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Iconicity in the emergence of a phonological system?

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Iconicity has been described as an impetus for creating sign forms in emerging sign languages and forming signs in established sign languages. Iconic signs are defined as spontaneous or stable signs that directly reflect the representation of their referent. In established sign languages, iconic signs have phonological features. Regarding the link between the motivation for iconic signs and phonological features, we aim to investigate how iconicity might influence the emergence of a phonological system along with the evolution of a new sign language by observing how the rise of a phonological system might be revealed by the evolution of emerging iconic gestures and signs in a new sign language. For this purpose, we inventoried and coded the iconicity nature and phonological structure of 200 signed lexical items collected in two moments of Sao Tome and Principe Sign Language (LGSTP) emergence: at T1 (after 2 years since the deaf habitants initiated their social meetings) and T2 (8 years subsequent to T1 data collection). In the 8 years of LGSTP's emergence, we found a dominance of iconic signs in tandem with changes in the signs' internal structure. The handshape is revealed to be the phonological parameter with the greatest development, presenting itself as more complex. The LGSTP lexicon reveals that iconicity seems to prompt the emergence of sign forms. However, iconic strategies remain stable across the evolution of the emergent signs and are independent of the internal structure change of the sign.

Keywords: iconicity; phonological emergence; emerging sign language; language evolution.

1. Introduction

The similarity between certain properties of the linguistic form (such as spoken and signed phonology forms) and certain sensory-motor properties of the corresponding referent bring to light the iconic nature of language, underlining the linguistic form-meaning relationship in languages (Fay et al. 2014; Perniss and Vigliocco 2014). Some studies identify iconic patterns in the lexicon of stable languages (spoken and signed) and homesigns, describing a relationship between the lexical form and the meaning of its referent (e.g., Taub 2001; Gasser 2004; Akita 2012; Aryani et al. 2013). The emergence of a language allows us to track the evolution of an emerging iconic gesture or sign into an emerging lexical item with internal structure, that is, its phonological structure. There is an apparent tendency toward somewhat less iconicity in linguistic forms as sign languages evolve, but there is no evidence that

iconicity totally disappears (Taub 2001). In this context, the question arises: How might iconicity influence the phonological system's emergence during the evolution of an emerging sign language? Here, we investigate the evolution of emerging iconic signs to study the emergence of a phonological system in a new sign language.

Iconicity has been identified as a source of communicative mechanisms in the early and modern stages of language evolution (Żywiczyński et al. 2021). The communicative means used by modern humans when a common language is absent, and there is space for the emergence of a new language, reveal iconic motivation in the use of holistic gestures, such as homesigns and emerging pantomime gestures (e.g., Goldin-Meadow 1999; Meir et al. 2010; Mineiro et al. 2021). In this way, iconicity may provide a key to understanding language evolution.

In established linguistic systems, iconicity has been observed in different linguistic structures, such as morphology, syntax, and lexicon, in spoken and signed languages (e.g., Sadowski 2001; Taub 2001; Perlman et al. 2018; Monaghan and Roberts 2021). From the point of view of semiotics, iconicity is characterized by motivated relationships between signs and objects and their concepts, that is, by the relationship between form and meaning (Peirce 1998; Dingemanse et al. 2015). The co-existence of iconicity and arbitrariness in some linguistic forms, each having different uses and functions, has even been reported (Gasser 2004).

In the lexicon of spoken languages, the link between acoustic elements of the words (phonomimes, phenomimes)[1] and objects, events, or psychological states, has come to characterize the type of iconic relationship (e.g., Akita 2012; Aryani et al. 2013). Although the traditional hypothesis that words are solidly arbitrary linguistic forms in spoken languages (Saussure 1959; Hockett [1960], 1977) is prominent in the current linguistic and psycholinguistic models, several studies are bringing to light evidence of a non-arbitrary relation between word sound and meaning in the use of spoken languages (e.g., Jakobson 1979; Schmidtke et al. 2014). These studies reveal a bond: (1) between the acoustic pattern of a given word and the word's meaning (e.g., Perniss et al. 2010; Blasi et al. 2016; Svantesson 2017; Aryani et al. 2019); (2) between the particular phonemes' frequency and the general emotional tone in the text (e.g., Aryani et al. 2013); and (3) between the sound of adjacent words to reference the meaning of a given word (Auracher et al. 2019). In light of these studies, iconicity in spoken languages can no longer be assumed to correspond to simple expressive forms of onomatopoeias, metaphors, ideophones, and mimetics (Schmidtke et al. 2014; Perlman and Woodin 2021).

In sign languages, the iconic nature of signs was recognized in early studies (Frishberg 1975; Klima and Bellugi 1979) because these languages use a visual-motor modality. In a signed context, iconic signs are defined as spontaneous or stable signs that directly reflect the representation of their referent. They can vary in input structures and form, maintaining meaning even outside the discursive context (Taub 2001). Iconicity exists when a word stands for a referent. However, iconic signs are not always transparent in their concept. Several studies have reported that non-signers experience difficulties in determining the meaning of iconic signs (e.g., Klima and Bellugi 1979; Pizzuto and Volterra 2000; Occhino et al. 2017), showing that iconicity may motivate sign formation but will often not be enough to determine the meaning of the sign.

Iconicity takes place in the lexicon of signed languages when a word/sign mirrors the shape of the referent and reveals the concept of its referent, pointing out the resemblance between the word/sign form and its meaning (Liddell 2003; Cuxac and Sallandre 2007). Regarding the interpretation of the concept of signs, when isolated and based on the idea of an iconic motivation for the evolution of signs, the early approaches classified stable signs into different degrees, from transparent to opaque signs (e.g., Klima and Bellugi 1979). The iconic relation of form-meaning has also been characterized based on the patterned perceptual features of the referent and its represented actions in the signs (Kendon 2004; Padden et al. 2013, 2015; Ortega et al. 2017). Pyers and Senghas (2020) have recently analyzed the iconic nature of signs across different generations of Nicaraguan Sign Language (NSL). In this recent language, pantomimic (body-to-body) and perceptual (features of the referent) iconicity are present in all cohort signers. However, the body-to-body iconicity was dominant, despite decreasing in the signs of the younger cohorts. These results confirm that embodiment is crucial for the emergence and creation of meaning in gestures and new signs.

Hence, the body can be considered an articulator and a semiotic source since it represents the subject in the sign languages clause (Meir et al. 2007; Padden et al. 2010). In this vein, Padden et al. (2015) analyzed the iconicity patterns of lexicon regarding the body involvement and referent's form in sign articulation—handling, instrument, and object. Padden's studies report that handling and instrument strategies are the most frequent iconic motivators when identifying tools and actions for stabilized lexicons in sign languages and silent gestures from hearers. These results may reveal that the iconic nature of the signs may show patterns of different grammatical elements in sign languages. Additionally, these studies show that distinct iconic strategies are expected to display different representations in the internal structure of signs. Hence, we may consider that the iconic strategy may be related to the internal structure of a sign. To explore this idea, we developed an analysis of Iconcity and the internal structure of signs across the development of the new sign language, Sao Tome and Principe Sign Language (LGSTP).

When considering the internal structure of the sign, the place of articulation/location, movement, and handshape, are the most reported iconically motivated elements in the phonology of established sign languages (Cuxac 1999; van der Kooij 2002; Fuks 2013; Wilcox and Occhino 2016; Brentari 2019). In general, the articulation site of a sign tends to represent the location of the referent. For example, signs articulated near the head are related to referents associated with the mind/brain. The movement of the sign tends to represent how the referent moves or is handled. For example,

the direction and type of movement may reveal which referent action was performed (e.g., open implies an outward movement, and closed implies means an inward movement). The handshapes tend to represent the shape or/and the parts of the referent. However, the role of handshape and its conventionalization is still under discussion (Goodglass and Kaplan 1963; Overton and Jackson 1973; Payrató 2014).

At the articulation level, iconicity seems to motivate the coarticulated movement of two-handed signs in linguistic phenomena such as marking plurality, referring to multiple participants or elements or parts (Acquaviva 2008; Börstell et al. 2016; Lepic et al. 2016). The role of the second hand in sign languages has been studied since the co-articulation of the second hand may play a more critical role than the one usually attributed, revealing that it can add, change or contextualize the dominant hand sign with which it coarticulates (Crasborn 2011; Lepic et al. 2016).

In emerging sign languages, the first pantomimic and iconic gestures seem to be typically holistic, that is, they involve the engagement of the whole body or parts of the whole body articulated in ample space to express the lexicon target-meanings (e.g., Senghas and Coppola 2001; Mineiro et al. 2017, 2021). Although these first gestures reveal a near-transparent relationship between gesture and meaning, their iconic transparency tends to decrease with stabilizing the emerging signs influenced by the economic nature of the human language (Abreu et al. 2022). It is a partial disappearance of iconicity (Mineiro et al. 2017, 2021; Dachkovsky et al. 2018; Abreu et al. 2022). Patterns of this iconic transparency decrease are mostly reported based on: manual articulatory preference and signing space reduction (Nyst 2007; Mineiro et al. 2017, 2021; Dachkovsky et al. 2018; Abreu et al. 2022). These patterns are also seen in earlier variants of mature sign languages (e.g., in ASL (Frishberg 1975) and Portuguese Sign Language (Moita et al. 2018)).

Phonological emergence studies on new sign languages reveal that the decrease of iconicity patterns in signs does not show the existence of an already well-organized and defined phonological system. The different cohort generations of signers of the emerging Al-Sayyid Bedouin Sign Language (ABSL) (Sandler et al. 2011; Sandler et al. 2014), show that the decrease of iconicity is associated with the regularity of articulatory elements, such as place of articulation and handshape. The absence of phonological patterns in ABSL did not support a defined phonological system since formal phonological constraints (constraints on finger selection and bi-manual co-articulation) and phenomena between signs (phonological assimilation) were not identified. These findings may reveal that the human language features, double articulation (Martinet 1960), or duality of patterning (Hockett 1960) do not arise in parallel with the grammatical regularity. This is sustained by the fact that the morphological, syntactic, and prosodic levels seem to be more regular in the first years of sign language emergence (Sandler et al. 2011; Sandler et al. 2014; Mineiro et al. 2017, 2021; Abreu et al. 2022). Throughout development, emergent sign languages increase finer linguistic features in the internal structures of signs associated with linguistic complexity (Meir et al. 2010; Sandler et al. 2014; Mineiro et al. 2021). However, not all cases of sign evolution show an apparent increase in complexity in their internal structure when compared to the previous pantomime gesture (e.g., Klima and Bellugi 1979).

Considering that a phonological system is not defined in the early phases of the development of a new language (Sandler et al. 2011, 2014) and that iconic features are still present and dominant in the lexicon across several cohorts of signers (Pyers and Senghas 2020) and lexicon of stabilized sign languages (Padden et al. 2013, 2015), we may question if iconicity might influence the internal structure emergence of new signs?

In summary, when observing iconic signs in emerging sign languages, iconicity is an element of the communicative behavior that motivates language structures. Recognizing iconic structures in the emergent and stabilized lexicon of natural languages, regardless of their modality, allows us to describe iconicity as a linguistic fuel that propels human communicative means and as a linguistic trace in the internal structures of natural languages' lexicon. Considering the primary iconic strategies in emergent signs and iconic traces in stabilized signs and recognizing that the internal structure of signs of new sign language may take longer to systematically develop, we question how the evolution of emerging iconic signs might show the first stage of phonological system emergence in a new sign language. To answer this question, we analyzed the signed lexicon in two periods of the emerging Sao Tome and Principe Sign Language (LGSTP) (Mineiro et al. 2017). Our main goal was to find possible patterns of connection between the iconic nature of sign development and the emergence of the internal sign structure.

2. Sao Tome and Principe Sign Language Emergence

In 2012, the emergence of the LGSTP was afforded by the Without Barriers Project. This 2-year project promoted the socialization of deaf inhabitants of Sao Tome and Principe and, consequently, the emergence of a sign language through daily meetings among deaf children and youngsters for a 2-year period to advance deaf education (for more concerning project context

and development, see Mineiro et al. (2021)). Before this project, deaf people from Sao Tome and Principe were linguistically and socially isolated. They were discriminated against, having no contact with each other or other deaf people and no access to school. It should be recalled that in this African country, public transport is almost nonexistent, making it nearly impossible for deaf people to meet and interact with each other. LGSTP emerged as a deaf community sign language, similar to NSL (Senghas et al. 1997; Meir et al. 2010). At the end of the project, approximately 100 deaf people participated in the project. The LGSTP emergence was encouraged via group activities, such as outings, thematic discussions, and storytelling. To determine the evolving structure of a set of concepts, the deaf researcher elicited signs via drawings representing referents.

As for the linguistic environment, all deaf participants belonged to large hearing families (with four or more siblings per family). Considering that isolated deaf children tend to develop a system of homesigns and that when these children are brought together, their homesign systems seem to adjust to each other (Goldin-Meadow 2005, 2012), we applied a questionnaire, a semi-structured interview, and we made regular visits to their family context to assess if there was a homesign system in place. The deaf children were not well-integrated into their hearing families (Mineiro and Carmo 2016) and did not interact much with the other family members. The interaction between deaf participants and their family elements was conducted through pointing gestures accompanied by vocal sounds, mimics, and coded gestures created within the hearing family members to meet daily communication needs. Only two participants had deaf siblings, whose communication was based on signed home communication. These deaf participants developed a gestural communication characterized by homesigns with each other but not much within the rest of the family (for more concerning the linguistic environment in this project, see Mineiro et al. (2021)).

Early studies on LGSTP have suggested that iconic signs may be following pantomime gestures (Mineiro et al. 2021; Abreu et al. 2022), along with other emerging linguistic structural patterns (Mineiro et al. 2017). During the 2 years of the project, meetings between deaf participants were video-recorded. Observing the data from the first year of interactions, pantomime gestures were predominant in the analyzed corpus. Conversely, during the last year of the project, signs, classifiers, and other gestures became the dominant structures (Mineiro et al. 2021). At the end of the Without Barriers Project, we collected the most frequent and stable LGSTP signs to build the first school dictionary of LGSTP (Carmo et al. 2014), composed of 287 signed items.

After the project ended, deaf signers continued to attend school. They congregated into a group of deaf young people and adults that maintained weekly meetings and activities, emerging a participatory and co-operative deaf community using LGSTP as a daily means of communication. During this time, new deaf people joined this community, expanding the number of participant deaf signers.

Taking advantage of the existence of the first formal record of LGSTP signs after 2 years of its emergence, the present study is based on a comparative analysis between the signs compiled for the LGSTP dictionary (Carmo et al. 2014) and corresponding signs data collected 8 years later, in 2021, from the same elicitation cards.

3. Methods

3.1. Data collection and procedures

In the present study on iconic influence in LGSTP phonological emergency, we collected 287 LGSTP signs in two distinct periods of LGSTP emergency with an 8-year interval (T1 and T2), using the same procedures: an elicitation task. T1 were the LGSTP data corresponding to the last year of the Without Barriers Project in 2013, when 287 LGSTP signs were elicited for the LGSTP dictionary compilation (Carmo et al. 2014). T2 is the LGSTP data corresponding to 8 years after T1 data collection. To select the LGSTP signs for the dictionary, we followed the criteria of high-frequency corpus signs and the most used signs in daily life during the last year of the Without Barriers Project selection (for more concerning sign selection's criteria, see Mineiro et al. (2021)). To determine the sign of a set of concepts, a deaf researcher applied an elicitation task based on drawings created by the deaf LGSTP signers (Carmo et al. 2014; Mineiro et al. 2017). The elicitation task of lexical items was based on cards with drawings of the target referents. These drawings were made by the deaf participants who also performed the elicitation task in T1 to guarantee the traces of the culture and environment of Sao Tome and Principe and to be close to the perspective and reality of the deaf community (Fig. 1). The deaf researcher were investigators in the LGSTP emergency project who instructed each deaf signer to generate the corresponding sign for each referent drawn on the card in LGSTP. There was no time limit to perform the task. All participants were video-recorded individually in a quiet room without visual distractors.

In T1, the recorded signs were collected from four deaf participants from 14 to 25.02 years old (two male adults, one female adult, and one female child). The elicitation task was applied in two sessions wherein each participant performed between 70/71 signs.

Figure 1. Examples of drawings used to elicit signs, in this case, CORN and SAD signs.

In 2021, we carried out a second collection (T2) 5 years after the T1 collection. In T2, the elicitation task was performed by five deaf young adults from 19 to 25 years old (three male and two female) who also participated in the emergence of LGSTP in the Without Barriers Project. All these participants from T2 are active members of the deaf community in Sao Tome and Principe. They use LGSTP as their main daily language and have used the LGSTP dictionary (Carmo et al. 2014) at some point in their educational, professional, or family life. Each deaf signer performed 50/60 signs during a single session.

When identification of the elicited items in T2, 87 items were excluded since the response to their elicitation was not given in the form of an isolated sign or did not allow the extraction of an isolated lexical sign. In addition, each produced sign from T2 was selected and extracted from the video to be isolated and easily compared with the isolated signs from the first school dictionary of LGSTP (Carmo et al. 2014) (T1).

After identifying the produced signs in response to the elicitation task in the second moment, the same 200 items from each LGSTP period were analyzed and compared.

3.2. Data analysis

All data were coded and analyzed considering their iconic nature (Padden et al. 2013, 2015) and internal structure based on sign language phonological parameters (e.g., handshape, location, movement, palm orientation, and non-manual expressions) and identifying the manual articulators (bi-manual and mono-manual signs) (Battison 1978; Klima and Bellugi 1979; Stokoe 1980; Brentari 1999; Wilbur 2000; van der Kooij 2002).

The coding of the internal structure and iconic nature of the signs was performed by one researcher and reviewed by a second researcher. The third researcher was consulted in contexts where there was no coding agreement.

The iconic nature of the items was coded based on the iconic strategies grounded in the formation of the approach of the iconic signs following Padden's research (2015), which analyzes iconicity patterns of lexicon regarding body involvement in sign articulation—handling, instrument, and object. Handling and instrument strategies are revealed when the sign represents human action with the tool. If the human action is articulated with the handshape showing how the tool is handled, this is a handling strategy. Still, it is an instrument strategy if the hand configuration shows the tool's shape. When the sign represents the shape of the referent without human involvement, the object strategy is present. Following Padden's approach, we considered the following:

i. Handling strategy—sign represents human handling the referent; see Fig. 2 as an example. To perform MANGO, the signer shapes his hands

Figure 2. Example of handling strategy used in MANGO sign production in T2.

Figure 3. Example of instrument strategy used in CARROT sign production in T1.

representing how the mango is held while eating it.

ii. Instrument strategy—sign represents human action with the referent, and hand configuration represents the shape of the referent; see Fig. 3 as an example. To perform the CARROT, the signer uses only the index fingers to represent the instrument's shape, showing how the knife peels the carrot's skin under human control.

iii. Object strategy—sign represents the referent's shape, properties, or movement without human involvement; see Fig. 4 as an example. The signer represents in one hand how the object (SHELL) moves on the surface, represented by the other hand, without human involvement.

To better understand the use of an iconic strategy in the emergence of signs, the 200 items were coded according to their semantic nature. Concerning the semantic categories, we grouped the original eighteen categories into four main semantic categories to avoid an expected count of fewer than five observations. Thus, we constituted the following four categories: living beings; things; actions; and others. In the living beings category, we generally grouped the following subcategories: animals, family, and some natural elements. In the category of things, we grouped the following subcategories: home, instruments, material, school material, food, and clothes. In the category actions, we only included action elements, such as TO SLEEP, TO FISH, TO SIT, and TO WASH HANDS, among others. Finally, in the others category, we grouped the following subcategories: body, calendar, emotions, numbers, pronouns, health, and others.

The analysis of the internal structure of iconic signs was based on identifying the manual articulators and the phonological features of handshapes, location, movement, palm orientation, and non-manual expression (e.g., Battison 1978; Klima and Bellugi 1979; Stokoe 1980; Brentari 1999; Wilbur 2000; van der Kooij 2002).

Regarding the identification of the phonological parameters, we classified the changes between the elicited signs from 2021 (T2) and the corresponding signs from the first school dictionary of LGSTP (T1): (1) no change—no change has been observed between the articulations of the elicited sign at T2 and the corresponding original sign (T1), see Fig. 5 as an example; (2) partial change—there have been specific changes in some phonological elements between the articulations of the elicited sign at T2 and the corresponding original sign at T1, see Fig. 6 as an example; and (3) new sign/total change—the elicited sign at T2 is entirely different (i.e., it presents at least three or more changed parameters) from the corresponding original sign elicited in T1; see Fig. 7 as an example.

4. Results

In order to analyze the emergence and evolution of iconic signs of the new sign language LGSTP, we analyzed 200 signs from each of two different periods of LGSTP emergence and development (from T1 to T2, with an interval of 8 years), and coded them according

Figure 4. Example of object strategy when performing the SHELL sign in T1.

to their iconic strategy ground, following Padden's research (Padden et al. 2013, 2015). In this first analysis, we do not consider the different semantic categories.

In both periods, we observed the dominance of iconic signs: 194 signs (97%) were iconic in the first period (T1) and 174 signs (87%) were still iconic after 8 years, that is, in the second period (T2) (Table 1).

To investigate a putative association between the two moments of elicitation (T1 and T2) and iconicity, we analyzed 200 items selected from the total item pool. We computed a Chi-Square test (two-tailed), and we did find a statistically significant association between the two periods of elicitation and iconicity, with a prevalence of 97% iconic signs in the first elicitation (T1) compared to 87% iconic signs in the second elicitation (T2). Thus, an association was found between iconicity and the elicitation phase ($\chi^2_{(1)}$ = 13.587, P < 0.001). Although only to a small degree, the number of iconic signs decreased from T1 to T2.

Regarding the body involvement and the form aspect of the sign, iconicity patterns of the lexicon were coded based on the iconic strategies grounded in the formation of the iconic signs' approach following Padden's research (Padden et al. 2013, 2015)—handling, instrument, and object strategies. For this analysis, we also considered the index signs. In general, we may observe a trend toward the existence of iconic signs created from object and handling strategies in both moments (Table 2). In T1, we identified 45% of iconic signs recruiting an object strategy and 37% recruiting a handling strategy. In T2, we identified 40% of iconic signs recruiting an object strategy and 33% recruiting a handling strategy.

Additionally, we observed an increase in the percentage of iconic signs formed by instrument strategy in T2 in LGSTP development. All these signs emerged from a handling strategy, such as the case of POTATO, SQUID, and PENCIL SHARPENER. Additionally, we detected some combinations of iconic strategies and index form in both periods; however, these are presented in a smaller percentage.

To better understand the use of iconic strategy in the emergence of signs, the 200 items were coded according to their semantic nature into four categories: living beings; things; actions; and others. Concerning the iconic strategies, we collected only information about the object, handling, and instrument strategies, excluding index signs, because we aim to analyze the functioning of iconic strategies in the emergence of language.

Given that we only analyzed object, handling, and instrument strategies alone, both in T1 and T2, from the total stimuli pool of 200, we analyzed a subsection of 147 stimuli.

We computed a Chi-Square test (two-tailed), and we did find a statistically significant association between the semantic category and strategy used in T1. With living beings using 86.7% object strategy, with no use of instrument strategy, and 13.3% handling strategy. On the other hand, things use 19.4% object strategy, 12.5% instrument strategy, and 68.1% handling strategy. Actions, on the other hand, make use of 9.1% object strategy, 45.5% instrument strategy, and 45.5% handling. Finally, the signs from the category of others use object strategy 85.3% of the time, only 11.8% instrument strategy, and 2.9% handling strategy. Thus, an association was found between semantic category and iconic strategy ($\chi^2_{(6)}$ = 79.913, P < 0.001). In other words, in T1, the distribution of strategy types depends on the semantic category of the stimulus.

We also computed a Chi-Square test (two-tailed) and again found a statistically significant association between the semantic category and strategy used in T2. Living beings use 83.3% object strategy, increased instrument strategy to 10.0%, and 6.7% handling strategy. On the other hand, things use 20.8% object strategy, 25.0% instrument strategy, and 54.2% handling strategy. Signs from the actions category use 9.1% object strategy, 45.5% instrument strategy, and 45.5% handling strategy. Finally, others use object strategy 76.5% of the time, with growth, from T1, in instrument strategy use to 20.6% and maintenance of 2.9% handling strategy. Thus, an association was found between semantic category and strategy

Figure 5. Example of a lexical item with no change in its articulation from T1 to T2, the ʙᴜᴛᴛᴇʀ sign.
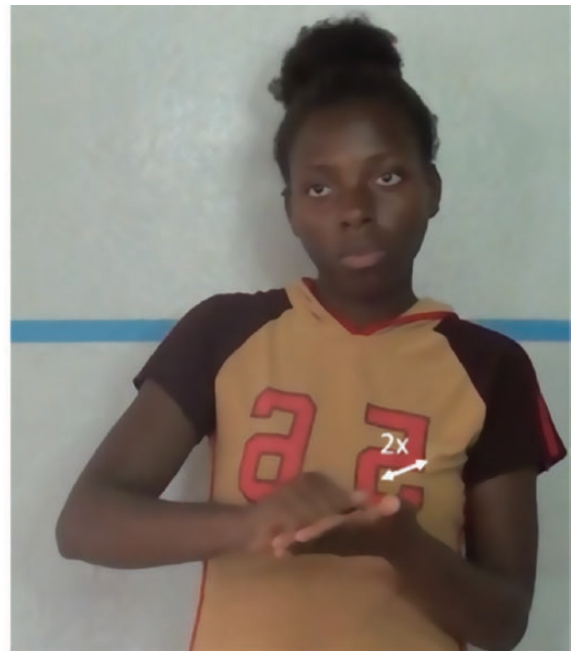

Figure 6. Example of a lexical item with partial changes in its articulation from T1 to T2, ᴇʀᴀsᴇʀ sign, in which handshape and location of dominant hand main of articulation have changed.

Figure 7. Example of a lexical item that has totally changed in its articulation from T1 to T2, POTATO sign, in which all the phonological parameters have changed except the spatial location of the sign.

Table 1. Iconic and non-iconic signs in the two periods of lexical elicitation in LGSTP emergence.

	T1		T2	
	Nb	**%**	**Nb**	**%**
Iconic signs	**194**/200	97%	**174**/200	87%
Non-iconic signs	**6**/200	3%	**26**/200	13%

Bold values indicates Nb of productions.

Table 2 Iconic strategies in the two moments of lexical elicitation in LGSTP emergence.

	T1		T2	
	Nb	**%**	**Nb**	**%**
Object	**87**/194	45%	**69**/174	40%
Instrument	**20**/194	10%	**35**/174	20%
Handling	**71**/194	37%	**57**/174	33%
Index	**12**/194	6%	**6**/174	3%
Object + handling	**4**/194	2%	**6**/174	3%
Object + instrument			**1**/174	1%

Bold values indicates Nb of productions.

($\chi^2_{(6)}$ = 61.002, P < 0.001). In other words, in T2, the distribution of strategy types continues to depend on the semantic category of the stimulus. Although we can find slight alterations, as presented in the figure below, generally amounting to a slight increase in instrument strategy from T1 to T2, the iconic strategy distribution remains very similar from T1 to T2, with no changes at all in strategy distribution in the actions semantic category (Fig. 8).

To analyze the phonological emergence in LGSTP, we have characterized the internal structure of the produced signs in both moments (T1 and T2) by identifying one-handed and two-handed signs and non-manual articulators and coding the handshapes, movement, location, and palm orientation.

First, we analyzed manual articulators (one-handed and two-handed signs) in the 200 signs produced at each period of LGSTP emergence. We considered one-handed and two-handed signs in the first and or second syllable as use.

In order to identify a possible association between the number of manual articulators used from T1 to T2, we analyzed 200 items selected from the total item pool. We computed a Chi-Square test (one-tailed) since we hypothesized that throughout time there should be an increase in economy of effort, that is, reduction of secondhand use. We did find a
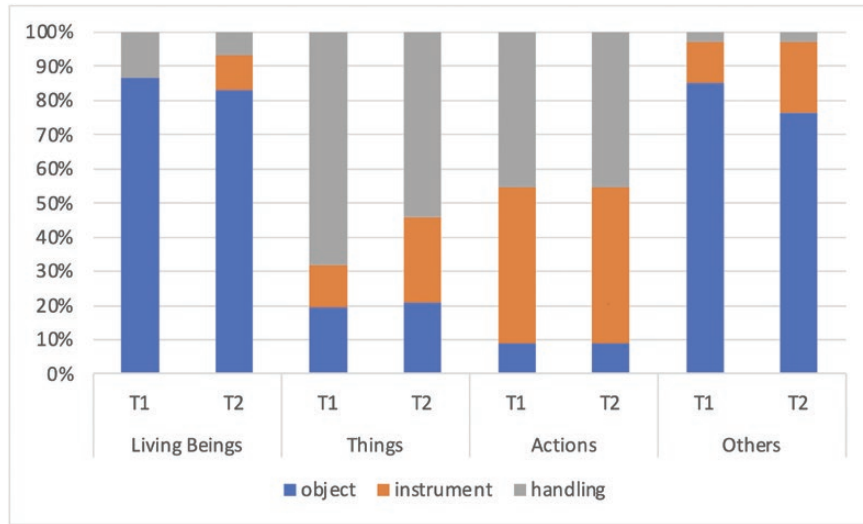
Figure 8. Iconic strategy percentage of distribution considering the semantic categories in both moments of lexical elicitation in LGSTP emergence.
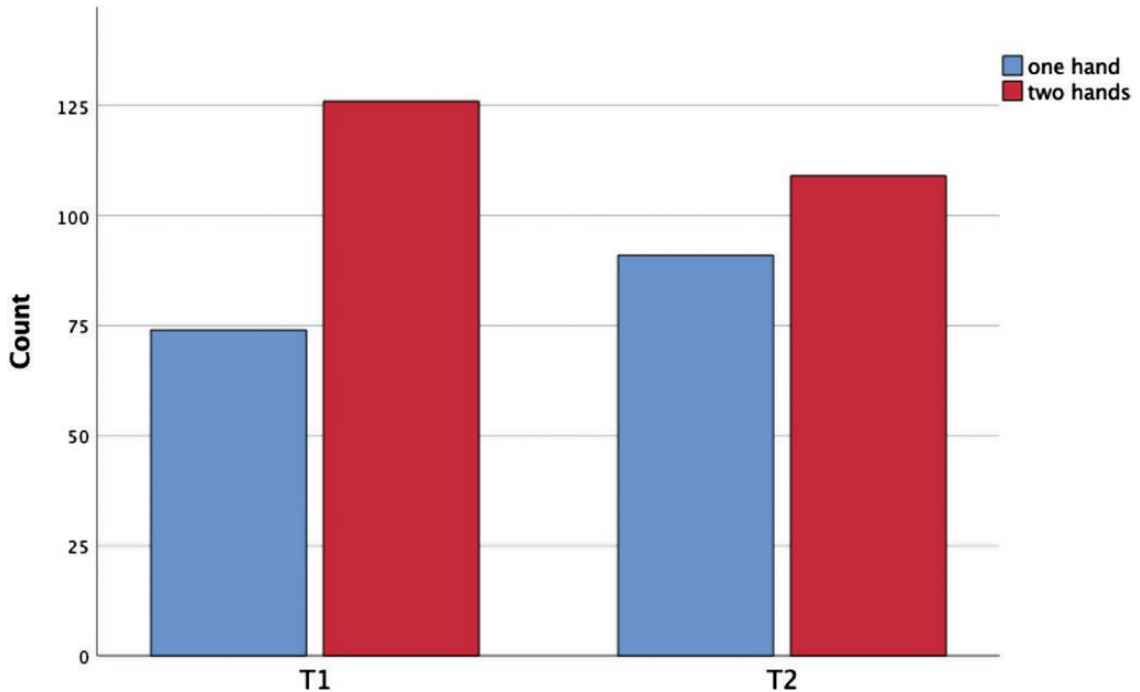

Figure 9. Distribution of the number of one-handed and two-handed iconic signs in both periods of lexical elicitation in LGSTP emergence.

statistically significant association between the two periods of elicitation and the number of hands used (Fig. 9), with a prevalence of 37% one-handed signs (vs. 63% two-handed signs) in the first elicitation compared to 45.5% one-handed signs (vs. 54.5% two-handed signs) in the second elicitation. Thus, an association was found between the number of hands used and the elicitation period ($\chi^2_{(1)}$ = 2.981, P = 0.042). Although small, there is a reduction in secondhand use from T1 to T2.

Table 3. Internal structure changes in iconic signs from T1 to T2 in LGSTP emergence.

Internal structure changes		
	Nb	**%**
No change	**55/178**	31%
Partial change	**54/178**	30%
Total change	**59/178**	33%

Bold values indicates Nb of productions.
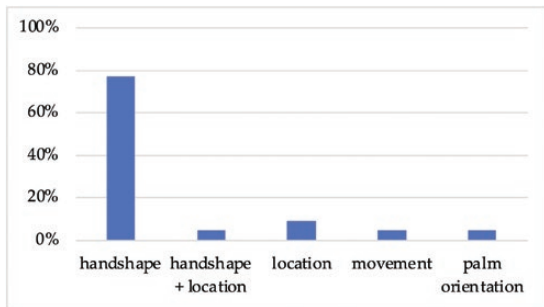
Figure 10. Percentage of changes of internal elements in the partial change cases from T1 to T2 in LGSTP emergence.

Table 4. Loan signs in calendar and numbers lexicon.

	New sign		Loan sign	
	Nb	**%**	**Nb**	**%**
Calendar signs	**0/7**	0	**7/7**	100%
Numbers signs	**1/10**	10%	**9/10**	90%

Bold values indicates Nb of productions.

Regarding the internal structure of LGSTP emerging iconic signs in the two collected periods, we identified the signs that, in T2, (1) underwent a total change in their internal structure; and (2) the signs that suffered a partial change in the internal structure—excluding the index signs, because they do not reveal an iconic strategy. Hence, we considered 178 items from the 200-item pool. Thus, considering all iconic signs, we observe that the structural changes (partial change (30%) and total change (33%) tend to be similar to the proportion of signs with no structural changes (31%) (Table 3)).

Analyzing the internal elements change in the partial change cases, we may observe that handshape is the internal element that underwent the most changes,

changing in 77% of the iconic signs and, together with location, in 5% of iconic signs. The changes in the other internal elements were residual (the location (9%), movement (5%), and palm orientation (5%) (Fig. 10)).

When analyzing the total changes/new signs, we noticed that 100% of the analyzed calendar items and 90% of number items (from the semantic category others) all changed into new signs, specifically into loanwords from another sign language, namely Portuguese Sign Language (Table 4) (Fig. 11). Only a total change corresponded to a new sign, the sign for the MOUSE referent. At T1, the sign iconically emerged from object strategy and totally changed to a non-iconic sign influenced by the oral spelling word in T2.

To assess a possible association between changes in internal structure (from T1 to T2) and changes in iconic strategy (from T1 to T2), these two variables were coded as total or partial changes in phonology from T1 to T2 as 1 and no change in phonology as 0. Moreover, we coded any alteration from simple to composite iconic strategies or alteration in iconic strategy as an alteration (1) and no alteration in iconic strategy as (0). We eliminated index strategies because we aim to analyze iconic strategies' functioning in the phonology system's emergence. Hence, we considered 165 items from the 200-pool (Fig. 12).

We computed a Chi-Square test (two-tailed). We did not find a statistically significant association between an alteration in phonology and an alteration in strategy, with ninety-three items (81.6%) with a total or partial change in their internal structure not having an alteration in iconic strategy and only twenty-one items (18.4%) had a total or partial change in their internal structure, showing an alteration in iconic strategy, given that strategy is essentially maintained from T1 to T2 (Fig. 12). Moreover, we found forty-two items (82.4%) without a change in their internal structure not showing an iconic alteration, and nine items (17.6%) showing a change in their iconic strategy. Thus, no association was found between alteration in phonology and alteration in strategy ($\chi^2(1) = 0.014$, $P > 0.05$).

In general, the results reveal that iconicity still plays a crucial role in the emergence and development of signs. Handling and instrument strategies are iconic strategies used to refer to things and actions. Additionally, we have observed that instrument strategy is currently used for living things and other referents.

In articulatory observations, we have noticed a reduction in iconic two-handed signs and handshape as the most frequent internal element that has changed during the last 8 years of LGSTP emergence.

It is noteworthy that as signs evolve, leading to signs wherein no phonological changes occurred or signs

ONE sign in T1

ONE sign in T2

Figure 11. Example of loan sign used to produce the ONE item in T2.

wherein total or partial phonological changes took place, we cannot find a relationship with an alteration in iconic strategy or the absence thereof. Thus, iconic strategies seem to remain stable across time and are independent of internal structure change.

5. Discussion

Studies on emerging and stabilized sign languages have pinpointed iconicity to be a resource strategy in the emergence or creation of new signs (Senghas and Coppola 2001; Liddell 2003; Cuxac and Sallandre 2007; Padden et al. 2013, 2015; Sandler et al. 2014; Mineiro et al. 2017). Sandler et al. research (2014) on the phonological emergence of a new sign language reports long-term phonological constraints on emergence and development. Here, we analyze the data from 8 years of LGSTP emergence and showcase that iconicity may motivate the emergence of sign forms throughout its early development.

In the early stages of emerging sign languages, it is possible to observe some linguistic stabilization in their development (Sandler et al. 2005; Padden et al. 2013; Mineiro et al. 2017, 2021; Abreu et al. 2022). However, these emerging sign languages still lack regular linguistic structures as they develop over time and across signers. In the first 2 years of LGSTP emergence, this language shifted from pantomime gestures to iconic proto-signs and signs disclosing the stabilization and economic nature of the language (Mineiro et
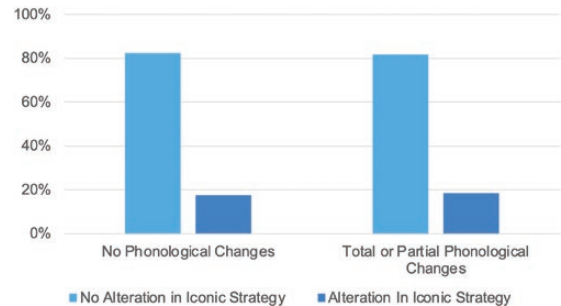

Figure 12. The frequency of occurrences of internal structure changes in iconic signs along with iconic strategy alteration between the first and second collection periods in LGSTP emergence.

al. 2021; Abreu et al. 2022). After 8 years of LGSTP emergence, iconic signs still dominate the lexicon of this sign language.

When considering all the data with the different semantic categories (things and actions), the LGSTP signers reveal that they prefer instrument and handling strategies. These results corroborate the literature on sign languages since instrument and handling are generally described as the dominant strategies used in sign languages (Padden et al. 2013, 2015; Ortega et al. 2017). Our findings and the extant literature on stabilized sign languages might stem from the fact that the literature focuses on tools/things, which are all based on lexicon related to hand-held tools (American Sign Language

(ASL), British Sign Language (BSL), New Zealand Sign Language, and from the new sign language ABSL (Padden et al. 2013, 2015), in homesign systems (on this issue, see Quam et al. 2021)). However, we have observed that, in LGSTP, the instrument strategy gains slight ground across all studied categories with LGSTP. This iconic strategy may involve more refined handshapes to represent the referent form. Therefore, the emergence of this strategy may raise internal form constraints of the signs by increasing the number of handshapes with fewer selected fingers and in different positions.

To seek the nature of iconic strategies considering the different semantic categories (in the present data: living beings, things, actions, and others) that the lexicon contains, we found an association between semantic category and iconic strategy. In both moments of LGSTP emergence, the signs related to living beings and others are predominantly object forms. The signs related to things and actions are mainly handling and object forms. LGSTP signers prefer handling forms to refer to object entities, corroborating previous observations of the new village sign language ABSL (Padden et al. 2013).

Hence, our results indicate that the iconic signs that refer to referents whose existence could be independent of the human being (e.g., trees, plants) are manually represented based on their individual properties via object strategy and not in a strategy associated with their possible relationship with the human being (handling or instrument strategies). Hence, the present data from LGSTP supports that the type of iconic strategy motivation in emerging sign forms is dependent on the semantic category of the stimulus, along with the way signers see and experience the world through their cultural and social background (Klima and Bellugi 1979; Emmorey 2014; Lepic et al. 2016; Occhino et al. 2017; Sandler 2017).

Respecting the universal economic nature of language that has been visible in the development of sign languages, whether in stabilized or emerging languages (Frishberg 1975; Senghas and Coppola 2001), LGSTP reveals a reduction in articulatory elements not only in its initial moment of emergence (Mineiro et al. 2021; Abreu et al. 2022). After 8 years, LGSTP shows a reduction in iconic two-handed signs throughout its development and the emergence of the finer-grained internal structure of signs. The second hand in emerging LGSTP seems to be iconically crucial in the two-handed signs with an asymmetrical role since it was found to represent an entity in interaction/related with the target-referent (e.g., in shell, the second hand represents the surface where the animal walks) or represents a property of the target-referent (for instance, in rooster the secondhand represent the rooster's crest).

The present data reinforce the role of the second hand, revealing that it can add, change or contextualize the dominant hand sign with which it coarticulates. This is in line with what has been previously proposed (e.g., Crasborn 2011; Lepic et al. 2016). We observe that this articulator was symmetrical with the other hand in cases where the second hand was deleted. This finding supports an economic effort pattern of human language since deleting the manual symmetrical articulator in two-handed signs is also described as a 'weak drop' in diachronic studies on established sign languages (Brentari 1999; Moita et al. 2018).

When exploring the internal structure emergence of language, we realize that LGSTP is still at an early stage since there seems to be a balance between iconic signs that have not shown a change in their internal structure, iconic signs that have undergone partial changes in their internal structures, and iconic signs that have undergone total changes. As was to be expected, over 8 years of linguistic emergence, the language elements and structures are still developing, and therefore, they need more time to stabilize. This finding supports the observation that a phonological system takes longer to be defined, as proposed by Sandler et al. (2014) concerning ABSL's internal structure emergence, where there were no phonological constraints or phonological processes in co-articulation contexts.

When considering the cases with partial phonological changes, we observe that handshapes are the phonological parameter that underwent the most changes in the analyzed iconic signs. The remaining parameters show fewer changes. These dominant changes in handshapes during the emergence of LGSTP corroborate the emergence and the stabilization processes of sign languages reported in studies on emerging and diachronic variation signs and homesigns (e.g., Israel and Sandler 2011; Sandler 2014; Moita et al. 2018). In these studies, it has been reported that handshape shows greater changes in its articulation, representation, and use in the first stages of sign language emergence and acquisition (Israel and Sandler 2011; Sandler 2014; Quam et al. 2021). Here, we observe that the handshape mainly involves the selection of the hand's fingers in the first period of emerging LGSTP. Conversely, we observed a greater refinement in handshape afforded by the selection of fewer fingers and the use of different finger positions in the second analyzed moment of LGSTP emergence. This led us to assume that the emerging handshape of LGSTP becomes more complex, involving reducing the number of fingers through a phonological substitution process of the hand configuration parameter.

When attending to the total changes in phonological/new signs cases, we identified that a restricted number of these are loan signs from other sign languages, namely

Brazilian Sign Language (LIBRAS) and Portuguese Sign Language (LGP). This probably results from easy access to the internet, wherein these languages' lexical data is recorded and accessible. The loan signs were identified in number signs and calendar signs. The lexical/morphological borrowing phenomenon from other sign languages has not yet been reported in emerging sign languages. Recalling that LGSTP emerged from a social project, 'Without Barriers Project' to promote deaf education in Sao Tome and Principe, we would expect there to be an urgent search for the lexicon to fill in the vocabulary gaps while trying to balance linguistic mastery and mastery of other areas of knowledge. Another reason might be the common oral language surrounding LGP and LIBRAS, and LGSTP: Portuguese makes the internet search easier. Although loan signs were identified occasionally, we expect to observe a greater influence of other sign languages in the data collection that will ensue.

When we analyze the iconic emergence and development of signs in tandem with the emergence and development of the internal structure of signs, we may consider that these develop independently of each other. The development of the sign's iconic form surpasses the sign's internal structure changes in tandem with the emergence of new handshapes and the substitution of other articulatory elements.

With this research, we present data from the first 8 years of LGSTP emergence, revealing that iconicity motivates the emergence of signs' forms and might influence phonological patterns observed in spoken languages (Auracher et al. 2019). Although, at this linguistic phase of LGSTP, it is impossible to identify phonological patterns, constraints, and phenomena involved. The findings do not evidence that phonological system emergence is linked with the iconic nature forms of the signs. This evidence seems to narrow the gap between the nature of the sign and spoken language, supporting that iconicity is a universal mechanism of language.

In future work, it would be interesting to analyze the iconicity of the present lexicon data with the Pyers and Senghas approach (2020) in order to observe common iconic patterns between new sign languages.

To better understand the grammatical emergence of a language, it will be important to explore to what extent iconicity can influence or determine the elements and structures at the grammatical level in the new language emergence. We will contribute by following LGSTP's emergence and assessing further developments.

Supplementary Data

Supplementary data is available at *Journal of Language Evolution Journal* online.

Ethics Statement

The studies involving human participants were reviewed and approved by the Catholic University of Portugal. The participant's legal guardian/next of kin provided written informed consent to participate in this study. Written informed consent was obtained from the individual(s) and minor(s)' legal guardian/next of kin to publish any potentially identifiable images or data in this article.

Data Availability Statement

The datasets presented in this article are not readily available because the data are with the principal investigator who has written permission to have the video corpus and analyse the data for academic purposes. Requests to access the datasets should be directed to Ana Mineiro, amineiro@ucp.pt.

END NOTES

1. Certain spoken languages, such as Japonese, have words that mimic the sound of its referent (phonomime), and words that mimic a certain physical form or motion of its referent (phenomime) (e.g. Akita 2012, 2013).

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