ed. by C. Bally and S. Sechehaye, tr. by W. Baskin, NY: Philosophical Library [1959]
- Schneider, W. and J.M. Chein (2003) "Controlled and automated processing: Behavior, theory and biological mechanisms", *Cognitive Science*, 27
- Scollon, R. (1976) *Conversations with a One-Year-Old Child*, Honolulu: University of Hawaii Press
- Snyder, A., Y Abdulaev, M.I. Posner and M.E. Raichle (1995) "Scalp electric potentials reflect regional cerebral blood flow responses during processing of written words", *Proc. Nat. Acad. of Science, USA*, 92
- Spitzer, M (1999) *The Mind within the Net: A Model of Learning, Speaking and Acting*, Cambridge, MA: MIT Press
- Squire, L. (1987) *Memory and Brain*, Oxford: Oxford University Press
- Squire, L. and S. Zola-Morgan (1998) "Episodic memory, semantic memory and amnesia", *Hippocampus*, 8
- Swinney, D. (1979) "Lexical access during language comprehension: (Re)consideration of context effects", *J.V.L.V.B.*, 18
- Számádó, S. and E. Szathmáry 2006 (2006) "Competing selective scenarios for the emergence of natural language", *Trends in Ecology and Evolution*, 2
- Tomasello, M.M. and J. Call (1997) *Primate Cognition*, Oxford: Oxford University Press Tomasello, M.M., J. Carpenter, J. Call, T. Behne and H. Moll (2005) "Understanding and sharing intentions: The origins of cultural cognition", *Brain and Behavior Sciences*, 28
- Trivers, R. (1971), "The evolution of reciprocal altruism", *Quarterly Review of Biology*, 46 (March)
- Ungerleider, L.A. and M. Mishkin (1982) "Two cortical visual systems", in D.J. Ingle, M.A. Goodale and R.J.K. Mansfield (eds) *Analysis of Visual Behavior*, Cambridge, MA: MIT Press
- Waddington, C.H. (1942) "Canalization of development and the inheritance of acquired characters", *Nature*, 150
- Waddington, C.H. (1953) "Genetic assimilation of an acquired character", *Evolution*, 7

- Washburn, S. L. and C. Lancaster (1968) "The evolution of hunting", in R.B. Lee and I. deVore (eds) *Man the hunter*, Chicago: Aldine
- West-Eberhard, M. J. (2004) *Developmental Plasticity and Evolution*, Oxford: Oxford University Press
- Williams, B. (1994) "Cratylus theory of names and its refutation", in S. Everson (ed. 1994)
- Wilson, E.O. (1975) *Sociobiology: The New Synthesis*, Cambridge, MA: Harvard University Press
- Wilson, E.O. (1978) *On Human Nature*, Cambridge, MA: Harvard University Press
- Zipf, G. (1935) *The Psycho-biology of Language: An introduction to Dynamic Philology*, Cambridge, MA: MIT Press