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A CONVERSATION WITH NOAM CHOMSKY: NEW INSIGHTS ON OLD FOUNDATIONS

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"It is important to learn to be surprised by simple things – for example, by the fact that bodies fall down, not up, and that they fall at a certain rate; that if pushed, they move on a flat surface in a straight line, not a circle; and so on. The beginning of science is the recognition that the simplest phenomena of life raise quite serious problems: Why are they as they are, instead of some different way?" (Chomsky 1988)

One of the leading intuition of Noam Chomsky's research on language and cognition is that it is important to learn to be surprised by simple things. One can take the questions presented here as an example of this approach. The questions were proposed by undergraduate and graduate students, reorganized by us and presented to Noam Chomsky on occasion of his visit to the Institute of Advanced Study in Pavia on September 15th, 2012. Simply and spontaneously, the questions raised by the students clustered around a number of fundamental topics concerning the architecture of the language faculty, its relation with other systems. Starting from the mathematical properties of language, Chomsky answered students' questions by discussing theoretical and epistemological consequences of the research on the biological foundation of language. He also posed new questions that such rational inquiry opens up and that can possibly get an answer in a future. The call for simplicity is reflected in the content of the answers Chomsky provided, and in the style as well. The discourse unfolds smoothly guiding the hearer – and the reader – through leading issues in the Chomskyan approach, from the foundation of the field (Chomsky 2004) to the ultimate synthesis (Chomsky 2011), across the milestones that made the scientific study of language possible in the modern era and still lucidly indicate where we should be heading to[1].

1) Can we study evolution of language? Is there any evidence that language evolved?

The subject "evolution of language" is a very fashionable one. In the last

[1]   This contribution contains the faithful transcript of Chomsky's seminar. The notes provide some additional references. Although the contribution has been organized and revised by all authors, V. Bambini is responsible for questions 1-2, 8-11 and for the notes, while C. Chesi for questions 3-7. We would like to thank the students who participated to the initiative and submitted their questions, and the Collegio Ghislieri in Pavia for hosting the seminar.

several decades there is a huge literature, libraries of books, international conferences, papers pouring out all the time. There are a few problems about it. One problem is that the topic doesn't exist. Small problem... Furthermore, everyone knows it doesn't exist. Evolution involves changes in the genomic characters of the organism. Languages are not organisms, they don't have genomes, they don't evolve. Languages change, but they don't evolve. What evolves is the language capacity of users of language, i.e., human beings. So problem number 1 is: the topic doesn't exist. Problem number 2 is that the work that has been done on the topic is utterly unlike anything that has been done in evolutionary biology. For example, suppose a biologist submitted a paper on the evolution of the eye. Consider that he has no idea of what an eye is and says that an eye is maybe something that you use to watch television. People would laugh. You couldn't submit a paper like that. But that is exactly what the literature on the evolution of language is about. It doesn't tell you what they think language is, just that language is something used for communication, which is about like saying that an eye is used to watch television. One of the many uses of language is communication, but that doesn't tell you anything. Other problems arise as soon as you begin to look at the work. For example, a lot of the work by really sophisticated people argues that frozen expressions in language are fossils from earlier periods. They tell you something about the earlier stages of language. It is usually English that is studied; so take a frozen expression in English. If it is a fossil, it is a fossil from a couple of hundred years ago, maybe a thousand years. What can that tell you about the history of language? Nothing. That is a tiny blink of an eye in the last phase of a long history of language.

The subject is one of the strangest subjects I have ever seen. Now, there is a subject: evolution of the capacity to use language, or to acquire language, the human language faculty. That is the real subject. But there is a problem with that subject too: we don't know anything about it. Actually, we know two facts about the evolution of the language capacity. One of the facts is sufficient to tell you that the study of the evolution of language is mostly a waste of time. For example, one of the things we know about the evolution of the language capacity is that nothing has happened for at least 50 thousand years since humans left Africa. And the evidence for this is pretty strong, in fact very compelling. If you take an infant from an Amazonian tribe in Brazil, a tribe that maybe hasn't had contact with other humans for maybe 20 thousand years, the child first of all learns Portuguese instantly, with no problems, and if the infant was brought to Pavia, he would be speaking just like you, exactly the same. And conversely, if you take an infant here

and dump him in the Amazon, he would speak exactly like the children of that tribe. We don't know any deviation from this: not every case has been studied, but such a wide range of cases have been observed that it is almost certain that this is universal. What that tells you is that the capacity for language hasn't evolved in a way beyond historic times back to the first humans leaving Africa, or at least their ancestors, roughly 50 thousand years ago. So at least in that period there has been no evolution of the language capacity.

The second fact that we know with not full confidence but kind of plausibility is that, if you go back quite a short period before that – a short time in the evolutionary time, maybe 50 or 100 thousand years before that, which is nothing in evolutionary time, there is no evidence that language existed at all. There is substantial archeological evidence that somewhere in that very narrow window, roughly 75 thousand years ago, there was a sudden explosion of evidence of creative activity, symbolic representation, indications of the phases of the moon, complex social organization, and various rituals, all sort of things that indicate that something happened in a very small group, maybe a small hunter-gatherer tribe, maybe a hundred people, and then spread. So, within again a short period of time, there was Homo Sapiens: in fact that is the origin of cognitive Homo Sapiens. Physical, anatomical Homo Sapiens, goes hundreds of thousand years back beyond that. But something happened cognitively in one small group and essentially took over. You can guess what the date is: within the last hundred thousand years probably. That tells you that some event took place, brief change which provided our ancestors with the creative capacities that we all have, and we all have essentially identically, because we are all different descendants from that small group who among their other talents succeeded in a way beyond everybody else. The human species is kind of unusual and all related species have been wiped out. There is no comparative evidence. There were plenty of other hominids – we know that from archeological evidence – but they are all gone. Neanderthal lasted until maybe 30 thousand years ago (there is a very slight interbreeding with Homo Sapiens, mostly in Southern Italy, incidentally), but essentially everything else was wiped out. And in fact it goes beyond that. If you look at the spread of Hominids, going back a million years or longer than that, as our ancestors spread, megafauna, i.e., big animals, disappeared. It was thought for a long time that it had to do with the expansion of the ice ages, but it turned out that, if you look at close dating, wherever proto-humans appeared everything else disappeared. We are now in the process of finishing it off... The end result is that there is essentially no comparative evidence. There is evidence that something happened within a very short period, essentially suddenly from an evolutionary point of view, and nothing

has changed since. And that is the evidence. There is essentially no other evidence about the evolution of language[2].

If you take a look at the literature, what is studied is a different topic: language change. Undoubtedly languages changed. We are not talking Latin, we are not talking Sanskrit, proto Indo-European or whatever came before that. Undoubtedly languages changed, but that is not evolution. If you want to study language change, that is a serious discipline. Historical linguistics is a serious discipline, it has rigorous standards: you can't say "maybe this happened, maybe that happened". That doesn't count in historical linguistics. But that is what the work is in so-called evolution of language; it is what evolutionary biologists sometime call "just so stories": "maybe this happened, maybe something else happened". That is not serious work. So, if there is something to learn, as I think there is, we can ask what small change could have taken place that could have given rise to something like the language faculty. There is linguistic work which I think shed some light on that. I won't go into it. But we have to look for some small mutation that caused some rewiring of the brain that provided the essential properties of human language which don't exist anywhere else. And I think there is work on it. Beyond that, to talk about the evolution of language is just cutting down forests for no purposes, as far as I can see.

2) Is there any new contribution from neuroscience to the understanding of language?

Yes, there is. In fact the best work I know is Andrea Moro's work. There is a fair amount of interesting work. But there is one result that is quite far-reaching and that is what has been done here[3]. Cutting it down to its simplest form, it is something like this: taking speakers of some language, German let's say, and presenting them with two kinds of non-sense languages, languages they don't understand. One of them is modeled on say Italian: it has the properties of Italian, but non-sense words. The other is a language designed to violate what appear to be universal properties of language. The most interesting case that was studied, the one with the most far-reaching results, has to do with the linear order. For example, in Italian, if you want to negate a sentence, there is a negative particle which appears in a certain position in the sentence and it has to appear in that position, a fairly complex position: the position is defined by various structural relationships. You can make up a non-sense language in which negation is

2   For a paleoanthropological perspective, see Tattersall (1998).
3   For a comprehensive presentation of this and other experiments on possible and impossible languages, see Moro (2008).

much simpler: you put it in a particular linear order, maybe say the third word of the sentence. If you want to negate a sentence, you take the sentence and put the negation particle in the third word. Computationally, that is a lot simpler. But no human language works like that. Every human language puts the negative particle in some structurally defined position, and this incidentally generalizes. Linear distance counting doesn't seem to exist in human language. There is nothing like third position or find the shortest, the closest word. I will give you a simple example. Take interpretation of adverbs in complex sentences: you can show it also in brief sentences. Take the sentence "Eagles that swim fly". Put the word "instinctively" in front of it: "Instinctively eagles that swim fly". Everyone knows, every young child knows that "instinctively" goes with "fly", it doesn't go with "swim". It doesn't go with the closest verb. If it is "Instinctively eagles that fly swim", you don't understand "instinctively" to go with "fly", although that is the only thing that makes any sense: you understand "instinctively" to go with "swim". "Instinctively" is not finding the closest verb: it is finding a remote one and one which happens to be the structurally closest by an abstract notion of distance. And that holds for every linguistic construction, every language. Languages don't use simple computational techniques like closest or third. They use complex computational techniques involving structural distance and structural position. Again, universally. Now, going back to the language modeled on Italian and the invented language with the simple position for negation, say third position, Moro and colleagues' experiment found that normal speakers could solve the language modeled on Italian: they learned it very quickly. As for the language that uses the simple computational principle, they could solve it, but it was a puzzle. So, different areas of the brain were activated, not the normal language areas. There is comparable work with aphasics, actually with idiot savant cases, cases of a person who has tremendous, fantastic, language abilities, but very limited cognitive abilities. Neil Smith has done work on it[4]. Somewhat similar studies that are behavioral and not neurolinguistic found essentially the same as what Andrea Moro found with the investigation of the activation of brain areas. The normals could solve the invented language problems that violated Universal Grammar, but in a complicated way: they treated it like any other puzzle. The idiot savants, the one with limited cognitive abilities but excellent language abilities, couldn't solve it at all. They can't solve puzzles. This evidence from neuroscience compared with evidence from behavioral studies provides independent and very significant evidence that languages just don't use simple computational procedures. They don't use linear order, linear distance, fixed positions. That tells you something about the language faculty. That is the

4   On idiot savants, see Smith & Tsimpli (1995), where the case of Christopher is described.

kind of neurolinguistic work which can be very significant, I think. A lot turns on the question of whether languages use linear order: first semantics, first syntax, do they have rules that involve linear order, linear position? There is a lot of linguistic consequences to that choice. Neurolinguistic evidence conforms to other evidence in indicating that, if you want to understand the human language faculty, you have to ask what property is it that would lead automatically to use of structural position and structural distance, while ignoring linear position and linear distance. And there are interesting results about that, I think.

That relates very closely to the question of what small changes would have taken place that would have led to the sudden appearance of language in the first place. For those of you that know the linguistic literature, what is suggested in both cases is that the change that took place was the sudden emergence of the simplest combinatorial operation that is unbounded in scope. It is an operation that takes two entities already constructed and forms out of them the simplest possible new entity, the simplest possible will not involve linear order, because that is more complicated, it won't involve any changes in the two entities put together, and in fact what it will form is just the set of the two, and that turned out to give you the basis. An operation like that is embedded somehow in every computational system: it is the simplest one possible and it does give you an unbounded array of hierarchical structure, and any property of the system that is emerging will depend on structural and not linear distance, structural and not linear position[5]. That has plenty of consequences.

3) What is the role of the notion of simplicity in modern formal linguistics, i.e., in technical terms, Minimalism? Is it the end or the starting point?

Simplicity is simply the core notion of science. That goes back to Galileo. He argued that nature is simple and it is the task of the scientist to show it. When you look at phenomena, they look extremely complex and diverse, and the task of the scientist is to show that this is a superficial misunderstanding: if you look more deeply, you will somehow figure out that there are simple elegant rules and principles. The whole of science is based on that. If you do not do that, you are not doing science, you are collecting data, you are flower collecting, which is ok, but this is not science. Furthermore, there is a substantial philosophical literature in this respects (Goodman[6] and others) which shows that the search for simplicity is identical with the search for explanation, and you can see

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5   This operation is technically called "merge" (Chomsky 1995).
6   The reference is to the philosopher Nelson Goodman, broadly known for the "grue and bleen paradox", introduced to highlight certain problems of induction (Goodman 1954).

why, even superficially: the more complex your account the less deep the explanations. If you can make your account simpler, your explanations are deeper, and the whole purpose of rational inquiry is to find explanations, science as well. That is the driving force behind the study of language as well, and what is called "Minimalism" – maybe the name shouldn't have been given to it – is just the latest stage in the effort to try to find simpler explanations[7]. It is a seamless continuation of everything that has been done in the study of language at least for the last 60 years, since the modern study took shape. In the early days, 60 years ago, it looked as if languages were extremely complex and very diverse: almost anything you can imagine could happen. Over the years it has been gradually found that, if you look at it properly, diversity is much more constrained and there are very limited options for change, and the things that look very complex on the surface often have deeper explanations that work. The case that I mentioned is just a quite interesting one: the fact that simple computational procedures are not used but rather things like structural distance and structural position. That tells you a lot: one of the things that it tells you is that the core operation in language is the one I mentioned, the simplest computational operation which could have emerged from some simple mutation, but here we are getting into questions about genetics and brain science that are not understood[8]. But it is quite possible that some very simple mutation could have rewired the brain to provide the simplest computational operation, which is unknown in the organic world, since it appears in the language and nowhere else.

4) Doesn't memory structure constrain grammar as the sensory-motor and the conceptual-intentional external systems do?

Memory structure certainly constrains usage, in fact humans have quite limited memory as compared with a number of other organisms, for example certain birds like crows. A crow can remember where it has hidden 10 or 20 thousand seeds, and not only where it has hidden them, but what quality the seed was, so that it will go first after the seeds that are going to deteriorate more quickly. Furthermore, the crow pays attention to other animals around that might see it hiding the seed and, if it sees that there is another crow around, it will wait that it goes away and re-bury the seed somewhere else. These are feats of memory that are absolutely unconceivable for humans: humans can get up to about 7 not 20 thousand:

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7   On the origin of the term Minimalism, which aims at reducing linguistic levels to the minimum number required by virtual conceptual necessity, see Moro (1996).
8   For an extensive discussion on computational operations, see De Palma (1974) and Chesi (2012).

that is an order of magnitude difference. The narrowness of memory is so that the number 7 is almost uniform across organisms (crows happen to be unusual): 7 plus minus 2 is a famous formula in the study of short-term memory that goes back to George Miller, 50 years ago[9]. Humans are in that range, a normal range, and that does constrain things you can say: it constrains numbers that you can add in your head, for examples. But that tells you nothing about language, just as it tells you nothing about your knowledge of arithmetic. Your knowledge of arithmetic enables you to add numbers of arbitrary size, and you can demonstrate that: if you give a person more memory and more time (say paper and pencil), there is no limit on the size of the numbers you can add. That tells you that you have an internal procedure, technically it is called the "generative procedure", which assigns a sum to any two arbitrary numbers. But memory constraints and time constraints limit how far you can go in real-time. You can go on and on indefinitely, if you have more and more time. Language is exactly the same. There is no indication that memory plays any role in the nature of language any more than it does in the nature of arithmetical knowledge. But of course, it plays a role in your use of language, just like in your use of your ability to do arithmetic, or any other generative process. We have to distinguish between the nature of the system and the use of the system: this is a very fundamental difference. In the study of language, this is often called the difference between "competence" and "performance": your internal knowledge, i.e., the internal structure, and what you do. It is considered a controversial distinction, but this has to be a confusion, since it is a conceptual distinction that cannot be avoided. There is a comparable distinction that is so obvious that it is just taken for granted everywhere else in biology. Suppose someone is studying the digestive system and doesn't know exactly how the digestive system works, i.e., the nature of the system: you don't just look at the performance, like if the person has intestinal flu or if he just ate a big meal; you don't pay attention to that, you abstract away from it, if you want to understand the nature of the system. That is so obvious that it is never mentioned: it is just taken for granted in all inquiry. But when you talk about language, for some reasons, rational assumptions dissolve very quickly. It is typical when we talk about ourselves: it can be very hard to be rational. But if you use normal rational standards, the distinction is obvious and it tells you where memory plays a role as far as we know: not in the organization of the system but in the use of the system, of course.

9   See Miller (1956).

5) What do you think is the most critical computational aspect of language for a computer program that aims at understanding it?

First of all, no computer program should aim at understanding language, because that is utterly hopeless. It is much too elevated goal. We don't even know what understanding language means. You can't try to construct a program that does something that you can't characterize: that is not a feasible task. Understanding of language involves some many complex things that we have no grasp of: it is not a formulable task. You can ask narrower questions. For example, you can construct a computer program that will determine from the sequence of sounds or some other representations the internal structure of the object that you construct in your mind that gets interpreted in ways that we don't understand. That you can do: it is called a "parsing program", technically, and it raises interesting questions. Just to go back to the question of linear order that I have mentioned, a parsing program would be much simpler if it could use things like linear order: say in the sentence "Instinctively eagles that fly swim", a program that will tell you that "instinctively" goes with "fly" will be far simpler that the one that we use that tells you that it goes with "swim". But language doesn't offer this possibility; in fact there is a striking conflict – we find over and over – between language design and ease of use of language. They are in conflict. Language is designed in ways that increase the difficulty of use. Put it differently, communicative efficiency and computational efficiency conflict in many cases, and those are quite interesting cases: in every single case that is known computational efficiency wins and communicative efficiency loses. So whatever language is about, it doesn't really care much about communication: it cares about internal elegance, being a simple system. And if you think about how language must have evolved, very recently, that makes sense: it was an almost instantaneous emergence. Whatever happened at that interesting moment, 75 thousand years ago, under no external pressure, no selectional pressure – it just happened in somebody's brain, it would naturally take the simplest possible form. Using an analogy that I have used occasionally and that Andrea has used, it should become like a snowflake: it just takes the simplest form that the proprieties of physics forces it to take. That is what seems to have happened: in so far as we understand anything about language, it seems to take the simplest form and not care much about the consequences for use, in particular for communication. There is a lot of evidence pointing to that, and it has many interesting consequences. To go back to the literature on evolution of language, it bears on that too: standard view is that language evolved

as a means of communication, but the evidence is overwhelmingly against that. It seems to have developed in a way that harms communication and doesn't care about communication. It does care about elegance, which makes sense if you think about the two or three facts that we have about the conditions for the emergence of the language faculty. All this hangs together pretty reasonably.

6) What is complexity in language? And in thought?

To answer the question about either language or thought, we first have to say what they are. You can't answer questions about something when you have no idea of what it is. In the case of language, we can say some things, there are some ideas about what the essential nature of languages is. What is complexity in language? If we adopt the Galilean guideline for the sciences, complexity in language is whatever we don't understand: if you don't understand something, it is complex. What you are trying to do is to show that it is your failure to understand that gives the impression of complexity: that is the nature of rational inquiry, science in particular. So there is plenty of complexity in language; pick anything random out of a page and it is very complex, which simply means that we don't understand enough. But that is true of everything you look at in the world. That is why physicists don't take video tapes of what is happening in the worlds and try to develop theories: this is way too complex. In fact, there is a standard joke in mathematics, that the only numbers are 1, 2, 3 and infinity, because anything else is just too complicated to study. In the case of physics, hydrogen you can study, helium maybe, but, if it gets bigger than that, you give it to the chemist and they will worry about it. If an organic molecule is too big or complicated for a chemist, you give it to the biologist; if it is too big for the biologist, you give it to historians; so it goes. You can study simple things, and when they get too complicated it gets harder, which means that you don't understand enough. That is the nature of things. That is language. What about thought? You can't do this for thought, until someone tells you what thought is. What is thought? We can say a couple of things about those aspects of thoughts that are expressed in language, but then we are talking about language. What about those aspects of thought that aren't expressed in language? What do we know about them? Actually what we know about them is mostly from introspection. I am sure that I am not the only person in the world who has the experience of knowing what I want to say but not thinking of how I can say it: "I know what I mean but I can't find the way to say it", and you try something that didn't work, maybe you try something else, maybe it is a little better, maybe you

end up with some complicated paraphrase because you couldn't figure out the right way to say it. That is a normal experience. Experience is like that. It tells you something: that there are a lot of things going on beyond the level of consciousness that we try to move to consciousness and even to the external world, often failing, which means that there is a lot of thought going on, and we have no grasp of it. Until there is some way to capture these things that are beyond the level of consciousness, which is probably almost everything in our cognitive world, there is nothing to say. There is other evidence about this that has been misinterpreted, I think. In the last couple of years ago, there were experiments showing that, when people make decisions, for example when I decide to pick up this cup, milliseconds before I make the decision, there is activity in the brain in the areas where you are going to act, i.e., milliseconds before I make the decision, the motor areas of the brain are already organized to pick the cup up. That evidence was used widely to conclude that this shows that we don't have free will[10]. But this doesn't show anything of this sort. This just shows that decisions are unconscious. We all know that, if we think for a minute: of course decisions are unconscious. Some of them reach the level of consciousness, some of them we can't even act on, but there is a lot there going on unconsciously, probably everything of interest, and we don't know how to deal with it. In principle it could be studied, maybe some day brain scientists reach the point where they can say something about this: it doesn't seem beyond the possibility of inquiry. But we have to overcome some dogmas. There is one dogma that has hampered psychology back hundreds of years: that is the dogma that contents of thought are accessible to consciousness. It is hard to find anyone in the history of psychology or philosophy who has doubted this, even Freud. Freud talked a lot about the unconscious, but the whole Freudian system is based on the assumption that you can tease out what is unconscious. That is the point of psychoanalysis: they try to make what is unconscious, conscious. But if you try to find somebody who questioned that, it is not easy; the only person I have ever found is Vico. This dogma is almost certainly false. We know that from our own experience. Going back to the question, until we have something to say about thought, we are not going to be able to ask questions about its complexity, its simplicity, its properties, or anything else.

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10   To this respect, see the studies of the neurophysiologist Benjamin Libet on voluntary movement (Libet 1985). On the implications of this type of evidence for the notion of free will, see Pietrini & Bambini (2009).

7) What comes first? Language or thought? Do they share a recursive structure?

It is the same question: until we have something to say about thought, we are not going to be able to give any serious answer. The only answer we can give is the one I have already mentioned: you simply pay attention to your own internal cognitive activity, speaking, planning, deciding, and so on. And I think you invariably come to the conclusion that something is going on beyond the level of consciousness. Probably, everything interesting is going on there. That is thought, if you like, and, whatever it is, it is coming before language, before deciding, before acting: it is just going on inside. But what is it? Well, it is a task for the future.

8) What is the place of context in language functioning? For example, metaphors are context dependent. Do they lay outside the language faculty?

Interpretation of metaphors, like interpretation of everything else, is context-dependent and lies outside the language faculty, specifically, unless by the language faculty you mean all of our cognitive abilities[11]. So, yes that would be true of metaphors, but it is also true of non-metaphors. Whatever you interpret in literal sentences goes way beyond the language faculty. Again, there are a lot of dogmas about this.

9) Why is it so difficult to explain that the difference between human and animal language lies the syntax?

That relates to the previous question. First of all, it is difficult to explain anything about language, because people have religious attitudes towards their language, religious dogmas about their language, as about almost anything else that is deeply personal. So you just feel you know everything: "you can't tell me anything, I can speak perfectly and I don't have any problem, there can't be any difficulties about it, so stop bothering me with all your complicated theories". That is very normal. You take a look at modern philosophy of language and it is full of this. People spell out their untutored intuitions about language and think they are saying something, because how could it be complicated? You could say the same about vision. What could be complicated about vision? "I see things, I don't have any problems with it". If you try to explain to people that the way you see things is because of quite complex computations that take place in the visual system, there is interesting experimental work which with you can sometime convince people. Somehow this goes back to unconscious

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11   On the constellation of cognitive abilities involved in interpreting metaphor and context-dependent meanings in general, see Bambini *et al.* (2011).

knowledge. The mammalian visual system, humans and other mammals that have been studied, has a way of interpreting objects in motions as rigid[12]. In standard experiment, if you give a person tachistoscopic presentation, like a screen with a couple of dots on it, maybe three dots, if you give them three or four successive presentations of three dots on the screen, what you see is a rigid object in motion. You can't help that: that is just the way the visual system works, which is kind of strange in a way. In the whole history of mammals, going as far back as you like, there was never any experience with rigid objects: rigid objects come in what is called "carpentered universes", in modern universes where people construct things. If you are walking around in a forest, there aren't any rigid objects. But our eyes and visual systems in all other mammals are constructed so that all of this completely unconscious activity is going on inaccessible to consciousness, which is giving a kind of a framework for visual perception. Try to explain that to somebody about cognitive abilities like language and they would just resist it: "It can't be. I know everything, don't bother me". It is hard to explain anything about language, unless somebody is willing to take on the attitude of the standard scientist: my intuitive judgments don't mean anything, maybe my intuitive judgment is that a heavy rock falls faster than a small rock; if I want to be serious, I put aside this intuition because it has been disproved. Unless you can make that leap, nothing can be explained.

What about the special role of syntax? The fact that matters is that human syntax has no counterpart in the animal world, none. No one has ever found any remotely like it. This fundamental combinatorial process that I mentioned simply appears nowhere else, at least anybody has been able to detect. But is that the difference between animals and humans? Well it is *a* difference, it is only one of many. If you take even the simplest word of language, the simplest one you like, "river", "cup", "person", whatever it is, there is absolutely no analogue in animal communication. Animal communication has essentially a 1 to 1 association between a symbol and some physically detectable set of circumstances. Take monkey calls: monkey might have five calls. One of them is reflexively produced when leaves are moving: it is a warning call, we interpret that as meaning "predator is coming". Leaves are moving, this call comes out: it is like seeing a rigid object in motion. Another call comes out because of some hormonal activity: we interpret its meaning as "I am hungry". In every animal communication system that is known the symbols are like that. Human words are nothing

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12   See the work on visual perception by David Marr (1982) and Shimon Ullman (1979), and specifically Ullman's rigidity principle.

like that, not remotely even. You cannot give the physical characterization of what it means to be a river, or a person, or a cup. All of these concepts, even the simplest ones, depend on internal interpretations in terms of function, design, intentions, psychic continuity, all sorts of things. And every infant grasps this instantaneously, and in fact fairy tales are based on it. Standard fairy tale has some prince turned by the wicked witch into a frog and he stays this way until the beautiful princess kisses the frog that becomes the handsome prince. During the interim period the physical characterization of the object was a frog, with all physical properties of the frog. But the child understands it as the prince: it just happens to look like a frog. That means that the concept of person is based on an intuitive notion of psychic continuity, which has no physical characterization, and that is instantaneous: no child has ever been confused about this. That is true for every word you look at. So, it is true that the syntax is different for the humans and animals, but so it is for everything else about language, including the meaning of the simplest words. This is another dogma, very resistant to reason and evidence, which has prevented the understanding of this. It is sometimes called the "referential doctrine": the idea that there is a relation between words and things, an association between a word and the thing, that runs through philosophy of language and history of inquiry into the subject in recent years. That is just flatly false. There is no such relationship. In fact that was known to Aristotle, but it has been forgotten. If you look back at Aristotle, he asks: what is a house? In the Aristotelian framework, a house consists of the interaction of two substances: the one is "matter" – house is something that is built out of bricks and wood and so on, its materials aspect – and the other is what is called "form", design and function – it is used for a place for people to live in. If form and matter coincide, you get a house. But form is not physically detectable. And in fact the Aristotelian definition, though is correct as far as it goes, it just doesn't begin to reach the meaning of house. But that is the right idea. That was understood pretty well until the 17th century, like a lot of things that were understood then and that are almost totally forgotten. Until those insights are recovered, it is going to be impossible to study this question.

But to go back to the question itself, it is true that syntax sharply separates human language from animal communication, so does the interpretation of the simplest atomic elements, so does everything else. Animal communication systems are – as the term indicates – used for communication. For human language that just doesn't seem to be a central property. It is certainly one of things you can do with language, just as you can watch television with your eyes. But that is not a core property and

there is plenty of evidence for that, of the kind I mentioned. So, in every respect it is just some novel thing in the organic world. I mentioned this morning Descartes: I think he was basically right in thinking that this is the dividing between humans and the rest of the organic world, something that happened very recently[13].

10) What is the difference between syntax in music and syntax in language? If they are alike, is it plausible that they have coevolved?

It is very plausible. Language is universal among humans. There is no human group that has been found that doesn't have a language very much like ours. In fact, languages are even invented by children with zero evidence. There are some remarkable cases. I will mention one case which is well studied. It is now known – it wasn't known 50 years ago – that sign languages are almost identical to spoken languages: they have the same structures, same rules, same acquisition rate, same neural representation even, which is a little surprising because they are visual. There is one well studied case of a group of three cousins, in Philadelphia, whose parents were indoctrinated into the prevailing so-called oralist tradition: deaf children should not be permitted to use gesture, they have to learn lip reading. The idea behind this is crazy but it was the prevailing ideology in raising children with deafness. These parents were so deeply indoctrinated that they never made gestures, they walked around the house with their hands behind their backs so that the kids wouldn't see any gesture. These three kids played together and it turned out, around the age of 3 or 4, that they invented a sign language: they developed a sign language and they were just using it. They were immediately taught American Sign Language, but the language was studied and it was about the same of any other language at that developmental level[14].

Actually, the first study of this was one of a friend of mine, back when I was a graduate student, Eric Lenneberg, who went on to develop the field of biology of language[15]. When he was a graduate student, back in the early 1950s, he was getting interested in the acquisition of language under a variety of conditions, and particularly language of the deaf. He went to visit a prestigious school for the blind and deaf in Boston, called

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13   In the morning of September 15, Chomsky gave the inaugural lecture at the Institute for Advanced Study, IUSS, on *Language and limits of understanding*, considering also Descartes's view on language and human creativity.

14   On deaf children spontaneously developing a sign system, see Goldin-Meadow & Feldman (1977) and Goldin-Meadow (2003).

15   On the biological foundation of language development, including the condition of congenital deafness, see Lenneberg (1967; 1969).

the Perkins School[16]. It was oralist, like everything was: no sign language, just lip reading. He just sat in on a class and he noticed that, as soon as the teacher turned to the blackboard, the kids started signing to each other. Obviously the kids had invented a sign language, somehow. There was no way to study it at that time, but it is very likely, it is spontaneous, you can't help it.

Music is the same. As far as the anthropological evidence indicates, no human group has been found that hasn't developed a pretty complex system of music. It may not be tonal music. It might be rhythm based or something else. But some kind of system of music seems to be universal, which is very curious because what function does it have? Why should there be music? A similar question arises about arithmetical knowledge. That is also universal. This is something that bothered Darwin and Wallace, founders of evolutionary theory, because it seems to violate the principle of natural selection. How could arithmetical knowledge have evolved, since it has never been used? It has only been used in a tiny period of human history, and only among very few people. How come that everybody has it? And where is the good evidence that this is universal? That looked problematic. The only sensible answer that has been proposed is that all of these are offshoots of the same cognitive system. Some cognitive system that emerged, which led to arithmetic, music, language, and any other behavioral pattern that has this basic properties and is universal. There are some reasons to believe that the combinatorial operation that I mentioned before actually does underlie all of them. For arithmetic, it is pretty easy to show, for music it is more complicated, but there is some work on it. In the last 40 years there has been a certain amount of work on the syntax of music, trying to relate it to the syntax of language. The first major studies were done by Leonard Bernstein, American well known composer and conductor. There was a lecture in Harvard, back in the early 1970s[17]. Since then there has been a certain amount of work. One of my colleagues in my department, David Pesetsky, is one of the people that has done the main work on this[18]. It is an interesting topic. You can see how it ought to end up. But trying to show that what ought to be true is true, is never an easy task.

11) What is your position about the new theories of embodied language? In

16   The Perkins School for the Blind was established in 1829. Famous students at the Perkins School were Anne Sullivan and Helen Keller.

17   Bernstein delivered six lectures at Harvard in 1973, broadcasted in 1976 and available also as a book (Bernestein 1976).

18   As a representative reference, see Katz & Pesetsky (2009), which follows the path inaugurated by the seminal work of Ray Jackendoff and Fred Lerdhal (Lerdhal & Jackendoff 1983).

particular, what do you think about the relationships between the motor system and semantics?

That is a quick one. I don't have any position. "Semantics" is a pretty loose term. If by "semantics" you mean everything involved in interpretation of language, then it would be pretty strange if it didn't have some relation to motor systems and everything else. What that relation might be, I am not aware of any more than superficial observations relating them. I am afraid I have to say the same thing about embodied language: that is another popular topic. If you think about things like emotions and reactions to things and so on, what has that to do with language? A lot, it has a lot to do with the use of language, trivially, but does it have to do with the structure of language, the principles that determine the infinite structure of an interpretative expression? As far as I am aware, nobody has thought of a connection and it would be pretty hard to imagine one. They just seem quite different systems[19].

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19   A discussion on embodied cognition theories with respect to the language faculty can be found in Tettamanti & Moro (2012).

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