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Learning and Evolutionary Constraints on Linguistic Variability[1]

Abstract

In this paper, we offer some insights that might contribute to the debate about English as a lingua franca (ELF) by addressing some aspects related to the broader topic of language acquisition and evolution. Specifically, it is our claim that some features related to the emergence of ELF can be explained in reference to the 'bottleneck of communication' generated by the sensory and memory processing constraints involved in language production and comprehension. We will refer to the usage-based perspectives to language (e.g. Tomasello 2003) according to which the bottleneck provides a constraint that affects the language system, both at the processing and acquisition level, leading to predictive and rapid learning processes that, in turn, cause an item-based language change: those linguistic forms that are easier to learn and more efficient from a communicative point of view will tend to spread and supplant those that are not functional to communication. On an evolutionary timescale, a similar adaptation process can shape the languages in accordance with a tendency to simplification and uniformity. Such a tendency might be responsible for the emergence of a global language that serves communicative purpose. In the light of these considerations, a systematic use of ELF can be explained within an integrated framework that focuses on the contribution of more general processes of language acquisition, change and evolution.

1. Introduction

Human languages are both systematically structured according to regularity and highly variable. These features - linguistic universals and language variation - make human language an extraordinary communication system in nature, which has inspired the attempts of many scholars to construct a

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[1] For the specific concerns of the Italian Academy, we specify that AC wrote sections 2, 3, and 4; IA wrote sections 2 and 6; FF wrote sections 1 and 5.

theory that would explain the emergence of a device with similar characteristics. The discussion on linguistic universals and variation involves several disciplines and may be addressed by different perspectives (e.g. Jakobson 1941; Whorf 1945; Greenberg 1963; Chomsky 1965; Good 2008; Evans and Levinson 2009; Fitch 2011; Corballis 2017). The issue of English as a lingua franca (ELF) – irrespective of the debate about its status, which is an open question (e.g. House 2003; Jenkins 2007; Seidlhofer 2011) – can be viewed as a specific case of the broader topic of language uniformity and variation. Starting from the methodological assumption that exploring the topic of language change is a way to address the issue of ELF, in the present paper we focus on the processes that might have affected linguistic variation, leading to the widespread and systematic use of a global language. Specifically, it is our claim that a focus on language processing, acquisition and evolution – at the level of ontogeny, glossogeny and phylogeny –[2] might shed light on the constraints and pressures which have fostered aspects of uniformity in the language structure.

In this respect, the notion of 'bottleneck of communication' – the fact that users have to face several limitations in the acquisition and processing of language because of the immediacy and poverty of the input – provides an interesting framework under which language change can be investigated, since it has been stated to affect language structure across different timescales (Christiansen and Chater 2016b). The notion of bottleneck offers crucial indications in support of the idea that language undergoes changes which are motivated by needs of learnability and communicative efficiency. In this regard, by referring to the usage-based models of language (e.g. Bybee 2010; Tomasello 2003), we will argue that the main properties of the linguistic structures can be explained with reference to cognitive and pragmatic constraints which pertain to domain-general processes operating in areas other than language. We discuss against this background how language learning and processing are constrained by the bottleneck of communication and the consequences for the issue of language evolution, both at the phylogenetic and historical level, a topic we consider of utmost importance to understand the mechanisms responsible for a global language to emerge.

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[2] While 'ontogeny' refers to the developmental processes responsible for language acquisition during the lifetime of a single individual, 'glossogeny' and 'phylogeny' concern the level of evolution: glossogenetic processes are the historical forces that drive language change in a speech community, whereas phylogenetic processes concern the biological adaptations that have fostered the evolution of linguistic communication in the human species (see Tomasello 2003, 282).

2. Views of language change

Although the variability of human language is widely recognized without any particular objections, the debate on the reasons why languages change through time is very lively. Within traditional linguistics, research on variation has mostly focused on synchronic descriptions of language without taking into account the potential role of historical development. This was largely due to the predominance of Saussure's perspective in historical linguistics, and his theory of the arbitrariness of the sign (Saussure 2001), according to which there is no intrinsic connection between a given signal and its signification, i.e. there is nothing in the properties of a particular sign that makes it suitable for the representation of a signification, and vice versa. The principle of arbitrariness establishes a dichotomy between synchrony and diachrony, in so far as at any given moment a language can be defined by the social agreement between the users rather than by historical evolution. Thus, it is possible to study language without investigating the causes behind linguistic signs, to the extent that "the sole object of study in linguistics is the normal, regular existence of a language already established" (Saussure 2001, 72). On the one hand, the arbitrary nature of the linguistic sign pushes towards the invariability of the sign, namely "tends to protect a language against any attempt to change it" (Ibid., 73). Since there are no reasons to explain why a certain sign is more suitable than another to express a signification, then a system of arbitrary signs lacks the basis to change itself. On the other hand, however, variability is a fact: Saussurean linguistics does not deny that signs change. To account for this characteristic of signs, the reference is again to the arbitrary nature of language: since signs are arbitrary, then a language "can be organized in any way one likes, and is based solely upon a principle of rationality" (Ibid., 78). In this respect, variation we observe in language could be explained in reference to a chance model of linguistic change (see Butters 2001). Indeed, if a vague general principle of rationality is enough to describe why languages change through time – there are no functional or intrinsic causes underlying this change – then it is plausible to claim that human languages are the way they are because of accidental processes.

Over recent years, the structuralist tenet of arbitrariness has been challenged and rejected by many theories of language. A claim that unites

these theories is that human languages do not vary at random and arbitrarily, but are highly conditioned by certain constraints, which have an impact on the possible structure a language may exhibit. By adhering to this claim, in the present paper we discuss some aspects and processes which may explain the conditioned nature of variation in natural language, and how they might be responsible for current phenomena such as ELF. Specifically, in what follows we refer to two different accounts dealing with the notion of variability: the Chomskyan generative linguistics and the cognitive-functional linguistics. Both these accounts make reference to a notion of conditioned variability; however, such a notion is framed in a very different way. While the Chomskyan account considers variation a superficial expression of deeper universal factors, the functionalist perspective – mainly, the usage-based models – views variability as a condition to attain commonalities across languages. It is proposed that the Chomskyan account lacks adequate explanatory power to account for phenomena such as ELF since it treats variability as an epiphenomenon of a priori conditions, which do not provide for aspects of uniformity related to the emergence of lingua francas. Conversely, the usage-based models, by stressing a process of convergence between languages due to constraints emerging in the repeated use, might offer insights on the debate about the causes behind ELF.

The Chomskyan theory of language and the related biolinguistic paradigm (Chomsky 1972; 2007; Moro 2016; Pinker 1994) consider the options of language variance to be determined by a set of innate constraints provided by our genetic endowment, termed Universal Grammar (UG) (Chomsky 1965). UG contains all the information needed to combine grammatical categories and give rise to any particular language, even before hearing an utterance of that language. To this extent, UG coincides with language universals, considered as structural principles permitting the acquisition of all human languages.

The main argument in favor of an innate UG is the argument from the poverty of the stimulus (Chomsky 1972; Crain and Pietroski 2001), the claim that the linguistic environment largely underdeterminates the human knowledge since it does not provide sufficient information to induce every feature of language. This gap between the poor data contained in the input to which the children are exposed and the complexity of grammar they develop can be overcome by assuming the existence of innate structure-dependent rules guiding language acquisition. Since these rules represent the prior basis of language learning, namely they are the essential component of

the human language acquisition device, the core of human language has to be identified in the UG. It is worth highlighting that the formulation of the argument from the poverty of the stimulus has been subjected to some criticisms and considered questionable and epistemologically weak. For example, Sampson (2005) has examined corpus data to analyze spontaneous speech and found that the various arguments for UG rest on false premises or logical fallacies. Similarly, by analyzing many classical cases used by the Chomskyan tradition to corroborate the argument, other works have shown that they have no empirical confirmation and offer no support against data-driven learning (e.g. Lombardi Vallauri 2004; Pullum and Scholz 2002). In spite of such criticisms, the argument from the poverty of the stimulus still remains a statement of the generative theory.

Despite the several different perspectives included in the generative paradigm, a major assumption is widely shared by these theories: the idea that the faculty of language is most successfully investigated in terms of an ideal formal system employed by an 'ideal language user' (Chomsky 1965). This assumption is tied to the Chomskyan competence–performance distinction. The linguistic competence is the 'knowledge of language', namely the abstract internalized system of rules possessed by the idealized speaker–hearer; the term performance refers to the ways in which this knowledge is put to use (i.e., the actual use of language) in real situations by the actual speaker–hearer. The competence–performance distinction is closely related to a further dichotomy, that between 'I-language' and 'E-language' (Chomsky 1986). The I-language describes the abstract computational principles underlying grammar processes "that are only manifested in very refined and rarified phenomena" (Boeckx et al. 2009, p. 197). In this view, the primary function of I-language is thinking itself as language is not primarily 'designed' for communication but rather for thought (e.g. Chomsky 2010). The languages we speak are referred to as external languages, or E-language, which are secondary to I-language. From this perspective, the processes and mechanisms involved in language use do not affect the core component of I-language, which is the very object of the linguistic theory and the real challenge (see Corballis, 2017 for a discussion).

These considerations have important implications for the question of language variation and change. In this view, in fact, despite considerable variation in superficial expression, languages differ very little as they rely on a deeper structure that is invariant across languages (UG allows large but highly constrained parametric variation across languages). To this extent, the issue

of variability is treated as the question of the biologically driven constraints which place limits on variation, by making a conceivable language possible or impossible (Moro 2016). In other words, the generative model connects linguistic variability to the question of universals. As Pinker (1994, 232) points out, "[a]ccording to Chomsky, a visiting Martian scientist would surely conclude that aside from their mutually unintelligible vocabularies, Earthlings speak a single language". Human languages seem different, but they are not.

As we have argued that the issue of ELF can be considered a specific case of the broader topic of language change and variation, from what we have said so far it appears that the generative model does not represent a good option to investigate ELF (in the Chomskyan model there is no room for the slowly convergence on a global language as language rests on a biological invariant). If one is interested in the study of ELF, an alternative view of variability seems to be necessary. A move in this direction might be that of replacing the Chomskyan innate perspective with a model of language centered on use, in which variability can be viewed as a constraint for the emergence of linguistic universals. Within the usage-based models, actual language use is the primary shaper of linguistic variability. As we will show, the repeated use leads to an intrinsic uniformity of the linguistic structures motivated by certain constraints, which might account for the cognitive and pragmatic causes behind lingua francas and, thus, might explain some aspects of ELF. Before going into details of the question of linguistic variation and change in the usage-based models, a brief overview of the main theoretical assumptions of these accounts is needed.

3. Usage-based approaches of language

Since the '70's, different traditions – from pragmatics to cognitive linguistics – have strongly rejected the idealization of language in terms of an abstract system, emphasizing the social dimension in which language takes place (e.g. Grice 1975; Sperber and Wilson 1986/95; Tomasello 2008). The socially oriented models determine a significant shifting in perspective compared to Chomsky's model: language is viewed as a cooperative form of intentional joint action (Clark 1996), which involves the speaker's ability to adjust expressions according to the recipient's point of view. Indeed, a linguistic interaction is primarily characterized by the speaker's meaning, a complex

communicative intention aimed to achieve a certain effect on the hearer's mind (Sperber and Wilson 1986/95). This way of looking at language stresses the role of a double pragmatic ability – on the side of both the speaker and the hearer – to engage with other minds, with the aim of using the right sort of evidence to allow the audience to determine a contextually appropriate interpretation of linguistic expressions.

The main consequence of the fact that language is socially embedded is that it cannot be studied independently from the contexts in which it is used and from the social cognitive abilities it involves. These claims represent the major assumptions of the functionalist usage-based approach to linguistic communication (e.g. Bybee and McClelland 2005; Croft 2001; Givón 1995; Tomasello 2003). In a pragmatic perspective, the functionalist hypothesis holds that a language evolves because grammar is usage-based (Tomasello 1998; 2003) or data-driven (Beckner et al. 2009), rather than a formal, static and autonomous system. The specific underlying tenets of this assumption are that meaning is use, and structure emerges from use (Tomasello 2009). From this point of view, the language structure has to be considered as a dynamic system that is continuously changing by virtue of psychological processes involved in language use (Elman et al. 1996; Tabor et al. 1997). Within a similar perspective, the pragmatic dimension primarily characterizes language as a broader communicative process, both ontogenetically and phylogenetically, with grammar being derivative.

The implications of the pragmatic approach for theories of language acquisition are rather revolutionary if compared to the generative approach. Indeed, a crucial claim of this approach is that the structural dimension of language, which is acquired in the process of language use, can be learned and transmitted through cognitive and social learning skills that are not specific to language. This view is in sharp contrasts with the Chomskyan idea that language acquisition and processing are driven by a language-specific computational system (UG) that is independent from other cognitive processes. For example, Tomasello (2003) has classified the socio-cognitive infrastructure necessary for the acquisition of language into two main general sets of cognitive skills: intention-reading and pattern-finding. Intention-reading concerns the functional dimension of communication, including skills that are necessary to convey and interpret the interlocutor's intentions; pattern-finding is related to the ability to find patterns of regularities within the input, and construct abstract schemas. Other scholars have identified further cognitive processes that might affect the emergence and development

of linguistic structures through the general mechanisms of chunking and categorization (e.g. Bybee 2010; Christiansen and Chater 2016a). These are, in any case consistent with Tomasello's model. The assumption that similar general-domain capabilities can guide the acquisition of language from item-based to abstract constructions is basically proved by the fact that these mechanisms are more powerful than it was previously assumed. Recent empirical findings have indeed shown that people are extremely good at detecting distributional and usage patterns (Bod 2009; Monaghan et al. 2005; Saffran 2001). For example, Diessel (2007) has found that frequency has an impact on the processes of language acquisition, with children learning a probabilistic grammar grounded in their experience. In this grammar, indeed, categories and structures are associated with statistical values determined by their frequencies in language use. Moreover, the ability to probabilistically extract grammatical constraints from the input through processes like structural analogy seems to concern the level of language production and comprehension (for a review, see Ibbotson 2013).

Taken together, these various findings have been used to propose that the fundamental argument for the existence of an innate UG – the argument from the poverty of the stimulus – is inconsistent since we are able to account for language acquisition and processing by appealing to sophisticated statistical learning skills involving categorization, analogy and distributional learning (Lieven and Tomasello 2008; Tomasello 2003). The acquisition and use of complex grammatical constructions can be, therefore, explained with reference to biases that are not language-specific in a perspective that integrates language within other cognitive skills. This leads to a theory that sees language as a complex adaptive system resulting from the interaction between cognition and use, where interaction represents the major source of variation. Differently from the Chomskyan tradition, universals of linguistic structure can be conceived of as deriving from the fact that people are endowed with the same set of general cognitive processes (Tomasello 2003) and variation is the norm as consequence of the dynamics involved in language use.

These psychological insights from usage-based approaches open the way for an integrated approach of linguistic variation which, through the specific focus on the dimension of language change, takes account of the interdependency between different timescales of language. A first timescale pertains to the production and comprehension of face-to-face language: here language variation can be generated as a consequence of the processes entailed

in the elaboration of language as described in the pragmatic perspective. The second timescale concerns the propagation of linguistic variants in a speech community: here certain variants are selected giving rise to specific language structures. In the next section, we will explore the relationship between language change and the level of language processing and acquisition (the first timescale). In the final section, we will investigate the implications of language change as regards language evolution (the second timescale). Both these interdependencies are addressed by using the notion of bottleneck of communication as a case study.

4. The bottleneck of communication

The usage-based perspective aims to take seriously the question of why we observe a conditioned variation in language structure. By taking linguistic change as a test case for exploring the issue, this perspective places emphasis on the specific notion of bottleneck of communication (Deacon 1997; 2003; Kirby and Christiansen 2003; Smith, Brighton and Kirby 2003), which represents a test bench for the critique of the poverty of the stimulus argument and, as we will argue, is also useful to investigate the issue of ELF. The notion pertains, indeed, to the fact that language users have to face several limitations when they are engaged in language learning and processing. There are two major ways of intending the notion of bottleneck: first, in terms of cognitive constraints and second, in terms of pragmatic constraints.

The cognitive sense of the term concerns the immediacy of language processing, namely the fact that language involves restrictions on storage and computation. In fact, in face-to-face conversation, people should process and keep track of information that is incredibly fast with limited sensory-motor and memory systems (Levinson 2000). This Now-or-Never bottleneck (Christiansens and Chater 2016a) determines that new incoming information can interfere with the previous input unless it is processed immediately. Christiansen and Chater (2016a) argue that such cognitive constraint has significant consequences, for example it can account for phenomena such as the abundant use of prediction and the continuous attempt to reduce cognitive effort in language production and comprehension, and the nature of what is learned in language acquisition.

As for the pragmatic sense of the bottleneck, it refers to the functional pressures of communication, which pushes towards informativity (Croft 2013; Lewis and Frank 2016). From this point of view, language serves a specific communicative function, with interlocutors striving to maximize the communicative success while minimizing energetic cost (Sperber and Wilson 1986/95).

In the usage-based approach, both the cognitive and pragmatic constraints exerted by the bottleneck impact on language change. To explain this impact, there have been identified two major causes (see Croft 2013): the child-based theory suggests that change is driven by a 'transmission bottleneck' during first language acquisition; a further hypothesis points to the pragmatic constraints and proposes to consider language change as a by-product of the individual speakers' attempts to achieve socio-communicative goals in language use. The former hypothesis implies a focus on the relation between language change and language learning whereas the latter emphasizes the relation between language change and language use.

4.1 Language change and language learning

The fact that language processing is highly constrained by the limits of human memory and sensory systems, which act as information processing bottlenecks, has important implications for the issue of language acquisition and transmission. To face the immediacy of language, children are also required to go through a transmission bottleneck, concerning the fact that languages cannot be transmitted in totality from one individual to another since the number of possible linguistic expressions of any human language is potentially infinite, whereas a child must acquire it on the base of the experience of a limited number of utterances (Smith, Kirby and Brighton 2003). The transmission bottleneck is clearly an aspect of the poverty of stimulus and, according to a long-standing hypothesis, represents a strong constraint for the features a language structure may exhibit.

Within child-based theory, the learning and transmission processes by which children acquire language are the privileged contexts where language change occurs (Christiansen 2016; Deacon 1997; 2003; Kirby and Christiansen 2003; Lightfoot 2010; Smith, Brighton and Kirby 2003). In this view, language change takes place through the change of generations from parents

to children, based on the fact that the processes by which children analyze the linguistic data are prone to error. In this respect, Deacon (1997, 109) highlights that:

Languages are under powerful selection pressure to fit children's likely guesses, because children are the vehicle by which a language gets reproduced. Languages have had to adapt to children's spontaneous assumptions about communication, learning, social interaction, and even symbolic reference, because children are the only game in town. It turns out that in a curious sort of inversion of our intuitions about this problem, languages need children more than children need languages.

The assumption underlying a similar hypothesis is that the learnability of a code is a fundamental constraint on the nature and development of that code: those linguistic structures that are easier to learn have an advantage over those that do not meet the learnability criterion. To support this claim, child-based theory of language acquisition has considered the parallels between child language and the diachronic evolution of language. The main changes and developmental patterns which are shared by child language and language history concern sound and morphology. For example, child language includes a pronunciation that is often deviant from that of adults, with a general tendency to reduce and simplify the phonetic structure of words (e.g. Menn and Stoel-Gammon 1994). Further, children tend to overregularize irregular morphology, as in the case of verbs (e.g. Maratsos 2000). Both these phenomena have been observed to characterize also diachronic change. But the strongest evidence in support of the hypothesis that language acquisition is the source of diachronic change comes from various computational approaches that, in recent years, have produced significant data in research on language development (e.g. Brighton et al. 2005; Kirby and Christiansen 2003; Smith, Brighton and Kirby 2003; Smith, Kirby and Brighton 2003). These data show that some general learning mechanisms involved in adults' language processing as well as in children's acquisition process can explain many features of language structure. In this direction, an influential proposal by Christiansen and Chater (2016a), based on a statistical model, suggests that sensory and memory constraints of the Now-or-Never bottleneck lead the language system to build chunks as quickly as possible at increasingly abstract levels of representation, from sound-based units to words to discourse-level representations. This Chunk-and-Pass processing is responsible for the compression processes realized in language production and the predictive

processes we observe in comprehension, with people anticipating upcoming information to construct an immediate and incremental interpretation of the global meaning of an expression (e.g. Ferreira and Patson 2007; Otten and van Berkum 2008).

The implications of this model for the timescale of language acquisition are striking. Child learning is constrained by the need of constructing and integrating the right chunks in the 'here-and-now'. The child, rather than "identifying the right grammar (...) [as] a 'mini-linguist', [is] a developing language user, acquiring the necessary skills to comprehend and produce language" (Christiansen 2016, 55). These skills comprise predictive abilities and statistical learning abilities – such as pattern-finding – which are directed to the task of tracking and interpreting linguistic information incrementally (Borovsky, Elman and Fernald 2012; Tomasello 2003). This, in turn, determines an item-based language change, which implicates the proliferation of linguistic forms that are more learnable.

Overall, the emphasis on the constraints of learnability and transmissibility implicates a view that considers the relation between language change and language acquisition in contrast to the Chomskyan tradition: the usage-based approach proposes a 'user-friendly' and 'child-friendly' theory of language (Fernald and Marchman 2006), which emphasizes the role of a wide range of cognitive and social capabilities from different domains. Importantly, in this view, the poverty of the stimulus becomes a huge advantage since it permits the language system to organize itself by exploiting these general capabilities, and enrich its own structure. To this extent, it is the poverty of the stimulus to solve the problem of the poverty of the stimulus (Zuidema 2003), because the restricted richness of input enables children to adapt language to their acquisition procedure, leading to the emergence of linguistic structures (see section n. 3.).

It is worthwhile to highlight that, within the usage-based approach, the reference to the timescale of language acquisition to explain language change and, consequently, language variation is not uncontentious. Some authors argue that there is no evidence that the imperfect learning process of children can explain diachronic change (e.g. Diessel 2012; Croft 2000, 2013). In fact, along with similarities, language acquisition and language history show many differences, with language changes being different from errors made by children learning their first language (Croft 2013). Moreover, the innovations introduced by children do not seem to be maintained into adult language (Kerswill 1996). These considerations open the way for an alternative

hypothesis, which considers adults as instigators of diachronic change when they are engaged in language use (Diessel 2012; Croft 2013; Lewis and Frank 2016). Although the two hypotheses are not mutually exclusive, the latter proposal focuses, to a greater extent, on the communicative pressures generated by the interactional dimension of language on the dynamics of language change.

4.2 Language change and language use

Along with the cognitive constraints, the bottleneck of communication implies pragmatic pressures generated by the communicative function of language. In fact, an essential characteristic of language is that it is cooperative in nature: it implies the sharing of information by participating to a form of intentional joint action (Clark 1996; Grice 1975; Tomasello 2008). According to a strictly pragmatic perspective, considering language as a form of joint action implies that speakers are constantly engaged in constructing hypotheses about the mutual communicative intentions starting from the contextual clues and the expectations about the interlocutor's behavior (Sperber and Wilson 1986/95).

In accordance with this way of intending language, it is possible to consider some aspects related to the dimension of language use as pressures shaping linguistic systems. In this regard, Lewis and Frank (2016) claim that the tendency to compression derived from the sensory and memory limitations is counterbalanced by a tendency to informativity derived from the communicative dimension of language. The way people adjust their language output in order to be understood represents an example of this tendency. In this respect, by extending the pragmatic account of language processing to the acquisition timescale, some experimental research shows that the resolution of reference in word learning depends on the use of contextual informativeness (e.g. Frank et al. 2009; Frank and Goodman 2014). Children make predictions about word meaning by combining knowledge of speakers' communicative goals and assuming that they are using language informatively to achieve these goals. Namely, their predictions are constrained by an implicit assumption of informativeness. Similarly, considering the impact of speakers' adjustments to the aim of being more informative, research (e.g. Piantadosi et al. 2011) has shown that along the

timescale of language evolution words that are less predictable in their linguistic context are longer, suggesting that the most communicatively efficient code for meanings is one that shortens the most predictable words while more surprising words are longer. This would therefore increase time for the listener to process them. This is consistent with the fact that communication involves two opposite functions: to minimize the cognitive costs (i.e. the speaker needs to produce easy and thus compressible forms), whereas the hearer needs to receive forms that are moderately ambiguous and thus not compressed (Lewis and Frank 2016). Different features of the language structure can, therefore, be explained as the result of an equilibrium between the memory constraints and the pressures to communicate informatively.

Another aspect of language use that has been claimed to shape linguistic structures is the tendency to reuse recently heard forms (Pickering and Garrod 2017; Smith et al. 2017). This phenomenon of convergence of language structures at multiple levels – i.e., phonological syntactic, and semantic – in face-to-face conversation has been termed 'alignment' (Pickering and Garrod 2004). Accommodation to approximate one's speech to that of the interlocutor can be useful as reduce the variability of the output of language users during communicative interaction. This might stabilize communication, given that: "deviations from the 'usual' way of conveying a particular idea or concept are (...) taken to signal a difference in meaning [while] part of the communicative utility of language comes from its conventional use, i.e., the fact that interlocutors tacitly agree on what words and constructions mean" (Smith et al. 2017, 11).

A work by Fehér et al. (2016) that directly tested the impact of alignment in participants learning a variable miniature language found that reciprocal priming leads pairs of participants to converge on a system that lacks variation. Regularization seems to reflect a strategic reduction in unpredictable variation promoted by the communicative context. Pickering and Garrod (2017) have put forward the idea that a similar mechanism of interactive alignment might have stabilized long-term routines in conversation, guiding automatic transmission across the community. In this regard, automatic community alignment can be viewed as a mechanism for driving language change. Overall, these considerations suggest that interaction may be considered as a powerful mechanism for reducing unpredictable variation, which might contribute to explain how language use constraints change in natural language.

The reference to the bottleneck of communication seems to provide important insights into the nature of language change, suggesting that biases in statistical learning interact with language use to shape the structural properties of language. A perspective of language as a system evolving on the basis of this double constraint has implications for the issue of language evolution: the notions of usage-based language and linguistic structure are claimed to be closely connected also when considering the path leading to a uniformity in the linguistic codes along the timescales of phylogenetic and historical evolution. Addressing the issue of language change at these timescales may thus be particularly relevant for the topic of ELF.

5. Implications for language evolution

Before discussing the implications of the usage-based perspective on the topic of language evolution, it is critical to make a clarification about the term 'evolution', which involves at least two senses. On one hand, the term is traditionally used in reference to the evolution of language as a human-specific trait (e.g. Boeckx 2011; Fitch 2010; Pinker and Bloom 1990). In this perspective, investigating the evolution of language means exploring the biological prerequisites of the linguistic competence at the phylogenetic level. On the other hand, some scholars interested in diachronic research have recently started using the term evolution to refer to language change, thus, to the historical evolution of languages (e.g. Bybee et al. 1994; Croft 2000; Ritt 2004). It is clear that these two kinds of evolutionary approaches to language are asking questions which are completely different, although intertwined. However, within the usage-based account, a particular concern is that, by using the level of language acquisition as link between the diachronic change and the phylogenetic evolution, these two timescales overlap. Specifically, the process of phylogenetic evolution collapses on the process of language change, on the basis of a uniformitarian principle (e.g. Smith 2008) which assumes that the processes underlying language change in the early stages of emergence correspond to the same processes underlying the change of languages at the present stage: "there is no sharp distinction between language evolution and language change: language evolution is simply the result of language change writ large (...), constrained by processing and acquisition" (Christiansen 2016, 57). Although the idea of a strong

correspondence between the evolution of language and the evolution of languages presents many problematic aspects (for a discussion, see Ferretti 2009), for the purpose of the present paper, it is not worth going into the details of this criticism.

This said, speaking of evolution in the case of languages may appear bizarre: can language changes be treated as phenomena undergoing evolutionary pressures as in the case of biological systems (see Steels 2017)? By adopting an organistic view of language inspired by the Darwinian tradition, the usage-based approach considers languages as 'organisms' that have evolved under selective pressures from learning and processing mechanisms (Christiansen and Chater 2008). From this point of view, it is possible to identify parallels between linguistic and biological change, in so far as language change is considered as involving an evolutionary process based on cultural mechanisms of replication and variation. Differently from biological variation, in fact, languages are claimed to change too rapidly to be the product of a biological adaptation to language (Christiansen and Chater 2008; Deacon 1997; Hurford 1999). In a perspective that views language as an integrated evolving system in its own right (Beckner et al. 2009), understanding what is being selected in language evolution requires looking at the acquisition and processing levels. As we have shown, indeed at these levels critical constraints – the bottleneck of communication – act by shaping the structure of language. The hypothesis of the usage-based approach is that the impact of these constraints extends to the longer timescale of language evolution (Christiansen 2016).

This hypothesis has led to the development of a computational model of language evolution — the Iterated Learning Model (ILM) — that explores the cultural transmission process generation by generation (Brighton, Kirby and Smith 2005; Brighton, Smith and Kirby 2005; Hurford 2002; Kirby and Hurford 2002). This kind of simulative model employs sets of agents, each of which learns their behavior by observing the behavior of others, in a situated environment. To this extent, in these simulations as in real learning processes, the population of agents has to face the poverty of the stimulus resulting from the fact that learners experience only some of the infinite possible linguistic expressions of the system – they have to go through a transmission bottleneck. The linguistic behavior of agents emerges from the cultural pressures generated by the process of repeated use and acquisition from generation to generation (Smith, Kirby and Brighton 2003). The results of this approach show that fundamental properties of language arise from the

process of repeated acquisition and use. For example, Brighton, Smith and Kirby (2005) have shown that compositionality is the product of the bottleneck transmission, which pushes the system to become more complex to compensate for the scarce quantity of information available in the initial holistic system. In fact, when simulations are characterized by the absence of a bottleneck of transmission, compositional structures do not tend to emerge. In other words, language systems change over time to overcome the transmission bottleneck and achieve advantages at the level of learnability. The learning-based constraints can be described on the basis of a general model of sequential learning as observed in the Chunk-and-Pass processing: Chunk-and-Pass processing at utterance level constrains the acquisition of language by the individual, which, in turn, influences the way a language evolves through learning and use by groups of individuals, on a historical timescale. The same mechanisms involved in language processing and acquisition are exploited in language evolution, through repeated cycles of learning and use (for a review, see Dediu et al. 2013).

Starting from the results of ILM, the usage-based model derives two main related conclusions: on the one hand, in an evolutionary perspective, the bottleneck of communication represents a solution rather than a problem (Lotem et al. 2016); on the other hand, there is no reason to suppose a biological device specific for language. Smith, Kirby and Brighton (2003, 385) bring together the two aspects:

This result is therefore surprising. The poverty of the stimulus motivated a strongly innatist position on language acquisition. However, closer investigation within the iterated learning framework reveals that the poverty of the stimulus does not force us to conclude that linguistic structure must be located in the language organ – on the contrary, the emergence of linguistic structure through cultural processes requires the poverty of the stimulus.

In this perspective, the poverty of the stimulus is the engine that drives the evolution of language itself, since language adapts through the stability of generalizations that can be transmitted through the learning bottleneck. As a result, the constraints necessary to solve the problem of the poverty of the stimulus are the product of a cultural process of iterated learning. By considering language as a complex adaptive system able to generate structure itself, ILM rejects the necessity to bring into play innate domain-specific constraints determining language structure, and account for language change by referring to the same general biases observed in the acquisition process,

such as those that underpin sequential learning. On an evolutionary timescale, these biases can lead to a basic uniformity. Indeed, if at the individual level the bottleneck of communication has been considered to produce an item-based language, which favors those linguistic forms that are easier to learn and more efficient from a communicative point of view, at the population level we might expect that linguistic patterns that can be processed through the bottleneck will tend to proliferate and spread in the population (Christiansen 2016). From this point of view, long-term processes of language evolution can be described as leading to linguistic patterns that are easy to acquire, produce and understand.

Overall, the evolutionary framework allows to embed language structure in a broader context, accounting for some of its aspects in terms of adaptations to the constraints involved in language use and learning. Such constraints exerted by the bottleneck determine that languages evolve to become easier to perceive, to learn and master, developing specific features that are optimal for this purpose (Smith et al. 2017).

6. Implications for the ELF debate

To what extent might the processes described here be responsible for current phenomena such as ELF? It is our claim that considerations deriving from the usage-based framework might be of particular interest for investigating some aspects of ELF (see also Alptekin 2013). Specifically, we argue that the tendency to uniformity that constraints the evolution of language variation and change because of the bottleneck of communication might be considered as a key element in the debate on ELF. In lingua franca situations, in fact, English makes communication possible between persons not sharing a common code. In this context, successful communication strongly depends on the cooperative enterprise of all speakers, who are engaged in the effort of making themselves understood. In a pragmatic perspective, a similar scenario requires participants to continuously adjust and negotiate their utterances for the specific need of ensuring mutual intelligibility (see section n. 3.). The notion of intelligibility represents the degree to which a piece of information is efficiently exchanged between different speakers (Munro and Derwing 1995) and is highly consistent with that of informativity, which we have identified as a major pressure constraining structural change in language use. But ELF users have to rely to lexical resources that are very high in terms of

cognitive load to a larger extent compared to native speakers who adopt a wide range of automatized routines. To this extent, they are continuously engaged in the challenge of making the linguistic form mutually intelligible and communicatively efficient while trying to minimize the processing load. Thus, a plausible hypothesis might be that ELF variants are the product of the relationship between complex pragmatically and cognitively driven constraints involved in the intercultural use of English.

The focus on intelligibility fits with the hypothesis that speakers tend to select linguistic forms and constructions that are more readily understood by their interlocutors. In this usage-based perspective, the frequency of use of contextually guided ELF forms, irrespective of their compatibility with the rules of English as spoken by native speakers, may affect the routinization of those forms, so that they become regular variants of a new language (see Alptekin 2013). Under this view, the constraints exerted by the bottleneck of communication, which act both at the individual and population level, can be considered as a cognitive cause of the emergence of lingua francas such as ELF. A systematic use of ELF can be explained with reference to features that might make it easier to learn and process and, therefore, more efficient once it is adopted.

7. Conclusions

In this paper, we have focused on the issue of linguistic variability, from the point of view of cognitive and pragmatic constraints. From a usage-based perspective, we discussed the role of the bottleneck of communication in the acquisition, processing and evolution of more stable and uniform codes. We showed how it contributes to item-based language change: those linguistic forms that are easier to learn and more efficient from a communicative point of view will tend to spread and replace those that are not functional to communication. The adoption of a similar perspective on language change can provide some insights into the reality of ELF, as long as it may explain some aspects of its emergence within an integrated framework that combines the intertwined contribution of language acquisition, processing and evolution.

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