CHAPTER 7

The pantomime roots of Sao Tome and Principe Sign Language

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Pantomime is a unique semiotic resource for human communication despite its non-linguistic character because it allows a wide spectrum of meanings (Zlatev et al., 2020). In our view, gestures and vocalizations are interconnected from the beginning of the emergence of language in human beings (Corballis, 2014). Recent studies in a newborn language showed a boost of linguistic systematicity (Mineiro et al., 2021; Abreu et al., 2022), which included a reduction in the use of pantomime, amplitude of signs, and an increase in articulation economy within a social interaction process. We claim this process constitutes a continuum and not a cut-off system. The evolution of a newborn sign language seems to follow the same phases of psychomotor development and to be linked to efficient use of energy while enhancing cognition, allowing for the accomplishment of social communication enabled by sign language.

Keywords: pantomime, sign language, newborn language, language evolution

1. Brief notes on language genesis

Many studies on the genesis of language point to the emergence of communicative conventions as the key to the debut of language (Vieira, 1995). Żywiczyński and colleagues (2021) suggest that the first communication system was sign-based, based on bodily mimesis as a cognitive mechanism and primary iconicity as a semiotic principle (Zlatev et al., 2020). Motivated signs can be iconic, easily interpretable outside the discursive context, and comprehensible when they occur in isolation (for example, the iconic sign formed by the hand grabbing a glass and bringing it to the mouth to express DRINK).

Bodily mimesis engenders non-linguistic communication by using the body as a tool for intentionally transferring referential-propositional information. It

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employs motivated signs to establish a connection between their non-pre-established meaning and their expressions (Żywiczyński et al., 2021; Zlatev et al., this volume). Bodily mimesis fits with the Mirror Neuron Hypothesis (Arbib, 2012; Rizzolatti & Arbib, 1998; Arbib, this volume), which argues that the roots of speech are integrated into a unique communicative system composed of sounds, facial expressions, and manual gestures. Arbib's evolutionary scenario (2012) includes: mirror system > simple imitation > complex imitation > pantomime > proto-sign and proto-speech > language-ready brain. This scenario was observed in the emergence of the Sao Tome and Principe Sign Language (LGSTP), in which pantomimic gestures were produced to communicate in the absence of speech, resourcing bodily mimesis for communication. As the acts of communication become frequent, LGSTP reveals restrictions on using body and spatial parts, culminating later in structural patterns with linguistic specificities (the language-ready brain). The data that we describe in this chapter supports pantomimic scenarios of language origin (Arbib, this volume) by showing that pantomime is an effective means of bootstrapping the new language.

However, Sandler (2013) has identified "kinks" within this chain, possibly disrupting Arbib's scenario. One argument is that each modality (sign and speech) relies on a different articulatory motor system. This is true from an exclusively linguistic perspective regarding input and output modality. Nevertheless, as neurolinguistic studies have overwhelmingly shown (Bellugi et al., 1988; Emmorey et al., 2007), language in the broad sense, which comprises both vocal and manual modalities, is processed in the same left-sided sections of the neocortex. In addition, recovery symptoms of brain damage support a "motor-gestural history of speech and language evolution" (e.g., Code, 2021). Furthermore, it is observed that deaf infants exhibit early vocal and manual babbling as also hearing babies exposed to sign language produce manual babbling along with vocal babbling, revealing that the babbling phenomenon, which is the babies' first step toward building a developed linguistic system during language acquisition, is amodal (Petitto et al., 2004; Petitto & Marentette, 1991). Regarding this evidence, it makes sense that both modality systems (manual and vocal) co-evolved together and seem coordinated in our species (Mineiro, 2020; Mineiro et al., 2021).

Another of Sandler's (2013) arguments points to the basic distinction between pantomime and symbolic signs, as it suggests that sign language has an abundance of iconically motivated signs, which can lead to the false supposition that they are conventionalized pantomime. Based on an analysis of the Al-Sayyid Bedouin Sign Language (ABSL), Sandler (2012, 2013) defines pantomime as a different non-linguistic form of expression that reenacts an event by recruiting body parts imitating certain body actions and which can go along with symbolic

signs. Representation of an action or an object of any other kind using body parts is defined as symbolic signs, distinguished by symbolically representing a meaning without reenacting it. Sandler proposes that this symbolic representation moves away from the iconic and mimetic nature of the new gestures. It is essential to notice that Sandler's (2013) distinction between pantomimic gestures and symbolic signs follows the observation that in ABSL, these symbolic signs occurred mainly in storytelling without the involvement of other body parts. However, as we will see in the analyzed data of LGSTP, the involvement of body parts other than the hand in gesture elicitations and conversation context was observed, revealing the linguistic nature of the body parts as elements in the first phases of this language emergence.

Sandler's argument follows from the distinctive definition of pantomime. Following gestural theories of language evolution (Arbib, 2012; Perniss & Vigliocco, 2014; Żywiczyński et al., 2018; Sibierska et al., 2022), pantomime is defined as iconic gesturing where there is no speech or no established sign language, although it can be accompanied by non-linguistic vocalization (Zlatev et al., 2017; Brown, this volume) that engages whole-body or body parts alone and can depict both objects and actions. In this context, pantomime occurs for communicative purposes, referring to entities that are and are not present in time (Gärdenfors, 2021, 2022). However, it is essential to recognize that both perspectives consider pantomimic gestures as non-linguistic signs (Arbib, this volume; Gärdenfors, this volume; Zlatev, this volume).

The beginning of human language may have been triggered by the necessity to communicate cooperatively via pantomimic gestures and non-pantomimic manual gestures (Tomasello, 2008) or by the neurocognitive adaptation to tool production and handling (e.g., Osiurak et al., 2021). This communication phenomenon can evolve into bodily mimesis with language communication functions (Wacewicz & Żywiczyński, this volume). When there is no settled language in common, even in modern humans, bodily mimesis and its core component – pantomime – are used. In this sense, we might consider pantomime the original system from which language developed and which is still used by modern humans as a communicative resource when no linguistic system is available (Żywiczyński et al., 2018; Mineiro et al., 2021). In this sense, there is evidence to assume that when there is no common language, modern humans communicate via bodily mimesis and use pantomime:

a. in language loss or impairment, humans rely on pantomime to communicate (Code, 2021; Göksun et al., 2015);
b. when there is no language in common (signed or vocal), humans communicate via pantomime;
c. pantomime gestures are used in the first stage of sign language emergence (Mineiro et al., 2021).

In order to contribute to the discussion of language evolution scenarios and consider pantomime as a communication system up until language emergence in modern humans, we gather some findings from our research on emergent LGSTP. In the first stage of LGSTP emergence, we found a pantomimic stage that arose before the emergence of linguistic complexity. These findings were not present in Sandler's research (2013), which found that the first generation of ABSL signers use only the hands to convey words, with the rest of the body uninvolved linguistically, and only occasionally use whole-body pantomimic expressions (for dramatic purposes).

Tracing language evolution from pantomimic gestures to conventional language supporting the existing pantomimic scenarios of language origins, the next section will summarize the route of a newborn language from pantomime to proto-signs.[1] We will detail the roots and aspects of language emergence in LGSTP, using the key-findings from five recent studies (Abreu et al., this volume; Mineiro, 2022; Mineiro et al., 2017, 2021; Moita et al., 2023).

2. Background information on the LGSTP studies

Sao Tome and Principe (STP) are volcanic islands located in equatorial Africa, off the northwest coast of Gabon. The socio-economic development is relatively low; STP is currently considered an "underdeveloped" or non-industrialized country. The official language is Portuguese, though inhabitants also use diverse island creoles. In this country, around 5000 people (or roughly 3% of the population) have been identified as deaf or hard of hearing and the causes of hearing loss were studied by Caroça (2017).

Due to social deprivation and a lack of communication opportunities, deaf children in STP have been excluded from schooling. The project Sem Barreiras, involving local governmental structures such as the Education and Cultural Min-

1. As proto signs, we understand the first gestures that exhibit preferences for manual configurations, movements, locations and other non-manual elements to represent specific semantic features of the referent.

ister of Sao Tome e Principe, was thus undertaken to promote the emergence of a sign language among the deaf people and to provide the deaf community with a language to access education.

This project aimed at creating a community by bringing deeply isolated people together through everyday linguistic immersion. It began in February 2013 and finished in February 2015, gathering deaf and hard-of-hearing people from all regions of the islands of STP in a shared space. Their names were listed from otolaryngology missions in STP, and also from intensive television and radio advertising campaigns.

2.1 Participants

From February 2013 until February 2015, approximately 100 individuals were enrolled in the project. The deaf participants were aged 4 to 25; 80% were female, and 20% were male. All participants enrolled in the project were deaf or hard-of-hearing children and young adults with hearing loss ranging from severe to profound. These descriptions were based on information obtained through interviews with the participants' families. Recruitment was implemented with ethical authorization, and all the families of the deaf underage participants and deaf adult participants signed informed consent forms to be enrolled in the project. The project transported them to a previously-defined common space where the participants would meet.

2.2 Procedures

Respect for cultural differences led the team leader not to use Portuguese Sign Language (LGP) signs. Instead, gestures, mimes, and other visual representations were used to communicate with participants while potential signs were identified and evaluated. Thus, the political choice of not "teaching LGP" was adopted and the goal was to support the emergence of a natural language.

Along with the various activities that promoted communication between deaf participants, the deaf researchers of our team elicited signs through cards with drawings or pictures of simple objects (animals, everyday items) in different phases of the project. The cards were drawn by local artists so that the participants could easily identify the cultural traits and that the drawing would help recognition of the items presented. As the deaf researcher showed the cards, the participants produced pantomimic gestures That gradually evolved into new iconic signs with manual patterns that may exhibit initial linguistic features.

As time went by, the task became more complex, and instead of simple objects, the researcher showed cards with drawings of more complex and abstract

referents (concepts, emotions) and also short stories reproduced in drawings that the participants could sign to each other. This was to promote more extensive utterances and begins dialogues outside the classroom. For communication to flow in a less formal context between the deaf participants, the deaf researcher announced weekend programs, tours, meals, and trips to the beach and the market, so the participants would get used to meeting each other, creating signs naturally and communicating with each other in this modality. As a result of these sessions, the deaf people of STP bootstrapped their language.

The sessions were all video-recorded, totaling about 400 videos of about 60 minutes each. The corpus collected was partially annotated with ELAN and served five different studies.

In the first three studies presented here (Abreu et al., 2022; Mineiro, in press; Mineiro et al., 2021), we divided the corpus into four phases according to the characteristics of the gestures and their evolution across time.

Phase 1: February 2013 to July 2013;
Phase 2: September 2013 to February 2014;
Phase 3: March 2014 to July 2014;
Phase 4: September 2014 to February 2015.

3. From pantomime to proto and early sign

In observing an emerging sign language, it was possible to analyze the trajectory of the emergence of the new linguistic elements and structures, revealing a continuum route from pantomime > proto-signs > early signs in a new sign language, the LGSTP.

In general, in the first phases of LGSTP emergence, communicative acts were grounded in gestures involving whole body parts or body elements from a participant perspective, employing an enacting mode of representation. These gestures mirror the definition of pantomimic gestures (Zlatev et al., 2017, this volume; Brown, this volume). Over time, the pantomimic gestures lost non-manual articulators and decreased in mimetic features turning into the first phonological structures of early signs. The new syntactic and morphological patterns and the emergence of articulation were routed.

3.1 From pantomime to early signs

To discover the emergence of lexical items in LGSTP, we observed 1000 produced items (pantomimic gestures and signs) over the four stages of data collection of LGSTP (Mineiro et al., 2021). From these produced items, only 759 of these were conventionalised signs (signs and classifiers), occurring systematically in the LGSTP corpus. These signs show trends of emergent phonology and morphology and combinatory and recursive characteristics revealed in the produced sentences, displaying iconicity in their formation (Mineiro et al., 2017).

In the early phase (phase 1) of our data collection, the data consisted of 70.1% pantomimic gestures and 29.9% signs and classifiers. In the intermediate phase (phase 2), pantomimic gestures comprised 62.7 % of the data, and 37.3% comprised early signs and classifiers. In the pre-final phase (phase 3), we found that 32.2% of the data consisted of pantomimic gestures and 67,8% consisted of early signs and classifiers, which turned into 24.1% of pantomimic gestures, and 75,9% for early signs and classifiers in the final phase (phase 4). Overall, over two years of data collection, the proportion of pantomime decreased, and signs and classifiers increased, as the following two graphs show (Figure 1).

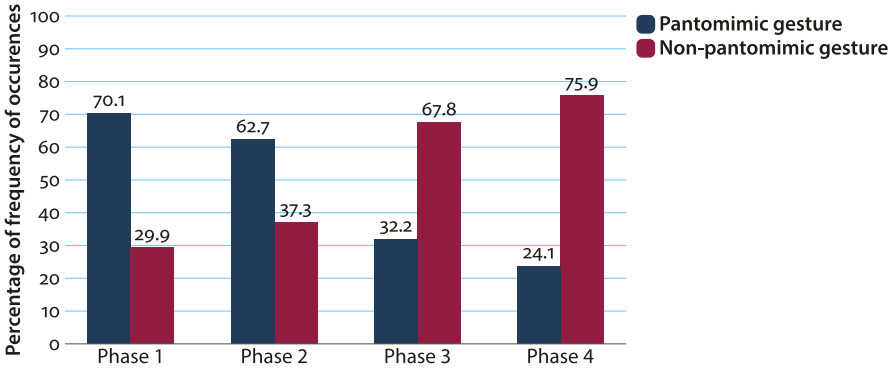


Figure 1. The evolution of LGSTP

In order to verify possible differences in the prevalence of pantomimic gestures between each pair of the phases analyzed, we applied the Mcnemar test (Table 1), which revealed significant differences (p-value<0.001) in the number of pantomime gesture occurrences between all phases. From phase 1 to phase 2, there was a 7.4% reduction in the occurrence of pantomimic gestures. Compared to the drop in occurrence between phases 2 and 3, pantomimic gesture occurrence dropped by 30.5%, and from phase 3 to phase 4 fell by 8.1%. Overall, pantomime decreased significantly along the 4 phases, and over the two years of linguistic immersion, the incidence of pantomime almost disappeared while signs emerged.

Table 1. Comparison of phase pairs based on the number of occurrences of pantomimic gestures and signs or classifiers in the 1 000 items analyzed, using the McNemar Test

	Phase 1 vs. Phase 2	Phase 2 vs. Phase 3	Phase 3 vs. Phase 4
Nb of pantomimic gestures that occurred in both phases	701 (70.1%)	627 (62.7%)	322 (32.2%)
Nb of signs or classifiers that occurred in both phases	299 (29.9%)	373 (37.3 %)	678 (67.8%)
Nb of pantomimic gestures that became signs or classifiers from one phase to the next	74 (7.4%)	305 (30.5%)	81 (8.1%)
Total Nb of items	1000	1000	1000
Test McNemar	$p < 0.001$	$p < 0.001$	$p < 0.001$

Over time, particularly in phases 2 and 3, there is a process of change in the way gestures are performed and in the body articulators they recruit.

3.1.1 *What did the evolution from pantomime to signs look like?*

In general, we noted that along the four phases of LGSTP emergence, the signing spaces become smaller, and the production of LGSTP gestures involves less and less effort (Mineiro et al., 2021).

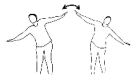
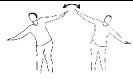
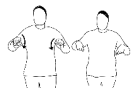
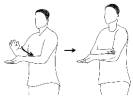
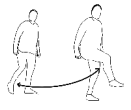
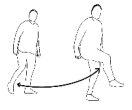
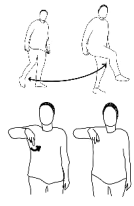
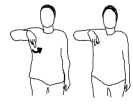
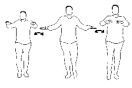
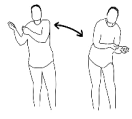
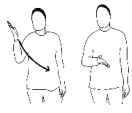
In particular, there was a loss of non-manual articulators (such as *trunk* and *legs* (as shown in the examples in Table 2) and a decrease in two-handed gestures. There was a demand for comfort in the production and articulation economy. This kind of path – in terms of a growing economy of articulation – occurred in almost all of the 1 000 items analyzed.

As we can see, a continuum exists between pantomime and proto-signs in a new sign language. It is a simple matter of time how the communicative system absorbs the rules and begins systematically recombining fractionation processes (Arbib, 2022) to seed the first set of conventional and combinatorial signs.

During phase 3 (Table 2), we saw the emergence of proto-signs which then consolidated themselves as first signs six months later (phase 4). Recently, these signs were analyzed and compared with more recent LGSTP data (Moita et al., 2023), which also contributes to the view that pantomimic gestures evolve into proto-signs and then into signs.

Since the pantomimic gesture evolves and gains constraints, such as space and movement change, how do bodily movements change from pantomimic gestures to proto-signs and early signs?

Table 2. Examples of LGSTP gestures and signs across 4 phases (Mineiro et al., 2021)

	Phase 1	Phase 2	Phase 3	Phase 4
AIRPLANE				
BICYCLE				
FISH				
GOAT				
FOOTBALL				
TO SWIM				
TO BEAT				

3.2 Evolution of movement and articulatory properties

Pantomime can be described as a whole-body process that engages body parts to represent objects and actions (Żywiczyński et al., 2018). When engaging the body, pantomime involves movement and body articulators. Throughout the development of the new sign language, we investigated how movement and body articulators – beyond hands – evolved in LGSTP (Żywiczyński et al., 2021; Abreu et al., 2022).

For this purpose, we focused on the first 100 sketch cards of the original 280 sketch cards (examples in Table 3) presented to the participants over the two-year project timeline. We analyzed the video-recordings registered during the implementation of the project and systematically observed how the gestures produced for the 100 cards evolved across four phases with regard to (i) signing space, (ii) body movement, and (iii) the involvement of hands and other body articulators. This resulted in 100 analyzable signs and gestures based on the highest frequency in the corpus per phase.

In this chapter, we will only report the body movement and involvement of the other body articulators as the main results found (for an in-depth analysis of all the phenomena of gestural evolution analyzed, see (Abreu et al., 2022)).

3.2.1 *Body movement*

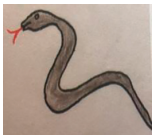
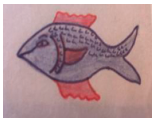
As has already been described, as the pantomimic gesture evolves and gains systematic patterns, it decreases the gesturing space. Consequently, it changes the way the movement is performed. Thus, when investigating the approximation to more abstract forms of communication with the appropriation of a new sign language, the type of bodily movements seen in a group can be very informative.

Analyzing the major movements performed in the four phases, in Figure 2, we observe a substantial decrease in the frequency of gestures of the "arched oblique" type and the "oblique in circle" type throughout the four phases of the project. In the same set of analyzed data, the prevalence of linear movements increased slightly.

Observing the prevalence of different minor movements over the specific phases (Figure 3), we found that minor movements also decreased across time, except for the hook-type movement that increased steadily across the phases.

In this study, we could not conclude that the transition from major movements to minor ones showed efficient signing in terms of articulatory economy. However, the number of gestures generally decreased. We could not conclude that the transition from major movements to minor ones showed efficient signing in the articulatory economy. It can be argued that the decrease in gestures needed to represent the same sketches itself indicates a reduction in articulatory effort.

Table 3. Examples of sketch cards used to elicit LGSTP gestures or signs (in Abreu et al., 2022)

Sketch cards	Meaning
	snake
	time
	butterfly
	fish
	sadness

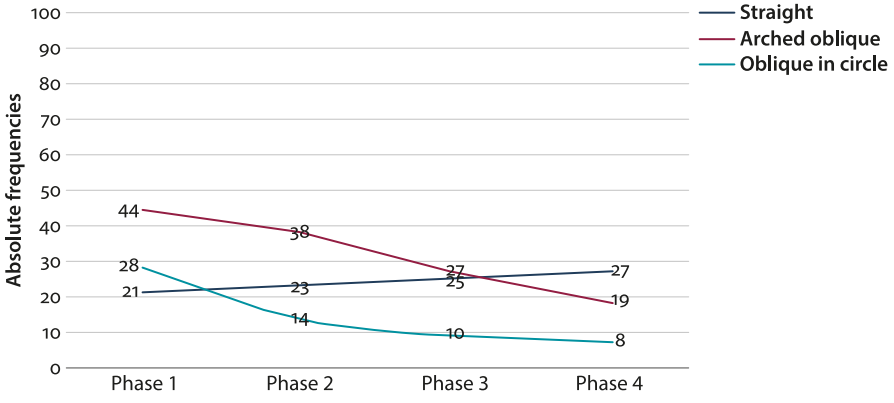


Figure 2. Variation of the prevalence of major movements across the four phases of the project

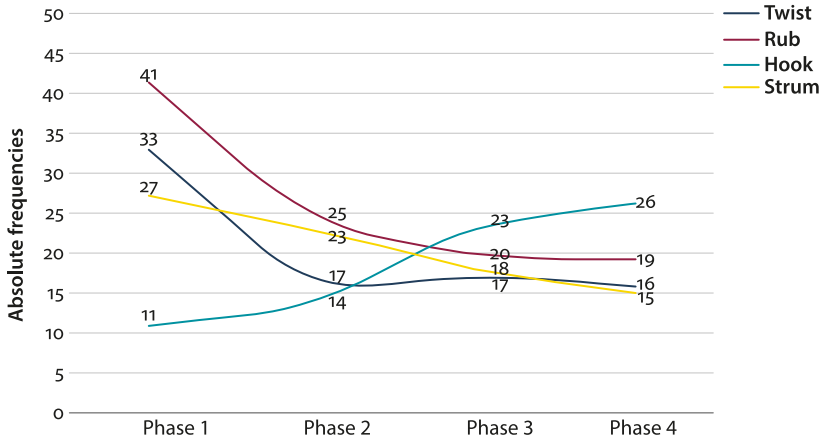


Figure 3. Variation of the prevalence of minor movements across the four phases of the project

3.2.2 *The involvement of body articulators (non-manual articulators)*

From our observations, it seems that the 100 sketches selected elicited pantomime gestures in phases 1 and 2. However, in phases 3 (a year and a half from the beginning of the project) and 4 (two years after the beginning), there was a transition from using the whole body to using restricted, conventional and combinatorial signs.

Analyzing the bimanual involvement and non-manual involvement in the gestures and signs produced across the four phases of the project (Figure 4), we see a decrease in bimanual gesturing.

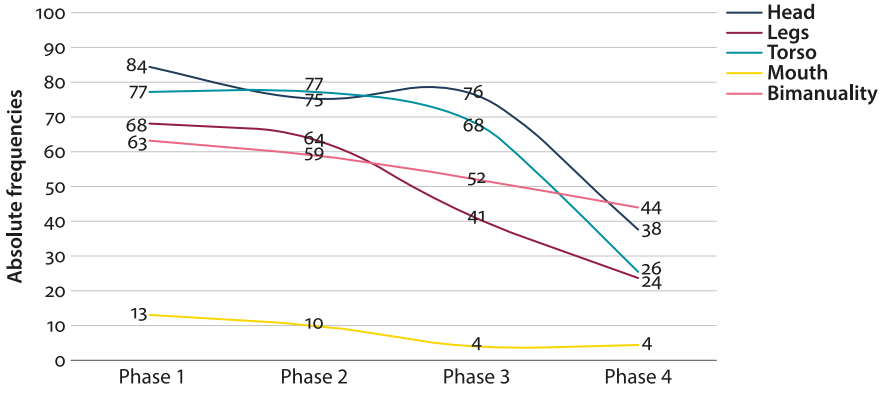


Figure 4. Variation of the prevalence of bimanual and non-manual gestures across four project phases

Overall, bimanual gesturing decreased across time; however, the steepest decreases were observed in non-manual areas of the body, such as the legs, torso, and head, indicating a transition from pantomime to proto-sign and early sign. A slight decrease also occurred in the frequency of mouth use over time. Together, the data shows that the number of manual and non-manual gestures decreases with time, indicating that gestures become more efficient and physically economical.

We hold that there is a strong iconic motivation in creating signs from pantomime (Zlatev et al., this volume). To explore the iconic motivation of emergent signs and their evolution, we explore the role of iconicity in LGSTP evolution.

3.3 The role of iconicity in the emerging phonological system

The visual nature of gestures results in large networks and connections between form and meaning (Perniss et al., 2010). The most recent sign languages, especially the emerging ones, establish their gestures' genesis through metonymy or synecdoche, which testifies to their iconic nature (e.g., Mineiro, 2016; Sandler, 2009).

Iconicity and arbitrariness co-exist in some signed linguistic forms (Gasser, 2004). For instance, iconic signs have phonological features in established sign languages (e.g., Brentari, 2019; Cuxac & Sallandre, 2007; Kooij & van der Kooij, 2002)

In newer sign languages, we see a strong iconic motivation in creating signs from pantomime (Zlatev et al., this volume). New signers use their whole-body, parts of the body, facial expressions, and first-person perspective to enact and express concepts (e.g., instrumentality and humanness) (Mineiro et al., 2021; Senghas & Coppola, 2001).

In order to explore how iconicity might influence the emergence of a phonological system during the evolution of an emerging sign language, we analysed the iconicity and phonological structure of 200 signs collected in two distinct moments of the LGSTP emergence: at T1 (phase 4 (end of 2014)) and at T2 (8 years later (2021)). It is important to remember that in phase 4 (T1), the signs present some systematic patterns (Mineiro et al., 2021), which suggests they should be classified as proto-signs and early signs.

3.3.1 *Iconic signs in the evolution of a new sign language*

To analyse the iconicity of the signs, we coded all the collected signs of T1 and T2 according to their iconic strategy ground: handling strategy (gestures/ signs represent human handling the referent), instrument strategy (gesture/ sign represents how the referent is used) and object strategy (gesture/ sign does not represent the referent but its shape, properties, or movement). In doing so, we followed Padden's research (Padden et al., 2013, 2015), which analyzes iconicity patterns of lexicon regarding body involvement in sign articulation – *handling*, *instrument*,

and *object*. In addition, we identified the signs that were not iconic. 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.

In both moments, we observed the dominance of iconic signs: 194 signs (97%) were iconic in the first moment (T1) and 174 signs (87%) were still iconic in the second moment (T2) (Table 4). To investigate a putative association between the two moments of elicitation (T1 and T2) and iconicity, we performed a Chi-Square test (two-tailed) on 200 items selected from the total item pool. We found an association between iconicity and the elicitation phase ($X^2_{(1)} = 13.587$, $p < 0.001$), observing a decrease in the number of iconic signs from T1 to T2.

Table 4. Iconic and non-iconic signs in the two moments of lexical elicitation in LGSTP emergence (in Moita et al., 2023)

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

3.3.2 *Internal structure emergence in iconic signs in the evolution of a new sign language*

Regarding the internal structure of LGSTP emerging iconic signs in the two moments, we identified the manual articulators and the internal structure of signs based on sign language phonological parameters – handshapes, location, movement, palm orientation, and non-manual expression (Klima & Bellugi, 1979; Stokoe, 1980; Wilbur, 2000). We then coded (i) the signs that in T2 underwent a total change in their internal structure; and (ii) the gestures and signs that underwent a partial change in the internal structure – excluding the index signs. The analysis of the internal structure of iconic signs was based on identifying the manual articulators and the internal structure of signs (handshapes, location, movement, palm orientation, and non-manual expression).

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 5).

Analyzing the partial change cases, we observe that handshape is the internal element that underwent the most changes, changing in 77% of the iconic signs

Table 5. 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%

and, together with location, in 5% of the iconic signs. The other internal elements' changes were residual (for an in-depth analysis, see Moita and colleagues (2023)).

In addition, we assessed a possible association between changes in internal structure (from T1 to T2) and changes in iconic strategy (from T1 to T2). The iconic signs 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 iconic composite strategies (with one iconic strategy to two iconic strategies) or alteration in iconic strategy (1) and no alteration in iconic strategy as (0). We eliminated missing values and index strategies because we aimed to focus only on iconic strategies in the emergence of language. Hence, we considered 165 items from the 200-item pool. In addition, we performed a Chi-Square test (two-tailed).

In this analysis, we did not find a statistically significant association between an alteration in phonology and an alteration in strategy, with 93 items (81.6%) with a total or partial change in their internal structure not having an alteration in iconic strategy and only 21 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 (Figure 12). Moreover, we found 42 items (82.4%) without a change in their internal structure, not 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 ($X2(1) = 0.014$, $p > 0.05$).

This study made us 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. Thus, iconic strategies remain stable across time and are independent of the internal structure change. In addition, regarding the internal structural changes, we observed that handshape is the phonological parameter that has undergone the most changes in the iconic signs analyzed (Moita et al., 2023), as reported in conventionalization and emerging processes of other sign languages (Israel & Sandler, 2011; Moita et al., 2018; Sandler, 2014).

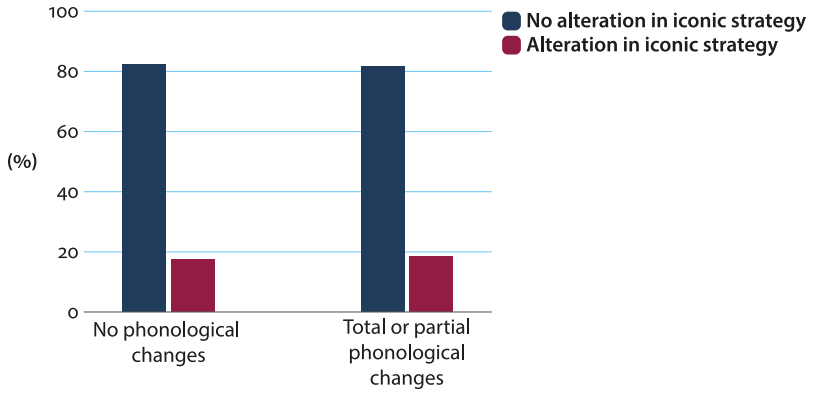


Figure 5. Internal structures change in iconic signs along with iconic strategy alteration between the first and second collection moments in LGSTP emergence

After eight years, the linguistic elements and structures of LGSTP are still developing. This finding supports the observation that a phonological system takes longer to be defined, as proposed by Sandler and colleagues (2014; 2017) concerning ABSL's internal structure emergence, where there were no phonological constraints or phonological processes in co-articulation contexts. Thus, we may conclude that we are still witnessing the linguistic emergence of LGSTP, which is still in the phase of evolution from proto-signs to early signs.

In addition to pantomimic gestures' evolution to proto-signs and early signs and their iconic motivation, the emergence of the basic order of the utterances may also indicate the first conventionalizations of word order structures.

3.4 The evolution of basic order

Research on language evolution has also focused on the issue of natural word order, that is, word order in the phylogenetic and cognitive sense (Gell-Mann & Ruhlen, 2011; Pagel, 2009). Sign language and gesture studies have inspired this discussion in the literature, with particular emphasis on the influence of language on our "linguistic" behavior concerning basic word order (Goldin-Meadow et al., 2008). The starting hypothesis was that if a structural pattern of basic word order for speaking were used in the native language, the production of the same message via non-verbal cues (by gestures) would reflect the same pattern found in the spoken language. Goldin-Meadow and colleagues (2008) found the SVO order for intransitive events much more often than any other order while finding the SOV order for transitive actions when analyzing utterances with intransitive and transitive verbs. The results of this study also revealed that participants tended to produce SVO and SOV word order regardless of the syntax of their native language.

Following this study, new evidence emerged from the work of Gibson and colleagues (2013), who used a new paradigm to investigate word order by using verbs with non-reversible argumental structure (for example, *the man kicks the ball*; **the ball kicks the man*) and reversible argumental structure (for example, *the woman hugs the man*; *the man hugs the woman*). The results from this study indicated that when participants had to pantomime events with irreversible argumental structure, they preferred the SOV word order. However, when participants had to do pantomime events with reversible argumental structure, SOV preference disappeared, giving rise to the SVO word order. Thus, the basic word order preferences were independent of the native language. These data suggest that we communicate events with reversible argumental structure using the SVO order to ensure the message is easily decoded.

A hypothesis is raised in the literature that SOV is the standard word order in events with irreversible argumental structure at an early stage of linguistic communication, which later evolves into the SVO order in events with reversible argumental structure. To address this hypothesis, we explored whether or not there was a dominant basic word order in the linguistic emergence of LGSTP in events with reversible and irreversible argumental structures. For this purpose, we compared ten utterances from phase 1 (a phase previously described as pantomimic) with ten utterances from phase 4 (a phase previously described as one of the proto and early signs) (Mineiro et al., 2021; Abreu et al., 2022). The 20 utterances from each phase were transcribed in gloss[2] (Tables 6 and 7).

Table 6. The 20 LGSTP utterances analyzed from phase 1

Utterances LGSTP from Phase 1	
Utterances with reversible argumental structures	**Utterances with non-reversible argumental structures**
BREAD MOTHER GIVES BOY	FISH I SELL
MOTHER GIVE SISTER BOX	TREE I CLLMB
DOG HOG BIT	BANANA EAT I
EMBRACE MOTHER ME	DEAF SCHOOL I LIKE
FRIEND BRAIDS ME	DISHES I WASH
RABBIT RUNS BOAR	HAVE FRIENDS FEW
GIFT GRANDMOTHER GAVE ME	LIKE CAJAMANGA
MARILIA LIKES RICARDO	COOK MOTHER (WITH) PALM OIL
GRANDMOTHER HUGGED BROTHER	BATH I (TAKE) RIVER
MOTHER LOOKED (AT) ME	DRAWING (I) LIKE (IN) SCHOOL

2. Gloss annotation is an annotation method that represents and describes sequences of gestural/ signed sequences based on oral language words.

Table 7. The 20 LGSTP utterances analyzed from phase 4

Utterances LGSTP from Phase 4	
Utterances with reversible argumental structures	**Utterances with non-reversible argumental structures**
TOMÉ DOG PLAYS	TOMÉ GLASSES HAS
CANDY (GAVE) DOCTOR NEIGHBOR	KEY I LOST
GOAT FIGHTED PIG	NEIGHBOR ATE BREAD FRUIT
CRAB BEACH PLAYS EDGAR	RUBBER ERASE DRAWING
CAT PLAYS DOG	NAME I WRITE
SHE PULLS BRAIDES MARIBEL	SERPENT ATTACK BROTHER
FRIEND CELSO KICKED	DAD MONEY SPEND DRINK
PARROT SPEAKS FATHER	SAFU TASTE SWEET
AMARILDO JULIETA GAVE SNACK	GRANDMA PURCHASED SALT BAG
AMARILDO KISS JULIET	HOT PAN BURNED MOTHER

The results indicated that, in the first phase, the LGSTP is taking shape and communication emerges from pantomime. There is some degree of freedom in the order of gestures in the utterance; however, there was a trend towards the use of the SVO order (60%) for events with reversible argumental structure, and towards the use of the OSV order (60%) in events with non-reversible argumental structure. Other orders coexisted, such as the VSO order in reversible events and OVS in irreversible events (Table 8).

Table 8. The number of occurrences and percentage of word order in 20 utterances from LGSTP during phase 1

	SVO	**OSV**	**VSO**	**OVS**
Events with reversible argumental structure	6 (60%)	3 (30%)	1 (10%)	0 (0%)
Events with non-reversible argumental structure	2 (20%)	6 (60%)	1 (10%)	1 (10%)

In the last phase of data collection (phase 4), in which pantomimic gestures decreased and gave way to signs that, although iconic, were not pantomimic, the data showed that the occurrence of the less frequent orders seemed to decrease, leaving room for the predominant use of the SVO order both in reversible events (50% of occurrences) and in the irreversible events (80% of occurrences) (Table 9).

As indicated above, we had initially hypothesized that, in an initial pantomimic communication phase, the order for events with a non-reversible argu-

Table 9. The number of occurrences and percentage of word order in 20 utterances from LGSTP during phase 4

	SOV	SVO	OSV
Events with reversible argumental structure	2 (20%)	5 (50%)	3 (30%)
Events with non-reversible argumental structure	0 (0%)	8 (80%)	2 (20%)

mental structure would be the SOV order and that, in the case of events with a reversible argumental structure, the order would be SVO. However, we found that the SOV order only appeared in the last phase (phase 4) for events with reversible argumental structure, not occurring in our corpus in the first phase (phase 1) for either type of event. Therefore, we may conclude that SOV order seems to be recurrent in emerging sign language, as our data suggest.

In phase 1, there was a trend towards using the SVO order (60%) in events with reversible argumental structure. The overall percentage of SVO order occurrences decreased in phase 4 to 50%, but still retained predominance over the other orders. This trend is described in the literature and is confirmed in the data collected, possibly indicating a natural order in our case.

In the case of events with a non-reversible argumental structure, phase 1 showed predominant use of the OSV order (60%); however, the percentage of OSV order use dropped to 20% by phase 4, with the SVO order taking precedence (80%) in this phase. The word order observed does not seem to agree with previous studies; future work based on a higher number of data points is needed to deepen our understanding of the predominant word orders which occur during the evolution of emerging sign languages.

3.5 The emergence of linguistic complexity

Linguistic complexity in LGSTP began to grow when the deaf signers started to name objects, feelings, and actions together, negotiating the best proto-sign for representing the referent shown in the cards (Carmo et al., 2014; Mineiro et al., 2021). If the first expression of their communication was pantomimic, gradually but quickly, the pantomimic component decreased, making space for repeatedly-used signs with high lexical frequency to name the referents. Linguistic structure arose within two years with some main trends, namely phonological characteristics – still visible after eight years of language emergence – an emergent morphology and word order.

3.5.1 *The articulatory and phonological characteristics of emerging signs*

The proto-signs in LGSTP follow the same phonological parameters of manual handshape, orientation, finger selection, movement, location, and the use of manual articulators – with either the dominant hand or both hands – like in the signs of other sign languages. No handshape and no location were observed to be particularly prevalent, and many signs were performed with both hands as articulators.

During the evolution of LGSTP, the location was articulated with no limited area; the signs could be performed anywhere in the space area around the signer's body, and some of the signs were anchored to certain body parts, such as the legs, stomach, and above the head. Then, as studies 1 and 2 demonstrated, the whole-body commitment dropped off, and a more economical, two-handed linguistic system emerged.

Numerous facial expressions are also visible in many of the signs collected and might become a parameter of distinguishing phonological features. This may be because, in the early stages of emergence, some concepts that had no sign were expressed by pantomime; for example, the concept ASK was articulated through the facial expression of wondering, similarly to what has been reported in the Israeli Sign Language (Meir et al., 2010).

The first productions also demonstrated a substantial articulatory involvement of other body elements, such as arms, shoulders, back, legs, stomach, and face (Mineiro et al., 2021; Moita et al., 2023). This pattern was similarly found in the first stages of ISL emergence (Meir & Sandler, 2008). For example, the word football was articulated through the leg movement of KICKING A BALL.

3.5.2 *Trends in emergent morphology*

At the level at which the first signs (proto-signs) appear, we lack any evidence; thus, we hypothesize that there might exist a tendency for certain types of compounding, as in the case of BANANA TREE = TREE + BANANA or GIRL = WOMAN + CHILD. In emerging sign languages, such as ABSL, compounding has been reported as prevailing over the derivational process (Aronoff et al., 2003), which also seems to be the case of LGSTP.

There were no compound signs in the sample analyzed in the first 30 videos representing the early data collection stage. In the second stage, we observed 21 compound signs in different contexts, for example: FRUITS (CAJAMANGA = CANJAMANGA + EAT); HUMANS (BOY = MAN + CHILD); and NATURE (SUNRISE = SUN + BORN). These compounds consistently appear in our corpus. In the final stage of data collection, more compounds were found regarding house divisions such as BEDROOM = ROOM + SLEEP, LIVING ROOM = ROOM + SEAT, KITCHEN = ROOM + PAN, and BATHROOM = ROOM + WASH. The total of compounds found at this final stage was 37.

Inflectional morphology in LGSTP is still nonexistent, no different than in other emergent sign languages (Meir et al., 2010), which is not surprising given that it is still a fundamental and developing language.

Nevertheless, we detected a systematic use of personal pronouns as subject and object within phrases. Interestingly, the LGSTP signers do not make any distinction in the videos analyzed between the pronouns I or WE in the position of subject or object. For example, in sentences like WE LIKE BEACH AND TEACHER LIKE US, the pronoun WE and US are signed similarly. This is also the case for the other personal pronouns.

The use of personal pronouns is one of the first steps in language acquisition in deaf children, which they acquire very early (Carmo et al., 2014). Thus, we can compare this initial use of pronouns with the first stages of sign language acquisition in deaf children from other sign languages. Another interesting finding is that the personal pronouns in LGSTP have a baseline of pointing just like in other sign languages (Petitto, 1987).

4. Signs do not emerge ex-nihilo

Signs or words do not emerge ex-nihilo. Within the studies on the origins of language, three main streams of thought regarding the role of gestures and other visually perceived body movements (Corballis, 2003; Tomasello, 2008; Zlatev, 2008) in the emergence of speech can be delineated: the gesture-first (Corballis, 2009; Hewes et al., 1973; Arbib, 2012, this volume), the multimodal, or equal partners, hypotheses (Kendon, 2004; McNeill 2012) and mimesis theory (Zlatev et al., this volume). If we consider Corballis' and Kendon's points of view, they differ only in the evolutionary timing and manner in which gesture was incorporated into language (Corballis, 2014).

We will agree with the statement that gestures and vocalizations are intertwined from the beginning of language emergence in human beings. This point of view is supported by the following evidence: both modalities of language, oral and visuospatial, are closely linked; in sign language, language involves not only manual articulation but also some vocalizations and movements of the face and hands, while spoken language is predominantly accompanied by manual co-speech gestures (Kendon, 1980; McNeill, 1992). Gesture research suggests that speech and gesture have the same underlying conceptual system (Kendon, 2004). In terms of human evolution, it makes sense that those systems (manual and vocal) co-evolved together and are intertwined with each other.

The five studies presented in the previous section led us to the following conclusions: signing in the absence of speech begins in pantomimic gestures

to communicate, and the first resource for communication in the absence of a structured linguistic system is bodily mimesis through pantomime.

The analysis of the evolution from pantomime to early signs showed how a community communicated through pantomime before having a structured linguistic system. This communication lasted for two years and was substantially reduced after one year when agreed-upon proto-signs began to appear in the community, solving the communication needs more economically in terms of articulation and time efficiency. There is no disruption between pantomime and proto-signs, and they fell onto a continuum during the emergence of the language (Table 2).

The analysis of the evolution of the movement and the articulatory properties showed us how the range of gestures, as well as the use of the hands, face, and body parts required by pantomime are reduced over time on account of neural efficiency. Regarding communication, when a more structured linguistic system appears, pantomime begins to become residual or a language fossil.

Analyzing the iconicity motivation of new sign emergence may reveal that iconicity motivates the emergence of signs' forms. However, this analysis does not provide evidence that iconic nature might influence phonological patterns since, at this linguistic phase of LGSTP, it is impossible to identify phonological patterns, constraints, and phenomena involved. Considering that iconicity might influence phonological patterns observed in spoken languages (Auracher et al., 2019), the strong presence of iconic strategies in new signs narrows the gap between the nature of the sign and spoken language, supporting that iconicity is a universal mechanism of language. This corroborates the hypothesis that pantomime can be considered a fossil of this new language.

The grammatical characteristics of the first type of communication amongst this population are also altered when the use of pantomime decreases. The analysis of basic word order showed us that in the first phase of sign language emergence, which is primarily comprised of pantomime, the order of reversible and irreversible events is communicated with great syntactic freedom regarding the order of the constituents; the same is not confirmed by the fourth phase of sign language emergence when linguistic characteristics begin to appear. In this last phase, syntax becomes more rigid with regard to the order of constituents. Again, pantomimic communication in an early phase of language emergence can be considered a fossil of this new language.

LGSTP's evolution showed mainly articulatory and morphological tendencies of the first signs that are in a phase of insertion into the linguistic system and exhibit characteristics inherent to it, namely the articulatory concentration in the manual articulators, the visible fall of the M2, as well as the progressive loss of the non-manual articulators (trunk, head, legs). In morphological terms, there is a

trend toward the composition of gestures based on existing gestures. These proto-sign trends remind us of a path that began in pantomime and was born from it.

Therefore, is pantomime a communicative fossil of language? Żywiczyński and colleagues (2021) argue that it is, although Marentette´s developmental study shows a different trajectory (see Marententte, this volume). The arguments presented in the introduction are convincing. First of all, pantomime is used when, because of pathology, there is a language impairment in the case of apraxia (Whiteside et al., 2015) or aphasia (Code, 2021; Dronkers et al., 1998). Secondly, pantomime is used to communicate when there is no common language, indicated by (i) the evidence from travelogues from the period of Great Exploration during the 15th to 17th centuries (Żywiczyński & Wacewicz, 2021), (ii) charades when the rules temporarily block the use of language blocked (Żywiczyński & Wacewicz, 2021), and (iii) situations when people who do not share a language try to communicate. Finally, pantomime seems to be a stage that precedes the proto-sign in a new sign language (Arbib, this volume; Gärdernfors, this volume).

Regarding this argument, Sandler's (2013) paper rejects this view by describing a lack of pantomime in ABSL as a precursor to signs and presenting the recordings of the origin of this language (a single video) showing the deaf signer using his hands and not his whole body. However, it is essential to place these findings in time. The example of LGSTP shows that it took less than a year for proto-signs to appear that are no longer pantomime. Thus, it is possible that there was a stage before the emergence of proto-signs or first signs in ABSL that was not recorded, possibly because the pantomime phase did not consist of signs, and linguists focused their work on signs. Another issue with these findings is that one informant – a single signer – cannot fully understand language emergence.

We thus hypothesise that language emergence starts with the stage of pantomimic communication, which at a later stage of language development becomes an evolutionary fossil, following the proposal from Żywiczyński and colleagues (2021).

This theory complements those of Emmorey and colleagues (2011), who found that the production of pantomime and language relies on only partially distinct neural systems in the brain (Arbib, this volume). Their research also revealed that pantomime production engages the superior parietal cortex bilaterally for deaf signers, while sign language production (verbs in ASL) engages the left inferior frontal cortex. Pantomime production does not engage the left inferior parietal cortex for hearing non-signers. Intriguingly, this study also reported that the neural networks for pantomime generation were not identical for the deaf and hearing groups, as deaf signers employ more extensive regions within the superior parietal cortex, and hearing non-signers employ neural regions associated with episodic memory retrieval.

In evolutionary terms, manual and vocal systems co-evolved. They have been neurobiologically sophisticated from the beginning, allowing a man to take food into his mouth without biting his fingers (Mineiro, 2020).

In our view, gestures and vocalizations are intertwined from the very beginning of language emergence in human beings. Our primate heritage has endowed us with hands that can provide a natural signaling system that is more natural than the vocal system. Language did evolve from manual gestures and shifted from a manual to a vocal mode (Corballis, 2000), so speech is also gestural. Sign language consists of vocalizations and movements of the face and hands. Manual gestures accompany spoken language.

In brief, Arbib's evolutionary chain (2012) of a Mirror System > simple imitation > complex imitation > pantomime > proto-sign and proto-speech > language-ready brain is a possible scenario for language emergence in humans, but it does not endorse a polymodal origin of language. Our studies permit us to place pantomime as an effective means of bootstrapping a new language. This scenario of language origin is also proposed by Arbib (this volume), who highlights the expanding spiral of language in line with cultural and narrative evolution. Interestingly, Gärdenfors (this volume) insists that the evolution of casual cognition and event representation are essential to transition phenomena when pantomime is exapted in communicative contexts.

5. End note

We believe that the studies described above – from pantomime to proto- or early sign – lead us to understand the evolutionary process of a newly-born language. This process allows us to extrapolate these findings to the genesis of language in modern humans, thereby shedding light on the roots of language emergence and evolution.

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