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**From Signals to Symbols : Grounding Language Origins in
Communication Games.**

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This short presentation brings together some of economics and linguistics on the topic of language origins. This topic has directed attention to properties of human

language, particularly how linguistic signs or symbols have inherited design features which are present in linguistic communication. In this presentation I will show how some features of language can be adequately understood as a result of coordination games. I will argue that modern language originated as a consequence of trade relationships and the division of labor involved by early humans around 40.000 years ago. As an economic activity, both trade (or exchange) relationships and division of labor call for coordination. The resulting outcome of this approach entails that games and economic behavior have a significant causal relationship to some general properties of the linguistic symbol.

1. Adam Smith's dog

Language and economics have been related since at least Adam Smith's reflections on the origin of the division of labor. Smith attributes the division of labor to language or the faculty of reason¹. In his *Wealth of Nations* of 1776. Smith writes :

The division of labour , from which so many advantages are derived, is not originally the effect of any human wisdom,..., it is the necessary consequence of a certain propensity in human nature : the propensity to truck, barter, and exchange one thing for another ... This propensity ... seems to be the necessary consequence of the faculties of reason and speech.

Smith goes on to assert that this propensity is unique to man, thus writing these well known words:

No body ever saw a dog make a fair and deliberate exchange of one bone for another with another dog.

According to Smith's speculation, division of labor, goods exchange and language could all be causally related. The division of labor produces a diversity of goods that could be exchanged. Goods exchange creates the necessity of a contract, and

¹ Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations.*, Indianapolis: Liberty Fund, 1981. General editors: R.H. Campbell and A.S. Skinner.

contracts require concerted or **coordinated actions** among the contracting individuals. In coordinating actions, agents are involved in communication games whereby they convey the information required for the exchange. A symbolic and complex language then subserves the communication of information

Modern linguistics as well has also adopted a view that leads to economics and even political theory and philosophy. I will start off by mentioning Ferdinand de Saussure. In his *Course de Linguistique Générale* of 1916, Saussure asserted that the linguistic signs, or "*la langue* ", had originated in a **social contract**: "*There is a language — Saussure says* ² -- *only in virtue of a kind of social contract handed on among members of a community* " Moreover, the Swiss linguist was the first to establish that language was comprised of related signs that form a system. The saussurean sign is a one-to-one mapping from meaning to sound that is lodged in the brains of at least two speakers. All individuals bound by language, Saussure ³ says, reproduce the same sounds ⁴ mapped onto the same concepts. The origin of this social crystalization, Saussure goes on to explain, lies in the fact that the meaning-sound mapping is the same for all the individuals sharing a language because there is a coordination faculty that makes such coordination possible.

² F. de Saussure, *Cours*, Introd. III, § 2 : "[*La langue*] *n'existe qu'en vertu d'une sorte de contrat passé entre les membres de la communauté* " .

³ F. de Saussure, *Cours*, Introd. III, § 2.

⁴Strictly speaking, it is a mental representation of the articulated sounds what is mapped into a concept or meaning. Both sound and meaning have a mental reality.

Some years later, in 1933, the American linguist Leonard Bloomfield in his *Language*, a work resting on Saussure's shoulders, emphasized more than Saussure that language is a coordination problem between sound and meaning, and that this coordination " makes it possible for man to interact with great precision ⁵ ". He bolstered Smith's speculation on the relatedness of language to the division of labor, when he asserted that language always accompanies every human action.

Bloomfield ⁶ argues that:

" In the ideal case, within a group of people who speak to each other, each person has as its disposal the strength and skill of every person in the group.. The more these persons differ as to special skills, the wider a range of power does each one person control. The division of labor, and with it, the whole working of human society, is due to language ".

⁵ Leonard Bloomfield, *Language*, Chicago: Chicago University Press, 1933, § 2.2

⁶ Bloomfield, *Language*, § 2.3

These words suggest that Bloomfield's approach to the function of language calls to mind Smith's speculation on language and division of labor. As economist Karl Wärneryd remarked, there is no logical reason to expect that language is what makes possible the exchange⁷. For one thing division of labor -- although not as in humans -- occurs in animals without a complex language as in ants, wasps, bees and wolf packs⁸. Specialization in social insects is so surprising that Dawkins⁹ asserts that these insects discovered - before man! - that cultivation of food is more efficient than hunting-gathering¹⁰. Therefore it is difficult to attribute the faculty of language as the main motivation that led to the division of labor¹¹.

⁷ Karl Wärneryd, "Language, Evolution and the Theory of Games", in J.L. Casti and A. Karlqvist, *Cooperation and Conflict in General Evolutionary Processes*, New York: John Wiley, 1995, 405-421, tackles the relationship between exchange and language in a different but insightful way.

⁸ Smith's oblivion of social insects was already noticed by Hendrik Houthakker, "Economics and Biology: Specialization and Speciation", *Kyklos*, 9-2, pp.181-1897, (1956). Recently, zoologist L. David Mech has added more evidence on the division of labor in wolf packs: "The typical wolf pack, then, should be viewed as a family with adult parents guiding the activities of the group and sharing group leadership in a division-of-labor system in which the female predominates primarily in such activities as pup care and defense and the male primarily during foraging and food provisioning and travels associated with them". L. David Mech "Alpha status, dominance and division of labor in wolf packs", *Canadian Journal of Zoology*, 77:1196-1203, (1999).

⁹ R. Dawkins, *The Selfish Gene*, Oxford University Press, 1989, p.180.

¹⁰ Slavery, warfare, and robbery can be found among social insects as well as in humans. See W.D. Hamilton, "Selection of Selfish and Altruistic Behavior in Some Extreme Models", in W.D. Hamilton, *Narrow Roads of Gene Land*, Oxford: W.H. Freeman, 1995, p.216.

¹¹ L. von Mises as well asserted that the division of labor makes man distinct from animals: "It is the division of labor that has made feeble man, far inferior to most animals in physical strength, the lord of earth and the creator of the marvels of technology". L. von Mises, *Liberalism: The Classical Tradition*, Indianapolis: Liberty Fund, 2005, p.18. Notwithstanding the core role of the division of labor, neoclassical and modern economists have observed that Smith's theory would lead to an organization of the market dominated by increasing returns, which is not borne out; see James M. Buchanan, "Generalized Increasing Returns, Euler's Theorem, and Competitive Equilibrium", *History of Political Economy*, 31:3, 1999, pp.511-523.

As the division of labor may occur without language, it would behoove us to look back to trade, or to the deliberate exchange of goods as a reasonable hypothesis to explain how language originated and acquired its properties.

In a recent paper, economists Richard Horan, Erwin Bulte and Jason Shogren¹² developed a mathematical model to explain why Neandertal man went extinct while coexisting with *Homo sapiens*. This paper's title is fairly suggestive to my own present purpose: " *How Trade¹³ Saved Humanity from Biological Exclusion...*". They explore two hypotheses : biological exclusion and behavioral exclusion.

Biological exclusion predicts that the neandertal extinction would have been slower than it actually was. Also, if neandertals were biologically more efficient, Shogren's model predicts, contrary to fact, that humans would not have coexisted with neandertals.

¹² Richard D. Horan, Erwin Bulte, Jason F. Shogren, " How Trade Saved Humanity from Biological Exclusion: an Economic Theory of Neandertall Extinction ", *Journal of Economic Behavior and Organization*, 58: 1- 29, 2005.

¹³ Trade means in Shogren's model " exchange " , be it voluntary or involuntary (centralized o dictatorial) .

The reason why humans survived, although they were biologically inferior to neandertals, is better explained by the behavioral exclusion theory. Behavioral exclusion theory proposes that humans survived due to the division of labor and specialization, which neandertals lacked. The most plausible scenario envisaged by Shogren's model is one in which there is complete division of labor within two groups of humans: skilled hunters that harvested meat and unskilled hunters who produced other goods. In passing, notice that these two groups of humans were already envisioned by Smith in his *Wealth of Nations* I.ii.3 ¹⁴

Even with a modicum of trade in neandertals, humans overcame neandertals. Their model proves that humans survived neandertals because of the availability of meat consumption was greater among humans due to the division of labor. These economists conclude their paper noticing that

“A crucial issue remains unresolved: it is an open question why the early humans first realized the competitive edge from trade. Some attribute the edge to differences in cognition or language abilities or both, but the jury is still out . “

¹⁴ “ In a tribe of hunters or sepherds a particular person makes bows and arrows, for example, with more readiness and dexterity than any other. He frequently exchanges them for cattle or for venison with his companions; and he finds at last that he can in this manner get more cattle and venison, than if he himself went to the field to catch them “ (A. Smith, *WN*, Liberty Fund edition)

The issue may be elucidated by looking into neandertal language. As there is no evidence that neandertals had a complex language as there is of early humans¹⁵, the hypothesis that the competitive edge could be realized by developing abstract symbols becomes compelling. The conclusion then that language and trade were originally in tandem seems unescapable. At this point it would seem logical to me that all cognitive capacities involved in trade (such as the designing of tools for manufacturing exchangeable goods, the exchange value of goods, and the ability to make decisions on goods) should be observable in language.

Now, the next step involves determining which came first, language or trade?

Although no sharp response can be given, there is some logical priority to trade as opposed to language. Three arguments may be adduced. First, language is neither a necessary condition for the division of labor nor for trade. In the Shogren - Smith's model, it is meat consumption and a previous division among members of the tribe (skilled versus unskilled individuals) which triggered the division of labor. According to Shogren, the assumption that early humans were more skilled hunters than neandertals, allowed them to produce meat enough to exchange for goods produced by unskilled hunters.

Second, as language basically involves coordination problems, the same that trade and the division of labor do, it is plausible to assume that language depends on trade and the division of labor as well as on the more complex social relations added by trade. The ground for this dependency lies in the fact that the division of labor leads to coordination between (at least) two individuals thus incurring external coordination costs¹⁶. As a result, language could be a consequence of external coordination costs,

¹⁵ There has been a hot debate on the issue of neandertal language. The issue has been settled by P. Lieberman, *The Biology and Evolution of Language*, Cambr., Mass.: Harvard University Press, 1984 and S. Mithen, *The Singing Neanderthals: The Origins of Music, Language, Mind and Body*, Camb., Mass.: Harvard University Press, 2006, p.221, who argue that neandertals at most had an inferior linguistic capacity than *Homo sapiens*. It should be emphasized that no real evidence for a neandertal language has been offered.

¹⁶ H. Houthakker, "Economics and Biology: Specialization and Speciation", *Kyklos*

contributing to set off against such costs.

A third argument is that some games can be played (or preplayed) using communication, and in particular **cheap talk** , which does not add more or less value to payoffs.

So trade may occur without language, but **language must be motivated.**, in the sense that a speaker S sends a message μ to a receiver R with a particular intentionality.

The scenario set up by trading can boost a symbolic communication system as rich as modern human language. Karl Wärneryd¹⁷ addresses the role of language in economic activities reminding that neoclassical economists start from the premise that exchange follows from the well-defined preferences of individuals with a basket of consumption goods . When preferences (or payoffs) are in equilibrium, however, it may occur that some equilibria are more efficient and stable than others. Communication selects the more efficient equilibrium if it is costless. Exchange , then, triggers or motivates language, not the other way around. Consequently, if animals do not have full symbolic communication it's because they do not exchange goods , which motivates the existence of a language ¹⁸ . Smith's dog has not evolved language because it requires exchange and coordination . As he has nothing to coordinate, he doesn't need a language . The dog is tied to its costly signals.

I'll wind up, then, that trade is a robust candidate for the origins of a modern symbolic language.

2

Games and Symbols

Now, I will take up a subset of Hockett's design features and will endeavour to show

¹⁷ Karl Wärneryd , “ Language, Evolution and the Theory of Games “ , in J.L.Casti and A. Karlqvist, *Cooperation and Conflict in General Evolutionary Porcesses*, New York:John Wiley, 1995 .

¹⁸ W.D. Hamilton , “ Innate Social Aptitudes of Man...” , in :W.D. Hamilton, *Narrow Roads of Gene Land*, Oxford: W.H.Freeman, 1995, p.342, makes out a case for the idea that tools and language confer benefits to a cooperative hunter .

how they fit into the coordination game framework . We should bear in mind the main difference between traditional game theory and coordination game theory : the former deals with winning strategies, and a solution concept or equilibrium , and the latter deals with players' common interests strategies and possibly multiple equilibria. Consequently, players in common interest games make use of cognitive strategies like imitation, analogy, reasoning , guessing, imagination, common knowledge, among others.

Design features are understood as properties that characterize language as a communication system which can be used to compare language to signals of other nonhuman communication systems. For the moment I will ignore animal signals and I will mainly focus on linguistics symbols as originated in the coordination game of trade and division of labor.

I will deal with the following Hockett's design features¹⁹ : (1) Duality , (2) Semanticity, (3) Parity, (4) Specialization, (5) Prevarication, and (6) Cultural transmission.

Let's look at these features to see precisely how they might be construed as games.

(1) Duality . Def.(Saussure, Course de Ling. Gen. I.1. §1) “ The linguistic sign [i. e. symbol] is a mental entity with two faces : a concept [meaning] and an acoustic image [sound] . These two elements are tightly joined and one demands the other[bidirectional mapping] ” .Idem I.1. §2 : “ The tie [the mapping] joining meaning and sound is arbitrary “ .

¹⁹ Some of these features were previously studied by Saussure and Bloomfield, but are known as Hockett's design features; C.F. Hockett, “ Logical Considerations in the Study of Animal Communication”, in: W. F. Lanyon and W.N. Tavolga,eds, *Animal Sounds and Communication*, Washington, Am. Inst. Of Bio. Stud., Sympos. Ser. 7, 1960, 392-430.

The first conundrum that the saussurean sign poses is a coordination problem. In order to communicate, agents-speakers of a community must make the same associations between sound and meaning. Such coordination is solved by means of a **coordination game**²⁰ between meaning and sound. It must be noticed that Saussure (*Cours*, Intro. III. § 2) put forth that speakers in a population P must be endowed with “ receptive and coordinating faculties “ to attain the same one-to-one mapping. Therefore meaning and sound must be coordinated in a communicating population P of senders / receivers because both meaning and sound are unattached to each other. Meaning of sign S_1 could a priori be attached to any other string of sounds σ_n and vice versa. This coordination problem can thus be formulated in the following way : how do sender and receiver of a message assign the same bidirectional mapping from meaning into sound and from sound into meaning ?

As all members of the population P want to use the same signs to communicate , all have a common interest and therefore must coordinate their choice. This is in essence a coordination game, in Schelling's sense²¹ . More specifically, he characterizes a coordination game according to the following three traits:

- (1) Players' preferences are identical, so there is no conflict of interest
- (2) Each player's best choice depends on the action he expects the other to take, which in turn depends on the other's expectations of his own. In other words, the game is based upon the players' mutual expectations.
- (3) The players' goal is to share some common- interest activity by means of some cognitive process (Schelling's imagination, poetry and humor). In the case of language,

²⁰ Wittgenstein's language games may be construed as coordination games. See L. Wittgenstein, *Philosophische Untersuchungen* , §§ 2, 8, 21, 48-51.

²¹ Thomas C. Schelling, *The Strategy of Conflict*, Cambridge, Mass.: Harvard University Press, 1980, 83-118.

players want to use the same signs to communicate with each other.

Look at table 1. One player chooses a Row and other player chooses a Column. Row and Column represent tacit processes determining the payoffs. Since the players' goal is not to win, as in zero sum games, but rather to share some common interest by searching tacitly through cognitive processes, payoffs then only represent the degree of coordination attained by the players²². So the payoff matrix for a coordination game is different from zero sum games and non zero sum games. If players combine < R1 , C1 > they are better off than combining < R1 , C2 > and better off than combining < R2 , C1 > and so on. As it is possible that whenever choosing one Row and choosing one Column players " win " , that is, they guess what each other is thinking, this winning results < 1, 1 > can be arranged in a diagonal line :

Please, number rows on the left side of the table top-down as R1, R2, R3, R4,R5.

	C1	C2	C3	C4	C5
R1	1	0	0	0	0
R2	0	1	0	0	0
R3	0	0	1	0	0
R4	0	0	0	1	0
R5	0	0	0	0	1

²² Such processes may equal to the usual strategies in conflict games, but contrary to conflict games, no minimax solution exists for them.

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Table 1

(Lower left entry in cells is payoff to row-player, upper right is payoff to column-player)

Let's get back now to design features of language. Duality is conceived in Saussure's sense as a bidirectional mapping from sound and meaning such that both sound and meaning being autonomous of each other, but must be coordinated by senders / receivers in order to attain optimal communication . What cognitive strategies are involved in duality ? Some tacit strategies come to mind : (1) Random mapping; (2) Imitation ; (3) Probabilistic mapping , and (4) knowledge of convention in Lewis sense ²³ .

Linguistic conventions are not explicit but tacit agreements. This means that speakers must use cognitive strategies to coordinate sound and meaning. Convention can be arrived at by calling on a variety of such strategies. Saussure assumed the existence of a coordinative capacity in man. This assumption , however, sets up a circular argument. A much more adequate explanation is that of Lewis' convention.

(2) Semanticity : Def. " The elements of a communicative system [linguistic symbols] have associative ties with things and situations, or types of things and situations, in the environment of its users... such ties are semantic conventions shared by speakers "

The bidirectional mapping sound-meaning should be distinguished from the mapping symbol - denotation (things, situations, or simply , actions). Adopting a lewisian theory of meaning, symbols (or signals in the game theory sense) are mapped into actions so that actions can be true or false if they establish a coordinating equilibrium. Table 2 shows such equilibrium. Signal A means (is mapped onto) action X , with payoff

²³ D.Lewis, *Convention*, Harvard University Press, 1969.

(1,1) , while signal B means action Y with payoff (1, 1) .Mapping is established by convention in Lewis' sense:

		Receiver	
		Action	
		X	Y
Sender signal type	A	1,1	0,0
	B	0,0	1,1

Table 2

(3) Interchangeability , or parity : Def. “ Adult members of any speech community are interchangeably transmitters and receivers of linguistic signals “ .

This feature derives from the definition of a coordination game without proof, as this game is played by dyads of speakers. Yet parity has been challenged by rationalist philosophers and linguists. Rationalist philosophers claim that language is used only for the expression of thought , not for social communication. However, the game theory approach to language demands that language strictly be used and motivated for the communication of intentions. Besides, this should be taken not only as its current function, but as the original function ²⁴. Since the communicative function overrides the representational function in efficiency or coordination, the claim that language is for the expression of thought is not motivated by game theory, Communication, not expression of thinking, subserves coordination.

²⁴ Assuming that communication is both the original and the current function of language avoids the issue (for which Darwinism lacks an adequate response) of how an original organ transforms its original function into another function, contrary to N. Chomsky that asserts that we don't know the original purpose of language, although he assumes a transformation of the original function into the “ expression of thought “ function; see Marc W.Kirschner and John C. Gerhart, *The Possibility of Life*, New Haven: Yale University Press, 2005; M.Hauser, N. Chomsky and T.Finch, “The Faculty of Language: What is it, Who has it, and How did it Evolve ? “ *Science* ,298, 1569-1579 , 2002.

(4) Specialization : Def.: “ A communicative act, or a whole communicative system, is specialized to the extent that its direct energetic consequences are biologically irrelevant . Obviously language is a specialized communicative system. “

Contrary to language, animal signals have direct biological consequences as well as energetic costs . In insects, signals (calls and songs) emitted by a male insect serve to attract females as sexual mates ²⁵ . The bees' dance informs only about the food source ²⁶ . Also birds' alarm signals alert other conspecifics to flee. The bird that warns its conspecifics by emitting an alarm call is in grave danger of dying because it attracts the predator's attention. This example shows that communicative behaviour in animals adopts strategies that incur costs - benefits²⁷ , as in conflict of interest games. Dawkins points out that “ the belief that animal communication signals originally evolve to foster mutual benefits, is too simple “ . Rather, he continues, “ all animal interactions involve at least some conflict of interest “ . As linguistic communication is basically a coordination game, it is costless, or cheap; costs and benefits of sending and receiving signals are irrelevant . Language, then, may be conceived as a signalling game, where both sender and receiver obtain equal payoffs because they share the same interests²⁸ . Moreover, animals signals may be dishonest, while language lacks dishonest signals. Language evolved for coordination, thereby it sets a big hurdle for a strict darwinian view on language origins ²⁹ .

²⁵ H. Carl Gerhardt and Franz Huber, *Acoustic Communication in Insects and Anurans*, The University of Chicago Press, 2002, observed that some insects lose weight during call transmission.

²⁶ For these and other examples of animal calls , see R. Dawkins, *The Selfish Gene*, Oxford University Press, Oxford University Press, 1989.

²⁷ R.Dawkins, *The selfish Gene*, Oxford University Press,1989, 68 -87.

²⁸ Otherwise said, the utility function of Sender $u(s)$ and Receiver $u(a)$ are equal.

²⁹ As linguistic communication is a pure coordination, mass phenomenon (individuals genetically unrelated), it is a real conundrum for a natural selection account of language origins and evolution, that ranges over either individuals or genes . This is skipped by S. Pinker, *The Language Instinct*, New York: HarperPerennial,1995 .

(5) Prevarication. Def. “ Linguistic messages can be false, and they can be meaningless in the logicien’s sense. “

A main difference between animal signals and linguistic symbols lies in that animal’s communication by means of signals is truthful , while communication by linguistic symbols may or may not be truthful . Signals correspond to a set of fixed states either of the animal type (hunger, sex) or the environmental type (danger). Therefore, prevarication or lying is not a real option for animals ³⁰ . However, the possibility of the receiver being manipulated by the sender has been emphasized as an option in animal communication ³¹ . Linguistic communication takes on truthful messages sent by truthful senders. This is called the “truth bias “ by game theorists .The speaker is, in turn committed to the truth of her messages.

The nature of lying is due to the symbolic makeup of human communication that comprises conventionality and unboundedness . Biologically, lying is a cost for a symbolic system because it contributes selfish , parasitical, but uncoordinating behavior ³² .

Game theory ³³ seems to open a window both into the existence of lying and The Decay of Lying, as Oscar Wilde put it in this comedy ³⁴ . Lying is a kind of behavior that fits into a two person partial interest game, that is, a game in which some agent is not

³⁰ W. D. Hamilton, “ Selection of selfish and altruistic behavior in some extreme models “, remarks that “ by our lofty standards, animals are poor liers” ; in W.D. Hamilton , *Narrow Roads of Gene Land*, Oxford:W.H.Freeman, 1995, p.218.In turn, Karl Popper artfully suggested that “human language evolved because it made lying possible “, in P.A. Schilpp, *The Philosophy of Karl Popper*, vol 2, La Salle :Open Court, (1974) , pp.1112-1113.

³¹ R. Dawkins, *The Selfish Gene*, Oxford University Press,1989, p.64.

³² W.D. Hamilton, “ Innate Social Aptitudes of Man : an Approach from Evolutionary Genetics “, in W. D. Hamilton, *Narrow Roads of Gene Land*, Oxford: W.H. Freeman, 1995, p.332.

³³ On lying as a game, s. L. Wittgenstein, *Phil.Untersuch.* § 249.

³⁴ Wilde’s words wittily express the nonpredominance of lying : “ With the possible exceptions of barristers, lying as an art has decayed. “

strictly coordinating . Table 3 represents such a game. Thus sender sends a signal which triggers a best action by receiver

		Receiver		
		Action		
		X	Y	Z
Sender signal type	A	4,4	1,1	6, 3
	B	1,1	4, 4	6, 3

Table 3

Partial interest game (lying)

This matrix takes on values of common interests as well as of conflict of interests. The combination < A, Z > = (6 , 3) and combination < B, Z > represent the case in which the sender has obtained a profit over the receiver³⁵ .

Note, however, that lying is a violation of linguistic conventions, but these conventions can't be associated with lying because if they were there would be a winning strategy for agents (receivers of messages) such as “ If the sender lies –using a lying strategy – do not act as the sender expects “ . Thus a better and winning strategy would evolve. Therefore, one can deduce that lying cannot be evolutionary stable³⁶. This evolutionary game explains why there are no markers (no conventions) for lying in human languages.

(6) Cultural transmission: Def. “ The continuity of language from generation to generation is provided by tradition. All traditional behaviour is learned [from others]. Tradition becomes transformed into cultural transmission when the passing down of traditional habits is mediated by symbols. “

It is beyond doubt that symbols of a language are learned across generations. Besides,

³⁵ Experimental work shows both that lying pays as well as the truth bias of agents; Toshiji Kawagoe and Hirokazu Takizawa, “ Why Lying Pays : Truth Bias in the Communication with Conficting Interests “. Tokyo, 2005. Accessible on Internet.

³⁶ See R. Dawkins

symbols make up grammatical patterns . Linguists and psychologists discuss whether or not there exists an innate device, not culturally but genetically transmitted, that makes grammar learning possible. Supporters of an innate device assume the existence of an absolute invariant³⁷ Universal Grammar (UG) genetically transmitted that would explain language learning with no resort to cultural transmission.UG is conceived as a random generator device or automaton.

The UG hypothesis , however, has proved unable to present observable or empirical universals that account for overt and regular crosslinguistic variation ³⁸.

³⁷ That is false in a strict (neo)darwinian view.

³⁸ Universals of the kind required by supporters of the random generator view of universal grammar are located at the biological (brain) level of inquiry, skipping most of overt linguistic properties and offering no general account of crosslinguistic variation. At present such universals are missing, apart from the automaton.

A different way to tackle this regular variation, aka Greenberg universals, is to look at it as a coordination game problem in Schelling's spirit. Language learning requires the input from the community where the learner grows up. All learners must converge on the input grammar, that is, they must coordinate their grammars with those of the input. When coordination problems persist among members of a community, that community yields regular patterns to solving such problems, otherwise they adopt them from other communities (for example, by cultural diffusion). These regular patterns come to be common knowledge in the community³⁹. Note also that in a coordination game an agent selects an action in an undetermined way within a bounded set. Thus we expect different conventions for different communities, using a bounded number of actions. In fact, some computational models of language evolution suggest that overt empirical universals arise out of multiagents evolving across generations⁴⁰. Linguistic generalizations (aka rules of grammar) spring out of cultural transmission, making innate Universal Grammar unnecessary.

³⁹ D.Lewis, *Convention*, Cambridge: Harvard University Press, 1969, adopted such a view, which can be extended to language learning and evolution.

⁴⁰ S. Kirby and J. Hurford, " The Emergence of Linguistic Structure: an Iterated Learning Model ", in A. Cangelosi y D. Parisi, *Simulating the Evolution of Language*, London:Springer,2001.

