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The Phylogenetic Foundations of Discourse Coherence: A Pragmatic Account of the Evolution of Language

Abstract In this paper we propose a pragmatic approach to the evolution of language based on analysis of a particular element of human communication: discourse coherence. We show that coherence is essential for effective communication. Through analysis of a collection of neuropsychological and neurolinguistic studies, we maintain that the proper functioning of executive processes responsible for planning and executing actions plays a key role in the construction of coherent discourses. Studies that tested the discursive and conversational abilities of bonobos have showed that apes are unable to construct a flow of discourse governed by coherence, and therefore, apes' conversational interactions are quite different from those of humans. We then propose that the emergence of coherence in communication occurred after the split between great apes' and humans' lines of descendants and that this emergence might have been the result of a specific gradual development in the course of hominin evolution of the executive functions.

Keywords
Ape language . Cognitive pragmatics . Coherence . Discourse processing . Executive functions . Language evolution . Neurolinguistics . Tool making

Introduction

In this paper we propose a pragmatic approach to the evolution of language. We start with an analysis of a particular property of human communication, specifically a keyproperty of discourse: coherence. We use the term pragmatic as it is conceived in the theoretical framework of cognitive pragmatics, that is, in relation to the study of the mental structures and processes involved in the use of language in communicative contexts (e.g., Bara 2010; Davis 2007). We aim to show that discourse coherence is a specific and unique property of human language that does not have an equivalent inanimal communication. We hypothesize that its emergence in human phylogeny might be linked with the development of systems tied to the planning and control of actions.

First, through analysis of a collection of neuropsychological and neurolinguistic studies, we show that coherence is essential for effective communication and that its processing does not rely on the grammatical systems that manage the internal constituents of the sentence. We demonstrate that coherence relies on the executive functions responsible for action planning and execution. Second, we discuss the results of studies on the communication between human beings and enculturated apes (i.e., primates bred in human environments trained for various aspects of human communication and culture). Specifically, focusing on studies that tested the discursive and conversational abilities of bonobos, we maintain that these apes, being unable to construct a progressive and cumulative flow of discourse governed by coherence, are involved in conversational interactions distinct from those of humans. Based on these considerations, we finally propose that the emergence of coherence in communication occurred after the split between great apes' and humans' lines of descendants and that this emergence might have been the result of a specific gradual development in the course of hominin evolution of the executive functions. Research in cognitive archaeology on the mental processes involved in making stone tools show that hominins preceding Homo sapiens in human phylogeny were indeed endowed with cognitive control processes computationally and anatomically similar to some of those involved in modern human language processing at the discourse level. Based on this, we propose that the development of executive functions in language processing provided the foundation for the emergence and the gradual development in the hominin lineage of a communicative system based on a kind of protodiscourse governed by coherence.

When is a Discourse Coherent?

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Because many disciplines study the concept of Bcoherence^ (e.g., linguistics, philosophy, sociology, psychology, etc.), there exist multiple definitions of this important property of language (cf. Louwerse and Graesser 2005). In general, coherence can be defined as the conceptual organizational aspects of discourse at the suprasentential level (Glosser and Deser 1990: 69). Discourse coherence depends, at least in part, on the speaker's ability to maintain thematic unity during speech production. Our hypothesis is that this ability requires cognitive capacities more than linguistic skills. Specifically, we propose that the construction of coherent discourse can be linked with the planning, organization and control of goal–oriented actions. In this sense, discourse coherence and goal–oriented behavior rely on the same neurocognitive systems responsible for planning and organizing action. Before we discuss the neuroscientific evidence that support this proposal, we provide an overview of the linguistic research on coherence.

When is a discourse coherent? According to some systemic –functional models in linguistics, discourse coherence depends on the cohesion between pairs of consecutive sentences, namely on the linear relationships of content between adjacent utterances (Halliday and Hasan 1976; Reinhart 1980; for a discussion see Bublitz 2011; Tanskanen 2006). In a text, cohesive relations are accomplished through grammatical and lexical elements (Halliday and Hasan 1976). Grammatical cohesion includes elements such as references, substitutions, ellipses and conjunctions; lexical cohesion is based on reiteration (e.g., repetition, synonymy) and collocation (i.e., co–occurrence of lexical item). Anaphora is a typical example of a cohesive device: in the pair of sentences "Peter is a very nice guy. Katie really likes him" the use of the pronoun "him" allows the speaker to connect the second sentence to the first. Another important cohesive maneuver is lexical repetition, as shown in the following text:

1) After the forming of the sun and the solar system, our star began its long existence as a so–called dwarf star. In the dwarf phase of its life, the energy that the sun gives off is generated in its core through the fusion of hydrogen into helium (Berzlánovich 2008: 2)

It is important to note that from this perspective, although coherence is distinct from cohesion, cohesion is, however, a necessary condition for the coherence of discourse: cohesion does not contribute generally to coherence, but is a conditio sine qua non of coherence (for a discussion, see Giora 1985:699; Giora 2014). In other words, coherence depends on linguistic capacities and elements.

The assumption that cohesive devices play a role in the construction of discourse coherence is not disputed: the fact that linguistic markers provide coherence to discourse is not controversial. From our point of view what is problematical is the hypothesis that there is no coherence without cohesive elements. Our claim in this regard is that the cohesive devices do not constitute a necessary condition of coherence since cohesion is the superficial expression of a deeper level of coherence that concerns cognition prior to language production (cohesion is only the conventionalized realization of coherence) (see also Adornetti 2013; Adornetti 2014). Central in this regard is the distinction between global coherence and local coherence (cf. Glosser and Deser 1990). Local coherence refers to the conceptual links between individual sentences or propositions that maintain meaning in a text or discourse. According to Agar and Hobbs (1982: 7), the requirements of local coherence are characterised by this statement: "Given what I just said, what can I say that is related to it?". Global coherence refers to the manner in which discourse is organized with respect to an overall goal, plan, theme, or topic (Glosser and Deser 1990: 69). Agar and Hobbs (1982: 7) stated that "the requirements of a global coherence say 'Given the

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overall goals I am trying to accomplish what can I say next that will serve them?'". As shown by text in 1), cohesion is responsible for local coherence. But is local coherence a necessary condition for global coherence? Theoretical arguments and empirical evidence suggest that global coherence does not depend on the local coherence; the cohesive bonds between adjacent sentences are not a necessary requirement of the overall coherence of the discourse. Consider in this regard the following text:

2) I bought a Ford. The car in which President Wilson rode down the Champs– Élysées was black. Black English has been widely discussed. The discussions between the presidents ended last week. A week has 7 days. Every day I feed my cat. Cats have four legs. The cat is on the mat (Enqvist 1978: 110–111).

In 2) the sentences are connected through the cohesive mechanism of lexical repetition. However, the set of sentences, despite the abundance of cohesive ties, does not constitute a unitary whole. The text is judged pragmatically inappropriate by the reader. As Giora (1985: 701) maintains, the inappropriateness lies in the text's vagueness as to its topic. The discourse in the example in 2) is, in fact, characterized only by local coherence, but not by global coherence. Consider, instead, the following example:

3) George's high pass was headed to the right. The forward shot at once without dribbling and made a goal. The referee declared the kick off–side (Enqvist 1978: 111).

Unlike text in 2), in 3) there are not cohesive bonds between consecutive sentences (there is not local coherence). Nevertheless, 3) is globally coherent because the topic is clear. In sum, these examples show that the linear concatenation of sentences (cohesion) does not guarantee the overall coherence of the discourse and that it is possible to have globally coherent discourse even in the absence of cohesive ties.

Discourse Coherence and Executive Functions

The theoretical arguments discussed so far regarding the distinction between cohesion and global coherence are also confirmed by ample empirical evidence (e.g., Davis et al. 1997; Davis and Coelho 2004; Marini et al. 2008). In this regard, the studies conducted on the discursive abilities of subjects with traumatic brain injury (TBI) are particularly important for the argument of our paper: these studies support the hypothesis that the production of discourse coherence can be linked with the planning and construction of goal–oriented behaviour and that a key role in the building of coherent discourses is played by the proper functioning of systems tied to the control of action. In this regard, and before presenting our argument, we have to make a clarification. In order to account for discourse coherence, it is necessary to make reference to several elements (i.e., learning processes and socio–cultural factors) and different cognitive systems (i.e., memory systems, inferential mechanisms, mindreading device). In this work we focus on a very specific system: executive functions responsible for planning and executing actions. Analysing the involvement of this system in the construction of coherence, we neither want to assert that the processing of discourse coherence must be reduced to executive functions, nor that the functioning of the neural areas involved in executive functions explains in an exclusive way how it is possible to be coherent. What we want to argue is that the proper functioning of executive processes plays an essential role in the construction of coherent discourses. In order to show this, we take into account the studies on TBI patients.

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It must be said that TBI patients are not an entirely homogeneous group from a cognitive point of view: the brain areas most frequently damaged after a brain injury are the frontal and parietal regions, but on the basis of the type and the mechanical characteristics of the trauma, other areas of the brain can be injured (cf. Zasler et al. 2012). Therefore, the subjects may suffer from various types of disturbances. The neurobehavioral disorders resulting from brain injuries in the frontal and prefrontal lobes are particularly relevant for our purposes. Such injuries cause damage to the system of executive functions. In fact, among all the problems resulting from a brain injury, a deficit in executive functions is the most characteristic (Gioia and Isquith 2004; Johnstone et al. 1995).

Executive functions (also executive control or cognitive control) is an umbrella term for a wide range of cognitive and behavioral skills, which are mainly mediated by the prefrontal cortex and involved in the organization and performing of goal–oriented behavior (Alvarez and Emory 2006; Banich 2009; Barkley 2012; Jurado and Rosselli 2007). From a general point of view, it is possible to characterize executive functions as the higher–order cognitive processes that are needed to guide behaviour toward a goal in non–routine contexts and in complex and conflicting situations (Banich 2009; Gilbert and Burgess 2008). Fuster (2008: 178) defines executive function as Bthe ability to organize a sequence of actions toward a goal [and] temporally organize purposive behaviour, language and reasoning^. Although there is not a precise taxonomy of executive functions (Jurado and Rosselli 2007), it is possible to delineate some aspects of convergence among the neuropsychological models. There is general agreement that executive functions are involved in processes such as action planning, inhibition, and mental flexibility, as well as in the initiation and monitoring of ongoing action (Chan et al. 2008; Fuster 2008). Specifically, executive functions allow for formulation of plans, starting a plan's execution, and maintaining attention on that plane until its realization; executive functions permit a rapid shift of attention allowing the adaptation to novel contexts and inhibition of inappropriate behavioural responses to the current situation (Hofmann et al. 2012).

Various studies have documented that TBI with lesions in the frontal and prefrontal areas are usually affected by executive deficits in action planning and monitoring, and in mental flexibility (e.g., Humphreys and Forde 1998; Zalla et al. 2001, 2003). For example, Zalla and colleagues (2001) showed that TBI patients with injuries in the anterior and dorsolateral prefrontal cortex had difficulties in the formulation and in the conceptual evaluation of a coherent and well-structured plan of action, and these difficulties in turn impaired the execution of actions, which were confused and disorganized.

As indicated above, in addition to problems in the domain of action, TBI subjects also have problems in the domain of linguistic communication (cf. McDonald et al. 1999), specifically in discourse processing. In fact, several studies have shown the existence in these subjects of a dissociation between the abilities underlying local coherence (cohesion) and those that underlie global coherence (e.g., Biddle et al. 1996; Coelho et al. 2012; Galetto et al. 2013; Glosser 1993; Glosser and Deser 1990; Strauss Hough and Barrow 2003; Marini et al. 2011). TBI subjects generally do not present serious difficulties in processing of individual sentences (lexical and syntactic level, i.e., the microlinguistic dimension). That is, people with TBI do not have lexical and grammatical problems, but they show severe deficits in the organization of the information at the global level of discourse (i.e., the macrolinguistic level of discourse processing) (Coelho 2002; Body and Perkins 2004; Le et al. 2011; Marini et al. 2011). People with TBI have been reported to omit essential information, provide a disrupted sequence of information, and include irrelevant and ambiguous material in their narratives. Consider the following transcript of a person with TBI (from Perkins et al. 1995: 305):

4) I have got faults and. my biggest fault is. I do enjoy sport . it's something that I've always done. I've done it all my life. I've nothing but respect for my mother and father and. my sister. and basically sir. I've only come to this conclusion this last 2 months. And as far as I'm concerned. my sister doesn't exist.

In this text the sentences are well–formed from a syntactic point of view. However, taken as a whole, this fragment of discourse appears pragmatically inappropriate because it lacks global coherence: it is characterized by a derailment of the topic, which makes the discourse communicatively ineffective. This same pattern is evident in the following transcript from Perkins et al. (1995: 304) in which C, a man with TBI, is talking to T, a speech and language therapist, about trade unions:

5) C: I admit this government we've got is not doing a good job but the unions aretrying to make them sound worse than what they are
T: mm
C: they . they . cos I'm a Tory actually but I I do vote . if there's a . er . a communist bloke there I will vote communist but . it all depends what his principles are but I don't agree . with the Chinese communism . and the Russian communism
T: right
C: but I believe every . should be equal but . I'm not knocking the royal family because y . you need them
T: mm
C: and they they they bring people in to see take photos

As Perkins (2007: 86) stresses, C shows Btopic drift^: despite the local sequential links between trade unions–government, government–Tory, Tory–communist, communism– Chinese/Russian communism, communism– equality, equality–Royal Family, Royal Family–tourist attraction, he is apparently unable to effectively monitor what has already been talked about or to relate each individual utterance to some overall coherent plan or goal.

On the basis of this type of evidence, several authors have argued that the inability to construct globally coherent discourses by TBI subjects is connected to their deficit in executive functions (e.g., Coelho 2002; Coelho et al. 2012; Le et al. 2012; McDonald 2008; Marini et al. 2014; Mozeiko et al. 2011; Strauss Hough and Barrow 2003). For example, in a study by Biddle et al. (1996), a group of TBI patients produced personal narratives that were less informative than those produced by a group of healthy individuals. The group of TBI patients could not adequately monitor their discourse and failed to include critical information in the story. Interestingly, according to the authors of the study:

The narrative impairments of the population of adults and children with TBI in this study appeared to be the results of problems with planning, production and monitoring discourse. […] It is possible that the disruptions evident in the narrative of the children and adults with TBI were related less to a language impairments that to difficulties with the executive processes utilized in discourse production (Biddle et al. 1996: 463)

Executive functions appear to be therefore critical to the construction and maintenance of global coherence. Specifically, action planning systems permit speakers to structure verbal behaviour for the attainment of a final goal by indentifying the sequence of steps required to achieve that goal,

i.e., by planning and organizing text units in a logical and sequential manner to coherently express the general theme of the discourse. Producing a coherent discourse also requires continuous monitoring of output to ensure that expressions are inserted logically and effectively into the flow of speech (cf. Ferretti et al. 2013: 329–330). Besides, the ability to produce a coherent narrative depends on the capacity to inhibit verbal responses that are inappropriate to the current topic of conversation. As McDonald (2008: 294) puts it: "often what is not said can be as important as what is". In sum, these observations suggest that a deficit of executive functions—that is, a deficit in the ability to flexibly plan and organize goal– oriented actions—interferes with the production of coherent and appropriate discourse.

Communication Between Apes and Humans

In this paper we propose an evolutionary explanation for the origin of the ability to construct coherent discourses. In general, one way to account for language from an evolutionary perspective—that is, to explain the emergence and subsequent development of the species–specific ability of human beings to acquire and use language—is to adopt a comparative perspective, focusing specifically on our closest relatives, the great apes (cf. Fitch 2010). If apes indeed possess (to varying degrees) some linguistic capacity and cognitive skill involved in language processing, we can speculate that our last common ancestor with apes also possessed these skills, and consequently we can conjecture that these skills also were present among the hominins preceding *Homo sapiens* in human phylogeny. On the contrary, if apes do not demonstrate linguistic capacity, we can conclude that such ability is a more recent evolutionary development, being a specific feature of hominin lineage. Based on these premises, it would seem that a comparative perspective can guarantee a unique response to the question of the continuity/ discontinuity between human language and cognition and animal communication and cognition. Of great relevance to our argument is that a question of this kind does not permit a univocal answer, specifically because language is not an unitary phenomenon identifiable with a single and exclusive trait. Rather, the faculty of language is a multifaceted phenomenon, a mosaic (cf. Hurford 2003) of properties that is made possible by different cognitive systems. For this reason, the answer to the question "Is human language a continuation of animal communication?" is: it depends on the properties and the cognitive capacities that are under analysis each time. The conception of language as a mosaic does not allow a univocal response to the continuity/discontinuity debate and, therefore, this conception maintains a liberal stance. This stance is very different from the absolutist conception that purports there are no continuities between human and non–human in respect to language; according to absolutists, language (generally identified as a single factor) is a special character of human beings that marks a qualitative difference between *Homo sapiens* and all other animal species (other hominins included) (cf. Bickerton 1990; Bolhuis et al. 2014; Chomsky 2005: 58–59; Hauser et al. 2014). An absolutist conception of this kind is closely tied to the Cartesian view of the separation of human beings from the rest of nature. This view in our opinion represents a very serious conceptual obstacle for the study of language from a naturalistic evolutionary perspective (for a discussion, see Ferretti and Adornetti 2014). Of course there are differences between human language and animal communication. However, we suggest that these differences, however great, are differences in degree rather than in kind (Darwin 1871, chapter III). Language is, then, not a special character, but rather a specific trait of human beings, interpretable in reference to quantitative, not qualitative, differences between Homo sapiens and other animals (Ferretti 2007). In the following sections, by analysing the phylogenetic foundations of coherence, we show that some cognitive systems have undergone a specific development in human phylogenesis that allowed humans to make possible the unique properties of human language. Therefore, from our point of view, it is possible

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to maintain, at the same time, that language conceived as a mosaic could be in continuity (in its entirety) with animal communication, even if specific properties of its functioning do not.

The starting point of our argument is a discussion of the results of studies on the discursive abilities of great apes, specifically of the bonobo (Pan paniscus). These studies were conducted on so–called enculturated apes: primates bred in human environments and trained for various involvements with human communication and culture (e.g., Gardner and Gardner 1969; Savage-Rumbaugh and Lewin 1994; Terrace 1979; for a review, see Gibson 2012). Traditionally, the majority of these studies have focused on isolated features of language. For example, they have analysed the great apes' ability to learn and use (mostly in a nonvocal mode) grammar rules (e.g., Gardner and Gardner 1969; Greenfield and Savage–Rumbaugh 1990; Terrace et al. 1979) or symbols (e.g., Lyn and Savage–Rumbaugh 2000). One of the first investigations conducted on enculturated apes was that of Allen and Beatrix Gardner (Gardner and Gardner 1969) who studied chimpanzees' (Pan troglodytes) abilities to learn elements of American Sign Language (ASL). Their first chimpanzee was the female Washoe who learned about 250 signs, which she used to communicate needs and desires, for example to request specific foods. Washoe was reported (Fouts and Mills 1997) also to have invented new sign combinations to label new objects (e.g., she called the refrigerator "open food drink"), though it is unclear if these new combinations were permanently incorporated into her vocabulary (Gibson 2012).

A different methodology to test ape's linguistics skills was subsequently introduced by David Premack (1977) and Duane Rumbaugh (1977). Rather than attempting to teach primates gestures, they proposed to investigate ape cognitive and communicative competences using visual symbols. Particularly relevant are the studies on Kanzi, a bonobo, who learned to communicate with humans in a completely natural and spontaneous way without being subjected to any explicit training. When he was an infant of 6 months, he observed the experiments that Susan Savage-Rumbaugh and Duane Rumbaugh were conducting on his foster mother, Matata. The experimenters were trying to teach Matata to comprehend and use abstract symbols on a keyboard to represent objects, actions, and ideas. Although the subject in the experiment was Matata and although no one was paying attention to Kanzi during the training process, at 2 years of age he began to use the symbol keyboard himself on his own initiative (Savage-Rumbaugh and Lewin 1994). According to the researchers who trained him (Savage-Rumbaugh et al. 1986; Greenfield and Savage–Rumbaugh 1990), over time Kanzi demonstrated the capacity to comprehend grammatical constructions of a complexity comparable to a human child of two and a half years of age. Additionally, he showed the ability to understand constructions that were pragmatically anomalous but correct from a syntactical point of view, such as "put collar in the water" or "put the toothbrush in the lemonade", and even more complex sentences with subordinate clauses such as "get the ball that's in the cereal" (Savage-Rumbaugh et al. 1998). Kanzi's protolinguistic achievements were also found in others bonobos and chimpanzees. Particularly relevant are the investigations on Panbanisha, step–sister of Kanzi. Several studies showed that Panbanisha was able to understand spoken English and communicate through the lexigrams of a keyboard (Brakke and Savage– Rumbaugh 1995; Brakke and Savage-Rumbaugh 1996). For example, like Kanzi, Panbanisha was able to map novel English nouns onto novel objects with few exposures to the novel item (Lyn and Savage–Rumbaugh 2000) and was documented to possess a significant understanding of human spoken English, comparable at least to that of a two–and–a–half–year–old child (Savage-Rumbaugh and Lewin 1994). More recently, Lyn et al. (2011a) showed that Panbanisha, and Panpanzee, a chimpanzee, were able to perform basic productive combinatorial symbolic communication. Specifically, the apes utilized their established vocabulary to create meaningful combinations, ordered their combinations according to category, and produced statistically reliable orders. Lyn et al. (Lyn et al. 2011b)

investigated the ability of nonhuman primates to produce comments and statements. The results showed that apes (Kanzi, Panbanisha and Panpanzee) were able to use declaratives to name objects, to interact and negotiate, to make comments about other individuals and about past and future events.

The results of these studies created a huge debate. Indeed, not all scholars are inclined to accept the conclusions on the ape linguistic skills mentioned above. The first most damaging critique regarding the grammatical competence of enculturated apes came from the work of Terrace (1979); Terrace et al. 1979), who reared a chimp, Nim Chimpsky, to use signs of ASL. Terrace and colleagues maintained that most (if not all) of the "sentences" produced by linguistic apes such as Washoe and their own Nim were not really sentences at all, but consisted of a lot of mimicking and repetition. In fact, Nim learned 125 signs, but in classroom sessions he rarely communicated with these signs spontaneously: many of his responses to trainers' questions were imitative and he often interrupted his instructor. Terrace concluded that the chimp developed language through rote imitation rather than the grammar used by children.

Several controversies also were generated by the research that showed apes were able to understand and manage another key aspect of language, the symbol. These controversies, mostly coming from the field of biosemiotics, depend on the very problematic definition of symbol. In this regards, Deacon (1997, 2003, 2012) maintains, referring to Saussure (1983 [1916]) and Peirce (1955 [1897/1903]), that for an expression to be symbolic, it not only must be referred to objects and events of the external reality in an arbitrary way, but primarily must be part of a system which mediates its external reference. He affirms, "even though a symbol can, under certain circumstances, stand on its own, its representational power is dependent on being linked with other symbols in a reflexively organized system of indexical relationships" (Deacon 2003: 122). Although many gestures (in the case of ASL) and most lexigrams used in the studies with enculturated apes were not iconic, but arbitrary signs of specific objects and actions (meeting one of the definitions of symbol), according to Deacon this is not a sufficient criterion to be considered truly symbolic. Following these considerations, Deacon asserts that, for example, the vervet monkeys alarm calls used in the wild to signal the presence of different kinds of predators (Seyfarth et al. 1980) are not symbols.

Several scholars also doubt the possibilities that apes are able to use declarative expressions (Tomasello 2008). For example, concerning the experiment of Lyn et al. (2011b), who suggested that enculturated apes use lexigrams declaratively, Carpenter and Call (2013) maintained that apes' responses were often explicitly trained, not spontaneous, and in any case, Lyn and colleagues used the term declarative not in the typical meaning as it is used with human infants (i.e., simply to share attention of objects). In fact, according to Carpenter and Call (2013: 56) declarative gestures/utterances require what they labeled "truly joint attention" (for joint attention to be truly joint, rather than just parallel attention to the same thing, participants need to know together that they are sharing attention) and this particular type of attention was lacking in apes.

That said, the results of these studies are undoubtedly relevant for discussion on the evolution of language. In spite of the considerable controversy the results generated, in our view what is important for research on ape language is not if studies show that nonhuman primates are capable to learn and use a linguistic system as human beings do. Rather, the crucial point that has to be stressed is that the studies show at least a rudimentary capacity for some aspects of language in the great apes. As apes are able to manage some basic aspects of syntax, symbolic communication and pragmatic use of language, we can maintain "that there is not a qualitative gap between bonobo and

human abilities, but rather a difference in degree" (Hurford 2007: 240). In other words, it is possible to speculate that the cognitive capacities necessary for these aspects of language were present in the last common ancestor of great apes and humans and that in hominin phylogenies they have had a subsequent development.

Can an ape Create a Coherent Discourse?

Given the importance we attribute to the discursive dimension of language, the question of continuity necessarily must take into account the property we have suggested to be at the basis of discourse: coherence. In recent years some authors have argued that to assess the effective communication skills of apes it is necessary to investigate not only the production and comprehension of single words or sentences, but also the ability of these primates to participate in spontaneous conversations with humans (Benson et al. 2002). Although, the systematic investigation of the conversational abilities of nonhuman apes currently is not as extensive as the studies of their ability to understand and use single signs and lexigrams, nevertheless the studies are interesting for the comparative analysis of language. Some of these investigations were collected in 2002 Benson and Greaves' book (Benson and Greaves 2002), through a systemic–functionalist approach, the Kanzi's ability to participate in discourse with human beings was analysed. For example, Benson et al. (2002) provided evidence for Kanzi's control of interpersonal discourse semantics in a negotiation with Sue Savage–Rumbaugh. More recently, Leitten et al. (2012) investigated the responses of five chimpanzees in conversational interactions with their human caregivers. Typical interactions between caregivers and the chimpanzee include game, activities, chores and meals. The aim of the study was to experimentally manipulate caregivers' responses to the chimpanzees' requests (for example, the interlocutor offered the chimps an object that was not part of the initial request) and determine if the changes in the chimps' signing were contingent on this interlocutor input. The results showed that the chimpanzees' responses were indeed contingent on the conversational input of the humans: when their request was satisfied, the chimpanzee most often ceased signing; when their request was misunderstood, the chimpanzees repeated and revised.

Although these studies emphasize the conversational aspects of communication, in our view they capture a character of conversation that, using Donald's (1991) terminology, we can define as "episodic": the content of the conversational interactions between apes and humans does not go beyond the here and now of direct perception. A very element of communication is the extended temporal dimension that confers to conversation a progressive and directional nature and which, from our perspective, represents the essential feature of the discursive character of human conversation (Ferretti and Adornetti 2012). The construction of this extended temporal dimension is strongly tied to the construction of a thematic unity governed by coherence in the flow of speech. What about this feature in the case of ape–human discourse? To our knowledge, there are no studies that directly have addressed these specific aspects of conversational discourse. Nevertheless, there is one study by Pedersen and Fields (2009) on bonobo–human conversation that allows us indirectly to make interesting considerations about coherence.

Pedersen and Fields (2009) analyzed the recording of a conversation between Panbanisha (PB) and Sue Savage-Rumbaugh (SSR). During the interactions a second researcher, Russ, and a dog, Mocha, were also present. The main aim of Pedersen and Fields' study was to establish whether Panbanisha were able to converse with human beings by respecting conversational turns, by using the shared knowledge among participants and by creating a cohesive discourse. In particular, Pedersen and Fields focused their attention on Panbanisha's ability to use the cohesive mechanism

of lexical repetition in the course of the conversation. This is a very important point for our purposes because according to the authors, repetition is "at the heart of creating Discourse" (Pedersen and Fields 2009: 28) as it "is what makes a text different from a random collection of words" (Pedersen and Fields 2009: 29). The results of the experiment showed that Panbanisha frequently used this cohesive device. Specifically, Panbanisha used repetition by indicating on the keyboard to the lexigram "carry" to persuade Savage-Rumbaugh to let her be carried by Russ, who was holding a dog. Here are three extracts1 of the conversation between the ape and Sue Savage–Rumbaugh.

1. PB: CARRY YES
2. SSR: you want Russ to carry you? ((quiet laughter)) instead of the dog. (1.0)
3. Panbanisha I'm going to tell you something (4.5)
4. Russ is going to CARRY the DOG because the DOG is SCARED of
5. PANBANISHA. the dog is scared of you.
6. (1.8)
7. PB: CARRY ((Panbanisha points to the lexigram on the keyboard))
33. SSR: Panbanisha the dog is scared of you
34. and the dog doesn't want to have anything to do with you (.)
35. most of the dogs have to, (0.5) (laughter)
36. Mocha just doesn't wanna see you Panbanisha (.) she wants you to (.)
37. Mocha wants you to (0.2) GO AWAY [that's what Mocha wants you to do (.)
38. she wants you to]
39. PB: [YES CARRY]
40. ((Panbanisha points to the lexigrams right as the overlaps starts, and the
41. keyboard speaks it aloud right as the overlaps ends.))
42. SSR: NO CARRY, no Russ can't carry you (0.2) you know what though (0.4)
80. SSR: i didn't see that. but you know what i wanna do
81. i wanna look for our friend Pam? Pam? you know what i think we should do?(.)
82. i think we need to (.) ups (.) TALK on the TELEPHONE.
83. we need to talk on the telephone and try to get a hold of Pam. (0.6)
84. how about if we go to Sue's office and talk on our TELEPHONE and get mister (.)
85. PINKY on the way (.), could we do that? (0.4)
86. could we go to SUES OFFICE and talk on the
87. PB: TELEPHONE
88. SSR: phone (.) and take mr =
89. PB: = YES TELEPHONE
90. SSR: =yes what? yes telephone [okay]=
91. PB: [CARRY]
92. ((she points to the lexigram, but not hard enough to make it speak))

According to Pedersen and Fields, the repetition used by Panbanisha, for example "CARRY" in line 1, and its repetitions in lines 4, 7, 39, 91, are not mechanical imitations of the human expressions because the ape was able to use the background of shared knowledge in the interaction with other participants. In their opinion, the capacity of the bonobo to use repetition is proof that she "not merely repeats words, but as in human discourse, the repetitions in her utterances are discursive acts, depending upon her interlocutor's utterances and the world they share. Her utterances are not random, but inserted highly selectively and sometimes even cunningly, and are part of co-constructing a meaningful and cohesive conversation" (Pedersen and Fields 2009: 35).

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There are two considerations regarding this study and its conclusions. First, there is the question if the repetitions used by Panbanisha really represent example of cohesive devices that give the text a thematic unit. As we showed previously, cohesion is much more than repeating the same word in the ongoing discourse: it includes formal devices such anaphora, given–new information, substitution, conjunctions etc. For how it is used by Panbanisha, repetition seems to be close to a mechanical reiteration with no linguistic function at all. Interestingly, Pedersen and Fields (2009: 36) admit that "Panbanisha's aim is not to create a cohesive and meaningful conversation, but to be carried by Russ. She repeats "CARRY" not to create a conversation, but simply to be carried. It is because we can recognize such an aim that we can recognize a conversation". Anyway, even if we are disposed to attribute true cohesion to Pananisha's repetition, we must recognize that the conversation between the bonobo and human beings is made of a set of autonomous and independent blocks. Indeed, even if the conversational interaction between the bonobo and the human being is held for several minutes and can count about 614 words, it does not proceed at all: it is stuck on repetition of the request "carry". The repetition has an episodic character: it is fixed in the here and now of Panbanisha's perception and desire. What this conversation lacks is the construction of a temporally extended dimension in which the several pieces are not autonomous, but finalized to construct a progressive and directional flow of discourse. This point leads us to the second consideration on Pedersen and Fields' study. The authors maintain that Panbanisha, by means of cohesion, competently engaged in conversational discourse because cohesion is "at the heart of creating discourse" (Pedersen and Fields 2009: 28).We call into question this assertion. As we have shown in the second section, a discourse well-construed from a cohesive point of view pragmatically cannot be appropriate. TBI subjects are a good example in this regards: although in their discourse they use cohesive mechanisms correctly to link one sentence with another, they do not communicate at all because their discourse lacks coherence. Therefore, if cohesion does not guarantee successful communication and if it does not represent a necessary condition for coherence, in our opinion it cannot be conceived as the essential property of discourse. Rather, coherence becomes primary: it is the building of coherence that confers to communication an extended temporal dimension allowing the construction of a progressive and directional flow of discourse. The central role of coherence in human discourse makes Pedersen and Fields' assertion— that cohesion is at the heart of creating discourse— extremely problematic. In our opinion, what follows from these considerations is that the conversational abilities of Panbanisha, albeit relevant, must be resized: the bonobo's contribution to conversation, lacking coherence, seems to be quite distant from what happens in the conversational interactions between human beings.

An Evolutionary Scenario for the Development of Discourse Coherence in Human Phylogeny

The arguments discussed in the previous section lead us to speculate that discourse coherence may be a specific feature of human language that emerged after the split between great apes' and humans' line of descendants. As we have defined coherence as a cognitive property rather than a linguistic one, in our view it is possible to suppose that the emergence of coherence in human communication could have been the result of a specific development in the course of hominin evolution of the cognitive systems underlying its processing. In particular, we hypothesize that the human capacity to exploit global coherence of discourse may have arisen though specific changes in the systems of executive functions during human evolution. The question remains whether there is evidence to sustain this hypothesis.

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A first piece of supporting evidence comes from the research of Semendeferi and colleagues (Semendeferi et al. 1997; Semendeferi et al. 2001; see also Smaers et al. 2010; Smaers 2013) that showed that in the last 8 million years the neural substrate supporting cognitive functions, such as the undertaking of initiatives and the planning of future actions, associated with the prefrontal cortex "enlarged and became specialized during hominid evolution" (Semendeferi et al. 2001: 224). Similarly, Schenker et al. (2005) suggest that human evolution specifically appears to have produced a coordinated enlargement of the lateral prefrontal cortex, which is involved in the regulation of action, and ventromedial prefrontal cortex, which is involved in theregulation of affective and somatic states. Distinctively human behavioural capacities (e.g., human technological performance and human social problem solving) are clearly supported by contributions of both (for a discussion, see Stout 2010).

A second line of evidence concerning the evolution of executive functions of the prefrontal cortex comes from several studies in cognitive archeology on Pleistocene lithic technologies. Researchers in cognitive archeology analyze archaeological records for evidence of the course, timing, and factors driving hominin cognitive evolution, providing a model of the cognitive foundations of stone knapping as well as a model of the evolution of the hominin mind (cf. de Beaunne et al. 2009; Stout and Chaminade 2007; Uomini and Meyer 2013; Wynn 2002). What emerges from these studies is that the gradual development of tool making industries during human phylogeny is strongly connected to the gradual development of the system of executive control (cf. Stout 2010; Stout and Chaminade 2012). According to Stout (2010), the evolution of making tools was supported by a gradual emergence of increasingly complex hierarchical action control. Using functional imaging techniques, Stout and colleagues (Faisal et al. 2010; Stout 2010, 2011; Stout et al. 2008; Stout and Chaminade 2009, 2012) showed that a crucial development in this regard occurred with the appearance of Acheulean industry, starting 1.7 million years ago (mya) with *Homo ergaster* and *Homo erectus* (Lepre et al. 2011). Acheulean is (in chronological terms) the second known lytic technique in the archaeological record. The first one is Oldowan flaking, dated from 2.6 mya to 1.4 mya (Semaw et al. 1997), which consists of nothing more than making sharp stone flakes struck from river cobbles. Acheulean is a technique of stone chipping characterized by the presence of a typical artefact: a two–sided hand axe. This artefact is built by modelling a large stone on both sides until an almond– shaped symmetrical and regular stone is obtained. This technique requires a more complex level of hierarchical control than individual flake removals: single flake removals must be now subordinated to the broader goal of shaping the stone. According to Stout (2010), the steps required to build Achuelean hand axes imply the contribution of the lateral prefrontal circuits involved in the assembly of the individual flake detachment in wider coherent blocks of actions (Koechlin and Jubault 2006) and in the management of the relationships of growing abstraction during the execution of the action (Badre and D'Esposito 2007). Brain activation data for later Acheulean tool making, present by 0.5 mya (Roberts and Parfitt 1999), provide further evidence for the association with the lateral prefrontal cortex (Stout et al. 2008). Later Acheulean hand axes are much more refined than earlier tools, with sharper, more regular edges and a thinner cross-section. The thinning of the cross-section requires that the tool maker has to strike very long flakes travelling more than halfway across the core surface. This in turn implies a careful preparation of the platform through abrasion and/or micro-flaking before flake removal. Such platform preparation requires a new subroutine in tool production "further increasing its hierarchical complexity and likely implicating additional demands for task shifting and inhibition of common actions that are inappropriate in a specific context" (Stout 2010:11). In other words, the involvement of the prefrontal areas in the tool making of the late Acheulean is indicative of an increased need for executive control over the various operations necessary to produce the tools (see also Faisal et al. 2010). Particularly interesting for our topic is the fact that the authors of these

studies establish a relationship between the operations involved in Stone Age tool making and those involved in discourse processing. As Stout and Chaminade (2012: 81) state:

The archaeologically attested ability of Late Acheulean hominins to implement hierarchically complex, multi–stage action sequences during handaxe production thus provides evidence of cognitive control processes that are computationally and anatomically similar to some of those involved in modern human discourse– level language processing.

From what has been said so far, it is possible to speculate that an important event in the evolution of language was the exaptation of the network of executive control (originally tied to the control of actions) for communicative purposes. This is not a new idea. For example, Deacon (1997) maintained that the specific organization of the prefrontal cortex is the main difference between the human and ape brain and that the human development of the prefrontal cortex has lead to the emergence of human symbolic capacity. Sebeok (1994) has also proposed that human communication is an exaptation of the modelling activities. By suggesting such an idea we would propose that the exaptation of executive functions in language processing provided the basis for the emergence and the gradual development in the hominin lineage of a communicative system based on a kind of protodiscourse governed by coherence. Such protodiscourse could be conceived as connected sequences of communicative actions using verbal and other resources (see Linell 1998) and might be compatible with Donald's proposal2 that a crucial stage in the evolution of language is that in which hominins communicated through forms of mimesis (Donald 1991; Donald 2001; for a recent development of this idea see Zlatev 2008; Zlatev 2014). Donald (1991: 168) defines mimesis as "the ability to produce conscious, self–initiated, representational acts that are intentional but not Linguistic". Specifically, a mimetic act is a performance that reflects the perceived event structure of the world. Its content is observable and learnable by others, enabling members of a group to share knowledge, feelings, skills, goals, forming the early foundation of a mindsharing culture. 3 According to Donald, the cognitive processes underlying mimesis involve the construction of a plan of action; the execution of an approximation of the action; and a comparison of the performed act to the intended one (Donald 2012: 181–182). These processes are the same as those involved in the planning and execution of goal–oriented behaviours, of which the construction of coherent discourses represents a specific case. Indeed, mimesis is a result of the evolution of better conscious control over action. In particular, according to Donald (2001: 266), "mimetic capacity was primarily the result of merging the executive brain with the action brain, when the hominid executive brain system extended its anatomical territory into the frontal and subcortical regions that control voluntary action". Interestingly, Donald (2012: 181) also assumes that the first hints of the presence of mimesis appear with early finished stone tools, about 2.6 mya, and that subsequently mimesis was refined with the appearance of the more complex Acheulean industry. Therefore, while the original adaptive function of mimesis could have been tool making, it would have naturally been exapted and extended for much more, including the production of communicative sequences of action - protodiscourse - governed by a principle of coherence. It is important to stress that in a scenario of this kind coherencemay have evolved long before any behaviour that lent itself to verbal description. From this point of view, coherence is a property that is phylogenetically ancient. First of all, it is a general feature of action planning and organization that only subsequently has been conventionalized in language because of its crucial role in the production of communicative acts pragmatically appropriate.

Conclusions

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In this paper we outlined an evolutionary scenario for the development of discourse coherence within the conceptual framework of cognitive pragmatics, that is focusing the attention on the mental systems and operations underlying the use of discourse coherence in communicative contexts. By reviewing a set of neuropsychological and neurolinguistic studies on the discursive abilities of patients with traumatic brain injuries, we suggested that the construction of coherent discourses represents a specific case of the more general ability to construct coherent actions that relies on the executive functions of action planning, organization and control. We proposed that the human capacity to exploit coherence might have arisen in human evolution through changes in the system of executive functions (indirectly observable in the evolution of Preistoric lithic industries) that were exploited for communicative purposes. In effect, research on the conversational competences of our closest relatives, the great apes, showed that they are endowed with discoursive strategies that are not organized in terms of coherence (even though they are able to learn and use some others basic aspects of language). Therefore, we argued that discourse coherence is a specific property of human language that emerged after the split between great apes' and humans' line of descendants. Considering human language as the product of a mosaic of cognitive systems (of which executive functions are only a single tile in the mosaic) allows to maintain the thesis suggesting that there are properties that characterize language in a specific way without abandoning the idea that human language must be evaluated within the Darwinian framework of continuism and gradualism.

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