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Abstract

In this paper we propose a narrative account for the origin of language. Such a proposal is based on two assumptions. The first is conceptual and concerns the idea that the distinctive feature of human language (what sets it apart from other forms of animal communication) has to be traced to its inherently narrative character. The second assumption is methodological and connected to the idea that the study of language origin is closely related to the analysis of the cognitive systems at the base of narrative. Research on narrative abilities of subjects with Autism Spectrum Disorder has shown that storytelling requires the capability to link events causally connected to one another, and especially events which are remote from one another on the temporal axis of a story. Based on this research, we hypothesize that an important cognitive device involved in narrative is Mental Time Travel (MTT), that is, the system that allows humans to project themselves into the past and future. We show that such a system is present (to a greater or lesser extent) even in non-human animals. By virtue of this, we argue that MTT is independent of language and that it may be considered a cognitive precursor for the origin of language. Specifically, we propose that MTT allowed our ancestors to develop a form of pantomimic communication that might be considered at the foundation of the narrative origin of language.

Keywords: Autism – global coherence – Mental Time Travel – narrative – origin of language - pantomime

1. Introduction

We treat the topic of language origin in reference to two assumptions. The first is conceptual and related to the idea that the distinctive feature of human language (setting it apart from other forms of animal communication) has to be traced to its inherently narrative character. Since the question of language origins is closely related to identification of its distinctive features, our hypothesis states that the ability to tell stories represents the basic condition of language. The second assumption is methodological, as well as conceptual, and concerns the adoption of a cognitive approach to the study of language evolution. In adopting such an approach, we adhere to the idea of a distinction between language and thought and specifically to the idea of the primacy of thought on language. On this view, thought has ancient roots and evolved gradually over aeons of time, whereas the capacity to communicate thought is much more recent (for a similar perspective, see Corballis, 2016). Based on this approach, the study of language origin is closely related to the analysis of the cognitive systems that had to be in place in our ancestors to make the emergence of human communication possible. Given the narrative nature of human communication, our aim is twofold: showing which cognitive systems underlie the human narrative capacity and showing that these systems were already present in our ancestral relatives even before human beings began to communicate through language.

2. Uniqueness and specificity

There is a great variety of communication types in the animal kingdom, but language is present only in the representatives of our species. Why is this ability only present in humans? This question is the focus of a debate between two opposing factions. On one hand, there are proponents of the idea that language is qualitatively different from animal communication and that it is meaningless to study the origins of language in reference to simpler forms of communication (Chomsky, 1988; Hauser et al., 2014), such as, for example, vervet monkeys' alarm calls (Seyfarth et al. 1980). On the other hand, there are the proponents of the idea that it is precisely this unique nature of language that compels us to face the riddle of the transition from animal communication to language (Origgi and Sperber, 2000; Scott-Phillips, 2014, 2015; Tomasello 2008). In this work, we adhere to the second theoretical hypothesis: the study of the origin of language is strictly connected to the analysis of the traits that distinguish human language from animal communication. That said, what makes the way humans communicate so unique?

The prevalent idea is that the uniqueness of human language is founded on properties such as syntax (Chomsky, 1988; Pinker and Bloom, 1990), the symbolic nature of linguistic expressions (Deacon, 1997, Donald, 1991), and the ostensive-inferential nature of human communication (Sperber and Wilson, 2002; Scott-Phillips, 2014). Although the topic merits further and deeper discussions, there are good reasons to argue that these attempts are not the best roads to follow. In fact, the study of syntax (even recursion) in non-human animals (from

birds to great apes; Abe and Watanabe, 2011; Greenfield and Savage-Rumbaugh, 1990, 1991), the investigation of symbolic abilities of non-human primates (e.g., Lyn and Savage–Rumbaugh, 2000) and the analysis of the ostensive character of great apes' communication (Moore, 2016) have greatly undermined the idea that such properties of language can be used to mark a difference between human language and the communicative systems of other animals. As the question of the origin of human language is closely related to the study of the properties that distinguish it from animal communication; it follows that these properties cannot be considered useful for the purpose. We need a stronger—and less controversial—criterion of differentiation (Ferretti, 2016).

Our proposal is that the distinguishing feature of human communication can be identified in the fact that language is a tool for storytelling. Niles (1999) defined the representatives of our species as *Homo narrans*, and Thompson (2010) argued that, unlike all other animals, only human beings are capable of telling stories. Scholars belonging to diverse theoretical traditions support the idea that the peculiarity of language is related to narrative capacity. Specifically, this idea has been proposed both by authors who invoke the Darwinian tradition (e.g., Corballis, 2015) as well as by authors in the neo-culturalist tradition, such as Everett (2012). One of the fundamental points that distinguishes these traditions is connected with how they consider the relationship between language and narration. The analysis of this relationship is a privileged point of view when investigating the narrative origins of language.

According to some scholars, language is a necessary condition to tell stories; narration is an ability humans have because they have language (Bruner, 1991; Collins, 2013; Scalise-Suyiama, 2005). Although highly intuitive, such a hypothesis represents an obstacle to the study of language origins: assuming the existence of language as a starting point is equivalent to assumimg (from an anti-Darwinian point of view) - without justifying it - what has to be explained (Knight, 1998). Contrary to this assumption, our idea is that the ability to tell stories represents the basic condition for the origin of language. How is it possible to substantiate this (counterintuitive) hypothesis on the origins of human communication?

To answer this question, it is necessary to analyze the representational systems and cognitive architectures involved in storytelling ability. Supporting the narrative origin of language means recognizing that our ancestral relatives had cognitive devices as the basis for constructing narrative representations of facts and events of the world before they were able to communicate these through language. With these premises, we aimed at identifying the cognitive systems that allowed our ancestors to invent language upon the ability to build narrative representations of reality. Before we explore the details, a preliminary analysis of selective pressures is needed.

3. Selection pressures

Although it is largely speculative, we have to identify and analyze the ecological and social contexts in which human communication arose before identifying the specific properties of language. Many theoretical models (cf. Számadó and Szathmary, 2006) have addressed the issue of the selective pressures for language origin. We will not enter into the details of the discussion (for a criticism, cf. Scott-Phillips, 2014); for our purposes, it is sufficient to refer to the interpretative hypothesis that is the basis for a large number of the models proposed in the

literature: the idea that selective pressures for human communication concerns the social role of language. For example, according to Dunbar (1998a, 1998b, 2009), language origin enables "the exchange of social information ('gossip') in order to facilitate bonding in larger, more dispersed social groups" (Dunbar, 1998b, p. 98). From Dunbar's perspective, language is a more effective and less onerous way to obviate the social role played by grooming.

When the study of language is put in relation with the description and understanding of others' behavior (who-is-doing-what-to-whom), the social brain hypothesis emerges in the foreground—the idea that humans are characterized by a brain that evolved mainly to manage interpersonal relationships (Dunbar 1998a; Humphrey, 1976). By virtue of this type of brain, humans interpret others' behaviors by appealing to others' beliefs and mental states. In fact, the so-called "intentional stance" (Dennett, 1987) is governed by mindreading devices that form the basis of the social brain (Frith and Frith, 1999). In addition to explaining interpersonal relationships, the social brain hypothesis underlies sophisticated models of language uniqueness. An important example is Relevance Theory (Sperber and Wilson, 1986, 2002), based on Grice's idea (1969) that the meaning of human communicative expressions relies on the speaker's intentions. A perspective of this kind, for obvious reasons, is closely connected to the idea that mindreading is the cognitive precondition for the transition from animal communication (conceived in reference to the code model) to human language (Sperber, 2000; Origgi and Sperber, 2000; Scott-Phillips, 2014, 2015).

In addition to supplying convincing arguments about selective pressures, the social brain hypothesis also has the advantage of an evolutionarily plausible cognitive architecture. Indeed, mindreading is a system independent of language (its primary evolutionary purpose is not communication)—a system that, under selective pressures for more efficient communication, is suitable for being co-opted as an effective tool for typically human communication (Origgi and Sperber 2000; Scott-Phillips, 2014). Moreover, the social brain hypothesis is the foundation of a human communication model that individuates a specific trait—the understanding of communicative intentions—that can distinguish human language from animal communication. Despite this, we believe that the social brain hypothesis is not enough to account for the origin of language because mindreading is a necessary but not sufficient condition to explain the narrative foundation of language. By virtue of this, the social brain hypothesis is not a convincing way to account for the transition from animal to human communication (cf. Ferretti, 2016).

A first indication of the difficulties of the social brain hypothesis comes from the analysis of the contexts in which the intentional stance is actually used. According to Herman (2013; see also Gallager and Hutto, 2008, pp. 26–35; Hutto, 2007, 2008), it is only in the wider scenario of narrative that the intentional stance can be considered an effective tool in interpreting others' actions. It is the narrative structure of a story, in fact, that makes it possible to interpret what others are doing (or have done or about to do) in terms of reasons. Through stories, it is possible to insert others' behaviors "into internally coherent and situationally appropriate accounts of why someone has acted—or failed to act—in the way he or she has" (Herman, 2013, p. 74). What emerges from these considerations is a holistic perspective: by linking together events and states of affairs in the causal-chronological wholes, narratives "provide a resource for connecting otherwise isolated occurrences into elements of episodes or 'scenes,' whose

components can be represented as systematically interrelated via causal networks" (Herman, 2013, p. 237).

In the light of these considerations, Hutto (2008, 2009) suggested that the *intentional stance* "is essentially a narrative practice — its exercise, always and everywhere, invokes our capacity to construct or digest narratives of a special sort" (Hutto, 2009 p. 11). Indeed, according to the author without narration any form of Folk Psychology (FP; a common-sense psychology that explains human behavior in terms of beliefs, desires, intentions and other intentional mental states; cf. Fodor 1987) is not possible. From this kind of perspective, narrative comes before mindreading. Hutto wrote:

> We don't just refine our pre-existing FP understanding by means of narrative engagements—on the contrary, we don't begin to exhibit FP skills proper until we've had the right sorts of encounters with the right sorts of narratives. Children are not FP competent until they have mastered certain narrative skills. Engaging in narrative practice is the *source* of our FP understanding (2009, p. 13).

The thesis of the narrative foundation of the intentional stance is convincing, and it is the way we must follow to provide a narrative account of language origins, provided that it is given the important distinction by way of conceiving narrative and especially by way of understanding the relationships between language and narrative.

The constructivist perspectives of narrative (Bruner, 1991; Dautenhahn 2002; Hutto, 2009) are strongly linked to the idea "that narratives are a distinctive and characteristic feature of human cultural niches, just as dams are for beavers" (Hutto, 2009, p. 27). Positions of this kind (as all culturalist perspectives) are inclined to diminish the role of internal cognitive systems. The proponents of the culturalist paradigm, in fact, suggest that, in the absence of internal cognitive systems, language—that is, its internalization through learning processes—is the instrument by which everything else can be explained. In line with the view of Scalise-Sugiyama (2001), Hutto's idea is that language is a necessary condition for the existence of narrative practices: without language, there is no ability to tell stories, and without the ability to tell stories, there is no intentional stance. Following Nelson (2003), Hutto's opinion is that "narrative is the vehicle of communicating representations of events between people by verbal means" (Nelson, 2003 quoted in Hutto, 2009, p. 11). In this way, the author endorses the idea of the logical and temporal priority of language over narrative; more precisely, Hutto adheres to the idea that narrative is the outcome of a specific type of language: *verbal language*.

We are skeptical about the constructivist consequences of a culturalist paradigm. The first reason concerns a specific issue related to this present work: assuming that language is a starting point for explaining everything else we can completely ignore the question of the origin of language. That said, there is also a more general theoretical reason: language cannot be a basic explanatory tool because language is not an entity of the natural world that you can get for free. To argue that language is the precondition of narrative (or, more generally, of thought), we need to have in mind a model of the origin of language. Studying the origin of language means not only establishing when language began but also unravelling its nature. As we shall see, the analysis of the relationship between language and narrative is a litmus test to investigate the nature of language.

In contrast to the thesis of the priority of language over narrative, our hypothesis states that without narrative, language never could have originated. Maintaining that narrative logically and temporally precedes language, from an evolutionary point of view, is a plausible way to deal with the study of the origin of human communication. The first step in support our proposal is the investigation of the cognitive systems involved in storytelling. The second step concerns the analysis of the type of communication that our ancestors were able to develop using such cognitive systems. Since, as we shall show, the property at the base of storytelling is *global coherence*, the study of cognitive systems at the base of language concerns those systems that enable the construction of a narrative level guided by such a property.

4. Global coherence

An intuitive case to start with. When we follow a presentation at a conference, we are able to understand each sentence uttered by the speaker. Nevertheless, understanding the individual sentences is not enough to understand what the speaker is saying. In spite of this, the mainstream of cognitive science (Chomsky, 1988; Pinker, 1994) states that the phrase represents the essence of language and how phrases are produced-understood equates to explaining the essential constituents for the functioning of language. However, in the context of use, language processing goes beyond the analysis of the phrase constituent structure. To understand what the speaker is saying, micro-elaborative analysis (lexical and syntactic processing within a single sentence) is not enough; it is necessary to refer to operations that affect the macro-level of language, that is, pragmatic and discourse processing between sentences (cf. Cosentino et al., 2013). The move from microanalysis to macroanalysis of language highlights some properties necessary for the production-comprehension of narrative—among which a crucial role is played by global coherence (cf. Adornetti 2015a, 2016).

Analyzing the discursive level of language, Giora (1985) showed that global coherence cannot be explained in terms of cohesion, that is, it is not reducible to the linear linguistic connections between consecutive sentences. Consistent with Giora's thesis, research on language pathologies has shown that the ability to construct well-formed (gramatically) sentences is not a guarantee of the production of coherent discourses (e.g., Glosser and Deser, 1990; Marini et al., 2008; Marini et al., 2014; for a discussion, cf. Adornetti, 2014). If sentence processing is not a sufficient condition for effective communication, then the properties (and systems) that underlie narrative are different from those used to process the phrase-constituent structure. A consideration of this kind leads us to consider that the systems that process individual sentences are part of the faculty of language, but they are not *all* that humans need to communicate.

In addition to shedding light on the difficulties of the models based on microanalysis, the shift of interest from sentence level to discourse level further highlights the explanatory deficiencies of a language model very close to our theoretical assumptions: the cognitive-pragmatic perspective advanced by Sperber and Wilson (1986, 2002) with Relevance Theory (RT). At the foundation of RT is the criticism of the code model of communication (Shannon, 1948). Sperber and Wilson (1986), going against the idea of communication as a coding-decoding activity, have shown that human communication is based on what the speaker

intended to say, rather than what she or he *actually* said. As shown earlier, this perspective relies on the idea that a mindreading device in communicative processes is what distinguishes human language from animal communication. Echoing Sperber and Wilson, Scott-Phillips (2014, 2015) argued that the ostensive character of human communication—the trait that makes human language unique—is primarily dependent on the cognitive systems at the base of the social brain: the mindreading device.

There are two considerations about the ostensive-inferential model of human communication. First, discourse coherence, as Giora (1997, 1998) has shown, is irreducible not only to cohesion but also to relevance, that is, the property (according to Sperber and Wilson, 1995) that specifically characterizes human communication. From our point of view, maintaining that global coherence is a property autonomous and independent from relevance is equivalent to arguing that the processing of narrative requires cognitive devices other than those used for processing relevance. This fact leads us to our second consideration: cognitive systems underlying narrative processing must be different from the mindreading device (Ferretti, 2014, 2016; Ferretti and Adornetti, in press). Considerations of this kind have important consequences when studying language origins: if the ability to tell stories is the skill that distinguishes humans from other animals, the cognitive systems of our ancestral relatives had to be able to process information differently from information processed by mindreading. Since the core property of narrative is global coherence, the question to be addressed is what cognitive systems can process such a property. To this aim, the study of narrative abilities of autistic subjects has given us a valuable hint.

5. Autism Spectrum Disorder and storytelling

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and interaction, along with restricted repetitive interests/behaviors (DSM-V 2013). Individuals with ASD have been reported to have relatively unimpaired phonological abilities (Kjelgaard and Tager-Flusberg, 2001). Studies have also shown that syntax is not specifically compromised (Shulman and Guberman, 2007). In contrast, several investigations have attested to limited narrative abilities in ASD (e.g., Baron-Cohen et al., 1986; Losh & Capps, 2003; for a review, Stirling et al., 2014) and have associated the deficits in storytelling with this population's social impairments (Tager-Flusberg, 2000). In particular, some research has reported that individuals with ASD have difficulties ordering narrative information at a global level and that such difficulties depend on problems in managing the causal relationships among the events of a story (King et al., 2013; King et al., 2014; Losh and Capps, 2003; Sah and Torng, 2015). Indeed, an idea widely shared among scholars in this field is that global coherence is the foundation of constructing causal relationships among events representing the structure of narrative (cf. Joliffe and Baron-Cohen, 2000). In line with this hypothesis, Sah and Torng (2015) defined *global coherence* as the "global representation of story meaning and connectedness" (Sah and Torng, 2015, p. 190) and maintained that the ability to tell stories requires the ability—governed by global coherence—to analyze the causal structure of the relationship among events. What kind of causal connections are involved in global coherence? Several studies (Sah and Torng, 2015; Diehl et al., 2006) have analyzed the stories produced by people with ASD by using the Causal Network Model (CNM) proposed by

Trabasso and colleagues (Trabasso et al., 1984; Trabasso and Sperry, 1985; Trabasso and van der Broek, 1985). From this perspective, a text's narrative structure is represented by "a causal network of events and event relations" (Trabasso & Sperry, 1985, p. 597). At the basis of CNM is the idea that the value a given unit plays in a narrative context is defined in reference to the causal role played by that unit in a narrative context.

Although this way of conceiving global coherence has highlighted important features of narrative in ASD, it has underestimated an aspect of narrative that plays a key element of the storytelling capacity: the role played in global coherence by the "time factor." As Bruner has suggested, narrative has an intrinsically temporal character:

> A narrative is an account of events occurring over time. It is irreducibly durative. It may be characterizable in seemingly nontemporal terms . . . but such terms only summarize what are quintessential patterns of events occurring over time. The time involved, moreover, as Paul Ricoeur has noted, is "human time" rather than abstract or "clock" time. It is time whose significance is given by the meaning assigned to events within its compass (Bruner, 1991, p. 6).

Bruner's view has received considerable support: Habermas and Bluck (2000) suggested that "temporal ordering provides a fundamental form of coherence in life narratives" (p. 750) and considered temporal coherence as a type of causation among events essential in the construction of the autobiographical narratives. Further, Karmiloff-Smith maintained the same position (1985, p. 62). In agreement with these authors, we suggest that the time factor (conceived as the ability to project oneself into the past and future) is an important aspect in the construction of global coherence. Following Giora and Shen (1994), in fact, we maintain that the comprehension-production of a narrative text requires the ability to analyze "a higher-order organization which hierarchically connects not only adjacent events . . . but also events which are remote from one another on the *temporal axis* of a given discourse" (Giora and Shen, 1994, p. 450, emphasis ours).

The appeal to the narratological tradition is the first step (a speculative one) of our argument. Recognizing that narratological studies can shed light on the abilities involved in the processing of storytelling, Herman (2013) has referred to the narratological tradition inspired by the work of Genette (1972; for subsequent developments, see Bridgeman, 2005; Herman, 2002; Ireland, 2001; Matz, 2011) as well as that of Ricoeur (developed by Bruner [1990] and cultural psychologists), which offer a clear idea on which to reflect: the intrinsically temporal nature of narrative. Herman argued that "stories . . . are a primary technology for making sense of how things unfold in time" (2013, p. 301). Similarly, Abbott suggested that "narrative is the principal way in which our species organizes its understanding of time" (2002, p. 3).

Scholars who investigate narrative from an evolutionary point of view have suggested a close link between storytelling and temporality (Corballis, 2014, 2015; Ferretti, 2014; Thompson, 2010). For example, according to Corballis (2015), language originated to tell others—that is, to make public—our (private) mental travels in time, and narrative is the best way to accomplish that. Corballis's (2015) opinion is that the temporal character of narrative does not pertain to the fact that telling a story requires a certain lapse of time; rather, that narrative always implies a detachment from the present and a projection in a time different from the here and now. Following Corballis, our idea in the present study is that among the

cognitive abilities underlying narrative coherence, the system of temporal navigation is crucial in allowing projection backward and forward in time. Following these considerations, the second step (the empirical one) of our argument concerns the investigation of the cognitive systems that process the temporal structure of narrative.

6. Mental Time Travel in Autism Spectrum Disorder and its connection with storytelling

The proposal of this work is that among the devices involved in processing global coherence, a primary role is played by the system that allows humans to project themselves in time - Mental Time Travel (MTT) (Suddendorf and Corballis, 1997, 2007). Two capacities strongly related to each other constitute MTT: Episodic Memory (EM) that allows reliving past events (Tulving, 1972, 2005) and Episodic Future Thinking (EFT) (Atance and O'Neill, 2001) that allows simulation of possible future scenarios. To unravel the nature of MTT, it is important to clarify the meaning of the term *episodic*. This term denotes one of the most remarkable features of MTT, i.e. its subjective character: EM and EFT are responsible for an individual's awareness of his or her existence and identity in time, from the personal past to the personal future. This means that the process of MTT does not merely reflect the extraction of a specific meaning or knowledge, which depends on semantic memory (the memory that deals with general knowledge of one's environment, such as facts and rules); rather, it also involves the retrieval of one's personal episodes, as well as the generation of potential future ones (Schacter and Addis, 2007).[1]

Neuropsychological and neuroimaging evidence suggest that EM and EFT are functionally and anatomically connected (Addis et al., 2007). For example, patients with deficits in EM exhibited deficits in envisioning future events too (Hassabis, Kumaran, Vann, Maguire, 2007; Klein et al., 2002; Tulving, 1985). Tulving (1985) reported that patient K.C., suffering from a form of severe amnesia related to medial temporal and frontal lobe damage, was incapable of remembering past personal events and unable to imagine specific events in his personal future. Neuroimaging studies with healthy subjects showed that many of the brain regions active when people remember the past are also active when they envision the future (Addis et al., 2007; Buckner and Carroll, 2007; Hassabis et al., 2007). For example, Okuda and colleagues (2003) reported that the frontal poles and medial temporal lobes (including hippocampal and parahippocampal regions) are active in tasks when people are asked to remember past as well as imagine personal future episodes.

Several studies suggested that EM and EFT may also be involved in the construction of past and future experiences of another person (e.g. Hassabis et al. 2014; Payne et al. 2014). Hassabis and Maguire (2007, 2009) maintained that foreseeing one's own future and foreseeing someone else's future both rely on a similar scene construction process. Similarly, Buckner and Carroll (2007) argued that the self-projection component of the episodic memory is also engaged to imagine the perspective or behavior of another person. Payne and colleagues (2014) found that 3- and 4-year-old children performed equally in planning their own future

[1] It is worth noting, however, that descriptions of episodic memories as well as future simulations also depend on semantic memories that are already in place: without factual knowledge, episodic constructs would be meaningless (Tulving, 2002; Suddendorf et al., 2009).

and in planning for another person's future. These results are important for our proposal since we suggest that MTT is involved not only in the construction of personal narratives, but also in the construction of narratives that are detached from any personal experience and involve events of another (both fictitious and real) person.

Based on these studies, it has been suggested that the two processes of remembering the past and envisioning the future are associated with a specific core brain system whose main function is projection (Buckner and Carroll, 2007; Schacter et al., 2007). The idea is that the brain uses stored information to imagine, simulate, and predict possible future events; the core brain system allows shifting from perceiving the immediate environment to an alternative, imagined perspective that is based mostly on memories of the past. Indeed, it has been proposed that anticipating future actions is the core function of cognition and the main reason that cognition evolved (Osvath and Martin-Ordas, 2014). From this, it follows that the primary role of EM may be that of providing information from the past for envisioning of the future (Suddendorf and Corballis, 2007). This explains why EM does not function in a reproductive manner, similar to a video recorder (Suddendorf and Corballis, 2007); rather, it is vulnerable to error and distortion (Schacter, 1999). On this view, then, EM and EFT both involve conscious acts of construction.

Recently, it has been argued that ASD offers an ideal test to further unveil the nature of MTT (Lind and Williams, 2012). Subjects with ASD, indeed, have been reported to have deficits in autobiographical memory that largely relies on EM (Crane and Goddard, 2008; Goddard et al., 2007). For example, Goddard et al. (2007) examined personal episodic memory, asking participants to generate memories of specific autobiographical events in response to cue words. Results showed that the adults with ASD recalled significantly fewer autobiographical memories and took longer to do so than did a control group. In addition to the impairments in remembering the past, several studies provided evidence that imagining the future is also impaired in ASD (Jackson and Atance, 2008; Hanson and Atance, 2014; Marini et al., 2016; Terrett et al., 2013). Terrett and colleagues (2013) tested EFT in a group of children with high-functioning ASD. In the study, participants were asked to complete an Adapted Autobiographical Interview in which they had to describe personal past events and plausible future events. Authors found that children with ASD performed poorer on both past and future tasks than a group without ASD. Recently, Marini and colleagues (2016) assessed self-based and mechanical-based future thinking in children with ASD. In tasks assessing self-based future projection, children were asked to project themselves into a near future. Mechanical-based tasks assessed the children's ability to predict the outcome of a physical transformation that did not imply any projection of the self. Results showed that children with ASD had impaired EFT in both kinds of tasks and that they had more difficulties performing self-based tasks than mechanical ones.

Research on time-travelling abilities in subjects with ASD and deficits of this population related to narrative global coherence are independent and, to our knowledge, without finalized research to identify a causal correlation between the difficulties of autistic subjects in time projection and their narrative skills. To identify a possible relation between MTT and narrative production, we conducted a study in which we hypothesized that the narrative deficits of individuals with ASD would respond specifically to their inability to travel in time (blinded reference, submitted). In our research, we administered a narrative-free task to autistic

children between 6 and 11 years, assessing their ability to simulate future scenarios. We also gave them three narrative generation tasks that required them to generate episodes related to the development of a story: its beginning (past) or conclusion (future). The administration of the non-linguistic task of future thinking was finalized to determine a subgroup of subjects with ASD that exhibited a deficit in time-travelling. The hypothesis was that this subgroup of individuals would show more severe difficulties in building globally coherent stories. The data from our research confirmed the hypothesis that narrative difficulties often reported in these children might, at least in part, stem from a difficulty in the temporal organization of the events in a narrative axis (blinded reference, submitted).

The investigation of storytelling in ASD and the study of the temporal representational systems are the litmus test to unravelling the narrative foundation of language. Although mindreading abilities represent a necessary condition to account for narrative (Mar, 2011), the results of our research point out that mindreading alone is not a sufficient condition to explain storytelling. Taking into account the temporal character of narrative, in this article we mainly focused on the role of MTT in the narrative origin of language. That said, emphasizing the role of MTT both in the functioning and in the origin of language, we do not intend suggest that this system is the only cognitive precursor for language. As we proposed elsewhere (Adornetti, 2015b; Ferretti, 2014, 2016; Ferretti and Adornetti, in press), our idea is that the origin of language has to be considered in reference to (at least) three different cognitive systems (that we called "Triadic System of Grounding and Projection": cf. Ferretti and Cosentino, 2013): mental mind travel (the system that allow us to read others' minds), mental space travel (the system that allow us to navigate in space) and mental time travel. In the present work, our focus on MTT depends on our intent to underscore the temporal dimension of narrative by using research on subjects with ASD.

After having shown the role of MMT in the narrative process, it is now time to address the core question of this current study: if our hypothesis of the narrative foundation of language is correct, then MTT is not only a device underlying the proper functioning of language but also a system that our ancestors had to possess when they began to develop language. A first step to justifying the thesis of MTT as a precondition for language is showing that it both logically and temporally precedes language. One way to corroborate this hypothesis is to deal with the case of non-human animals.

7. Phylogeny of Mental Time Travel

The possibility that nonhuman animals are endowed with the ability to project themselves in time has raised wide debate and controversy. According to Tulving (2005)—who first proposed the concept of MTT—the ability to project in time is uniquely human. His idea has been that such an ability implies a form of *autonoetic consciousness*, the consciousness involving explicit memory that requires self-awareness. Since only humans have a first-person phenomenal experience of events (such as episodic memories and future simulations) existing only as mental constructions, Tulving's view is that only humans have the ability to project themselves in time. Similarly, Suddendorf and Corballis (2007) considered subjective experience as crucial in episodic recollection and foresight, thus suggesting that MTT is not present in non-human

animals. These considerations echoed the Bischof-Köhler hypothesis according to which non-human animals are stuck in time (cf. Suddendorf and Corballis, 2007). The idea underlying such a hypothesis is that the members of no species other than human beings are able to anticipate future needs or otherwise live in anything other than the immediate present. These theoretical considerations seem to exclude the possibility that non-human animals can represent past and future. Furthermore, methodological problems add to this picture. Since EM and EFT generally rely on self-reporting, it is difficult to assess if non-human animals have such abilities in the absence of language.

Even though evidence of memories for personal experience and simulations of future events are not easy to obtain in non-human animals, many comparative studies on MTT have been carried out. Indeed, there is a growing opinion that the attention to phenomenal experience in human memory has resulted in conceptualizations of EM that are difficult (or impossible) to apply to non-human species (Osvath 2016; Templer and Hampton, 2013). Therefore, comparative research is now working on the identification of objective behavioral criteria that can be applied in nonhuman animals but still capture features of memory thought to be critical in humans. Some of the most comprehensive behavioral data on EM has come from studies of birds (e.g., Clayton and Dickinson, 1998; Feeney, Roberts, and Sherry 2011).

The study of EM in birds has used mainly the *what-where-when* paradigm (cf. Zentall 2013). This paradigm was created in reference to Tulving's early conceptualization of EM (1972). According to Tulving, a person has EM if she or he is able to recover the what, where, and when of a personal event. Clayton and colleagues (Clayton and Dickinson 1998; Clayton et al. 2001) used such a paradigm to test memory ability of scrub jays. In their experiments, the authors exploited the natural caching behavior exhibited by these birds. The basic paradigm was to provide scrub jays with two kinds of food: one they preferred but that perished with time (worms) and another that is less preferred but did not perish with time (peanuts). Scrub jays were given access to both kinds of food and cached them in different places. During the training trials, the birds learned that the worms—but not the peanuts—had a retention of 124 hours. On the test trials, the birds could choose between locations where they had cached worms and where they had cached nuts. If only 4 hours had passed after caching, scrub jays preferred to search in the locations where they had cached worms. Interestingly, if 124 hours had passed after caching, the birds chose to search where they had cached peanuts. According to the authors, these behaviors demonstrated that scrub jays remembered *what* food items they had cached *where*, and *when* they had cached them. Related experiments conducted with rats obtained similar results (Zhou and Crystal, 2009).

Research on MTT in animals focused also on the assessment of future projection abilities (e.g., Bräuer and Call, 2015; Osvath and Karvonen, 2012; Osvath and Osvath, 2008). Studies on non-human primates are relevant in this regard since the experiments that assessed future thinking in great apes have shown that these animals could pass the Bischof-Köhler test. To succeed in such a test, the end goal must be out of sight, and future planning must not be elicited by a present need or a current physiological state: future-oriented behavior must occur in anticipation of future need. In natural observations, great apes have been reported to manufacture tools or pick up suitable materials in advance of a need, sometimes out of sight of the place of use (Goodall, 1964; Boesch and Boesch, 1984). For example, they were observed carrying stones to nut-cracking sites even when the sites were not within view, or

manufacturing probes for termite-fishing from one termite nest to another. According to Byrne and colleagues, "These observations imply that the animals are able to use a mental representation of an adequate tool or appropriate natural material for a task that is not immediately confronting them" (2013, p. 59).

Great apes have also displayed future planning abilities in studies carried out in the laboratory. Mulcahy and Call (2006) tested foresight abilities in bonobos and orangutans. The authors construed their setup experiment using the methodological setting of Tulving's spoon test. The test is based on a story of a little girl who dreams that she goes to a party where they are serving chocolate pudding. All the children brought a spoon with them, but because she did not bring one, she could not eat the pudding. The next day, she goes to bed clutching a spoon in her hand. According to Tulving (2005), the behavior of the girl can be considered future planning because she was able to anticipate a future need at a time when it was not present. In their experiment, Mulcahy and Call (2006) first trained apes to use an appropriate tool to get a reward from an apparatus in the first room (the test room). Then, they were given access to several tools (some appropriate and some unsuitable) in the test room without access to the apparatus. Next, subjects were moved into a second room (the waiting room), and all the tools left in the test room were removed while the subjects watched. Fourteen hours later, the apes were allowed to return to the test room and given access to the apparatus. To solve the problem, the subjects had to select an appropriate tool from the test room, bring it into the waiting room, and then bring it back to the test room upon their return. Results showed that apes learned to choose the appropriate tool and bring it with them when they had to leave the test room. According to the authors, these results prove that "apes selected, transported, and saved a suitable tool not because they currently needed it but because they would need it in the future" (Mulcahy and Call, 2006, p. 1039). Subsequent studies have replicated and extended these findings (Osvath and Osvath, 2008; Osvath, 2009).

Recently, it has been suggested that route-planning may also be used to investigate future thinking in non-human animals (Thom and Clayton, 2015). Indeed, mentally travelling the route to breakfast ahead of time could be considered consistent with a broad definition of future-oriented cognition. Evidence of neural activity (especially in the hippocampal regions) corresponding to navigation of future routes in rats has led Corballis (2013) to opt for a more phylogenetically continuous view regarding future thinking in mammals. Specifically, it was observed that individual cells in the rat hippocampus discharged not only when the animal was in particular locations in an environment (as would be expected since the hippocampus is involved in the processing of cognitive maps) but also in sharp-wave ripples for sometime after the animal had actually been in the maze, such as during slow-wave sleep. According to Corballis, "It seems highly likely from an evolutionary perspective that this activity is homologous to that involved in mental time travel in humans" (2013, p. 5).

The presence of forms of time-travel abilities in animals that cannot talk is a way to justify MTT's independence from language. This is an important step against the culturalist models that, emphasizing the priority of language over storytelling, exclude the possibility of cognitive precursors of language. The idea that MTT is a system at the origin of language has two advantages. First, it does not imply the reference to processing systems specific for language before the advent of language. Second, it allows for considering the advent of language

in terms of exaptation, i.e. as a form of re-use for new purposes of cognitive systems that our ancestors already had.

In the light of these considerations, it can be argued that MTT is not only one of the devices at the base of processing global coherence, but it is also one of the devices on which the narrative origin of human language can be founded. To account for this latter aspect, however, there is one more step to take: it is necessary to clarify what allowed our ancestors to develop a communicative system appropriate for their way of representing reality; that is, if narrative is the specific way in which humans represent reality, what is the best means to communicate to others the (internal) narrative representation of reality? We propose that, at the beginning of human communication (in the absence of codified language), pantomime was the best means of expression to face the difficulty of communicating representations to others using a narrative format. Pantomime is the evolutionary bridge between the need to face the selective pressures for a communication that goes beyond the code model and the exploitation of the cognitive systems available to our ancestral relatives. If the transition point from animal to human communication has to be found in narrative capacity, pantomime is the appropriate means to tell stories before the advent of verbal language. From this point of view, the narrative origin of language largely coincides with the pantomimic origin of language.

8. Pantomimic origin of language

8.1 Pantomime as storytelling

The first step in support of the narrative origin of language thesis is to show the possibility of a form of storytelling without language. In this regard, it is worth quoting Boyd, who has suggested that "narrative need not involve language. It can operate through modes like mime, still pictures, shadow-puppets, or silent movies" (2009, p. 159; see also Sibierska, 2016). The reference to mime is particularly relevant for a language origin scenario. Indeed, according to several authors, a mimetic or pantomimic stage has characterized the evolution of hominin communication (e.g., Arbib, 2012; Corballis, 2015; Donald, 1991; McBride, 2014; Tomasello, 2008; Zlatev, 2014). It is not our task to debate the details of the pantomimic account of language evolution. Here, we stress that pantomime can be considered the basis on which our linguistic narrative abilities are founded since it is an ideal medium for the expression of narrative representation. The point to start is the definition of *pantomime*.

In a recent article, Żywiczyński and colleagues (2016), comparing different areas of studies, proposed an accurate and systematic definition of *pantomime* for language evolution research. According to the authors, pantomime is:

> . . . a non-verbal, mimetic and non-conventionalised means of communication, which is executed primarily in the visual channel by coordinated movements of the whole body, but which may incorporate other semiotic resources, most importantly non-linguistic vocalisations. Pantomimes are acts of improvised communication that holistically refer to a potentially unlimited repertoire of events, or sequences of events, displaced from the here and now (Żywiczyński et al., 2016, p. 9).

Although Żywiczyński and colleagues (2016) used a definitional criterium that is typical of conceptual analysis (which does not consider if such features are actually present in a communication system), in our view the definition they proposed is also a good starting point to inform empirical research. Specifically, relevant to our proposal are some features that, according to Żywiczyński and colleagues (2016), could be attributed to pantomime and, in our opinion, make it an ideal means of expression for narrative representation. In particular, the authors suggested that pantomime has a *holistic* nature that makes it *communicatively complex* and *self-sufficient.* The holistic nature of pantomime relates to its structure as a communicative act; specifically, it concerns the fact that it can refer to whole events or sequences of events with movements that constitute a communication stream not divisible in individual parts. In this sense, pantomime is different from isolated gestures, which are characterized by movements with clear boundaries and correspond to discrete concepts. Because of such a holistic nature, pantomime is communicatively complex and self-sufficient. That is, "pantomimic acts are 'the size of' propositions or utterances rather than smaller component unit; rather than being elements of a larger communicative whole, they express complete, *self-contained* communicative acts" (Żywiczyński et al., 2016, pp. 8–9, italics ours). It is important to highlight that the self-sufficiency condition represents an advantage in the context of language origins. Indeed, saying that pantomime is self-sufficient means that it is independent of any verbally established context and, as such, must be comprehensible in the absence of any conventional semiotic resources. This fact is crucial because explaining the origin of language cannot appeal to a pre-existing code (the appearance of a code is exactly what has to be explained). Then, the capacity of pantomime to represent and communicate relatively complex sequences of events without relying on pre-existing semiotic conventions, makes pantomime a medium of expression of human narrative representations and a medium on which language, in the form of narrative, arose.

8.2. Pantomime as uniquely human

In the light of these considerations, one last important issue emerges: if pantomime can be considered the first form of narrative language (and if narrative is a specific trait of human language), non-human animals should not exhibit forms of pantomimic communication. Before exploring such an issue, it is necessary to make a general clarification. From what we have said until now, our proposal could appear in line with a discontinuist perspective. This is not the case. For a very important reason. By virtue of the distinction between language and thought, and specifically by virtue of the primacy of thought on language, in our theoretical framework the priority has to be assigned to the cognitive systems – i.e. the ability to mentally travel in time - that made language possible. From this point of view, we suggest that there is a continuity between humans and non-human animals, specifically great apes, in terms of cognitive abilities, but a discontinuity in terms of communication, namely in terms of the expressive skills that are necessary for language. On such a view, narrative communication and pantomimic communication (that has been the first expressive medium for narrative) are not evolutionary

continuous with non-human primate communication, but are continuous with non-human primate cognition (for a similar perspective, see Scott-Phillips 2014)[2].

Several scholars have suggested that pantomime is uniquely human (Arbib, 2012; Perlman et al., 2014; Zuberbühler, 2013; Żywiczyński et al., 2016). In spite of this opinion, Russon and Andrew (2011a, p. 629) have proposed that "orangutans pantomime spontaneously". When mining the existing databases of free-ranging rehabilitant orangutans, the authors identified 18 salient pantomimes (14 addressed to humans and 4 to orangutans). Furthermore, Russon and Andrews (2011b) have suggested that other apes can also produce pantomimic gestures. According to the authors, ape gestures are pantomimic because they are complex phenomena. Indeed, in addition to being a form of triadic communication, pantomimic gestures used by orangs have compositionality, systematicity, and productivity—three features typical of human language (Fodor, 1987). Exploiting such characteristics, "Orangutans can communicate content with propositional structure and have the kind of cognitive capacities with constituent structure typically associated with linguistic capacities" (Russon and Andrew, 2011a, p. 629). An example is that of Cecep (juvenile-male adolescent) struggling with a request, "picking a leaf and a stem. In front of A.R., with eye to eye contact, Cecep wiped dirt off his forehead with the leaf then gave the leaf to A.R. to request that she do the same" (Russon and Andrews, 2011a, p. 629).

It is legitimate to consider the pantomimic communication of Cecep to be complex. The point is to understand the *type* of complexity under discussion. The complexity in the case of the orangutan's pantomime is attributable to the sentence constituent structure. As Russon and Andrews stated: "Complex pantomime may enable in gesture some of the communicative complexities that sentences enable in language" (2011a, p. 630). It is not a coincidence that by appealing to the essential properties of thought and language, Russon and Andrews referred explicitly to Fodor (1975), the father of the Language of Thought (LoT) theory, according to which the constituent structure of linguistic utterances reflects the propositional structure of the sentences in the LoT. Fodor's thesis is the strongest argument in favor of the centrality of the sentence in the study of language. That said, what about the possibility that great apes are able to pantomime? More specifically, are apes able to pantomime in a narrative way (which is the precursor of human language)? The reports about orangutans show that they are unable to produce gestures characterized by the holistic nature that, following the definition of pantomime proposed by Żywiczyński et al. (2016), we considered the core trait on which the possibility of storytelling without language can be founded.

After discussing the reasons that orangutan pantomime is an equivalent of sentences in language, Russon and Andrews (2011) argued that pantomimic ability of apes can also be expressed at the narrative level:

> In addition, one orangutan pantomimed complex and sequential information that portrays a story. Kikan re-enacted part of a past event: a caregiver had used a pencil to remove a sliver from the sole of Kikan's foot and then daubed latex from a fig leaf stem on the wound to dry it. A week later, after gaining this caregiver's attention, Kikan picked a leaf and poked its stem at the sole of her (now healed) foot in similar fashion. This suggests rudimentary narrative abilities, where narrative is defined minimally as "the representation of an event of a series of events". This case counters the common view that narrative

[2] We thank an anonymous reviewer for the comments related to this issue.

is a uniquely human capacity. It also shows some of the components of episodic memory of reconstructing one's own past experiences as situated in time (Russon and Andrews, 2011b, p. 316).

Leaving aside the fact that, at present, the anecdote on Kikan is the only case in the literature concerning the (alleged) narrative abilities of apes, it is unclear why such an anecdote should be considered a case of storytelling. Also referring to the (very narrow) definition of narrative proposed by the two authors, it is difficult to argue that Kikan described a causal sequence of events: Kikan's gestures lacked those properties that we have considered fundamental to considering pantomime as a way to express the causal relationship between distinct (and distant) events in time. As we said, the relationship between events is closely tied to global coherence. It does not seem that Kikan's gestures have such a property. All that is possible to state about Kikan's pantomime is that it is a succession of movements within a complex action. This is exactly the kind of situation that Russon and Andrews interpret as a case of propositional complexity (as in the example of Cecep). If an orangutan's pantomime is stuck at the sentence constituents structure, these animals are incapable of a pantomime in the full sense.

The available data in the literature lead us to argue that great apes can pantomime only if we accept a very weak definition of *pantomime*. However, accepting an oversimplified notion of pantomime, we risk leaving out those properties that make pantomime a valuable instrument for the study of the origins of language. What we need for the origins of language is a sufficiently rich expressive system that is able to convey the richness of the representational systems. Since humans represent reality by means of narrative, the expressive devices that convey the mental representations of individuals of our species must have properties that allow them to create stories of the facts and events of reality. Pantomime is a transit point for the advent of language because it is a means of expression capable of representing the narrative character of mental representations of which humans are capable. The difficulty of interpreting the expressive gestures of Kikan as a (primordial) form of storytelling corroborates the skepticism about the possibility of attributing pantomimic capacities to non-human animals. We agree with Żywiczyński et al. (2016, p. 6) according to whome "no other non-anecdotal reports exist of ape behavior meeting or approximating such 'richer' criteria for pantomime". A way to confirm the idea that (cf. also Zuberbühler 2013, p. 136): "[in apes], pantomiming is conspicuously absent, apart from isolated anecdotes").

9. Conclusions

In this article, we have argued that to account for the origin of language it is necessary to analyze the traits that distinguish human communication from animal communication. Among the specific features of human language, we have assigned a prominent role to narrative skills. In fact, while it is possible to recognize that non-human animals are capable of complex forms of communication, at the current state of research, it is not possible to attribute storytelling skills to them. Given the narrative nature of language, we proposed that the study of the origin of human communication has to be tied to the study of the cognitive systems underlying storytelling. Specifically, we have suggested that the origin of language is due to the functioning of the cognitive systems involved in the processing of global coherence (an essential property of the narrative level) that our ancestral relatives possessed before starting to talk.

Referring to autism, we have shown that among the crucial cognitive systems involved in coherence processing are the systems of temporal projection that connect events causally distant in time. The fact that such systems are present (to a greater or lesser extent) even in non-human animals has allowed us to argue that they are independent of language and that, by virtue of this, may have represented the precursors for its advent. To these considerations is connected the fact that the origin of language has to be closely linked to the ability to tell stories without language. Pantomime perfectly meets the requirements to link the way, typically human, of representing reality with the need to communicate this form of representation. The fact that pantomime is uniquely human could be a logical step in explaining why language is a uniquely human ability.

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