

JOSÉ MORAIS, SYLLABLES, LITERATURE AND MUCH MORE

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In the present paper, José Morais is praised for his great achievements in several fields of language processing, in particular in reading. Furthermore, his views on the role of syllables, consonants and vowels are reviewed. It is obvious that it is unfair to classify José Morais as belonging to a narrow academic discipline. He has shown to be an intellectual who is interested in social matters, arts and science. We thank him for his contributions.

It is hard to believe that José Morais – a star student at Bertelson’s laboratory whom I met when I taught a course on psycholinguistics in 1973 – is approaching retirement. José Morais had formerly been a Portuguese political activist with whom it was possible to discuss about a large variety of topics ranging from language, communism, music, literature and much more. We became colleagues who would meet in many different circumstances. José came to the meeting in my honour in Paris when I was, so to say, put into retirement. It was nice to see him there with his inquisitive look and I imagined that he was judging this event as a strange anthropological landmark that some of us dread and despise while others expect with impatience. I don’t know how José views his future, however, I am persuaded that he will find a new interesting way to pursue all his interests and that Régine will use her great skill to act as a “marraine” to coach him to find his way. We all know that José has many strings to his bow and that he will still surprise us with whatever he will continue or enterprise.

In the early sixties I gave a résumé of post-generative psycholinguistic investigations which had become more sophisticated than most of the studies carried out during the first sixty years of the twentieth century. Most graduate students began to take the Cognitive Revolution originated in Cambridge, Massachusetts very seriously even though there were many more skeptics in Europe than in other parts of the world. I was already a member of the CNRS in Paris where it was very difficult to pierce through an ambience of skepticisms that was to continue for quite some years. In Brussels the ambience was much more open. Before arriving in Brussels, Bertelson had done much of his early investigations in Cambridge, UK, where there were excellent colleagues pursuing a line of research which kept some of the attitudes of harsh positivism without being active enemies of theoretical approaches,

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or of “frameworks” as this was called a few years later. It seems to me, with a perspective of the years that have gone by, that Brussels and the brilliant students that were attracted to work at Bertelson’s lab were in several ways building bridges between the two cultures.

Morais had a very curious mind and was interested in what was coming from the UK, Massachusetts, Paris, Genève and many other places. He was outspoken, clever and enterprising. He enjoyed engaging in discussions, possibly a tendency that had developed from his political days. As a graduate student with Paul Bertelson as advisor, they made important discoveries. They were exploring a terrain that was mostly unexplored, namely how learning to read affects “phonological awareness”. Specialists studying the different writing systems attested in the world had speculated about such issues and neuropsychologists were beginning to explore patients, which helped to uncover that different reading systems may be processed by different brain areas.

Readers of a phonemic-graphemic correspondence writing system, at least for those who read languages like Spanish, which have relatively transparent correspondences, can think that speech sounds are composed by segments that correspond to the letters that make them up. This state of affairs has damaged considerably the early studies of speech.

What the Belgian ULB team, through various seminal papers, discovered is that smart illiterates behave very differently from alphabetically sophisticated adults in their ability to detect and respond to word initial phonemes whereas they respond to syllables like adults (see the famous “Does awareness of speech as a sequence of phones arise spontaneously?”, Morais, Cary, Alegria, & Bertelson, 1979, as well as the equally important “Literacy training and speech segmentation”, Morais, Bertelson, Cary, & Alegria, 1986). Needless to remind you that these papers are among the top cited in the field of psycholinguistics, nor do I have to highlight the seminal value of José’s investigations.

Having mentioned José’s important contributions to Cognition, I would also like to point out that José is also a novelist who published a novel, which I read and still remember quite vividly. I also read *L’art de lire* (Morais, 1994), which is a very nice résumé of this strange module, i.e., the module that mediates reading and writing in schooled humans. Indeed, humans have the ability to learn and assemble this module, whose properties resemble those properties that J. Fodor (1983) attributes to the input or vertical modules.

Fodor’s view of input modules includes the following properties:

1. They are domain specific (here Fodor envisioned the traditional sensory/perceptual modes and many of our “innate abilities”, i.e., language, “highly specialised computational mechanisms for generating hypoth-

eses" inter alia).

2. Vertical modules also have other properties, e.g., they are mandatory, they convey their information to a central system and they are informationally encapsulated, they have fixed neural architecture, etc.

Not all the properties of Fodor's definition of input modules are equally important. However, it seems clear that innateness is an essential property, which has been greatly criticised. Yet, we all have to agree that writing and reading are as acquired as are the other systems that Morais explored, namely music, the arts in general and also pedagogy and politics. Not all of us can be good teachers, or astute observers of the political scene. However, Morais was also interested in brain science, functional lateralization, etc. which shows that his perspective was quite broad.

In the rest of this paper to honour José I will try to point out common interests in the attempt to encourage the reader to verify if there are domains where our opinions diverged. In any case I am aware that we shared many interests and that the many discussions we had influenced my own work.

Presumably, most readers of this festschrift have previously read José's "Does awareness of speech as a sequence of phones arise spontaneously?" (Morais et al., 1979), therefore they know that for the ULB group the *syllable* is viewed as the most natural unit available to speakers, regardless of whether they are literate or not. Illiterates, instead, show no trace of being "aware" that [b] and [l] are the initial phonemes in the word *blood* or that the same phoneme [b] is the first segment of the word *bad*. Chinese or Japanese native speakers who have learned to read and write in a non grapheme-phoneme system (i.e., the characters of the kanji or kana systems) have an awareness of segments that is like that of the illiterates that the Brussels group had highlighted with their work. In fact, both Bertelson and Morais and several of their colleagues were instrumental in conceiving and demonstrating these facts and presenting them in a very cogent way as to induce others to expand the understanding of this important field of research.

In a conference I gave in 1980 at the Royal Society I presented a paper entitled "The role of syllables in speech processing: Infant and adult data" (Mehler, 1981). Those who read this paper will readily see that my interactions with the ULB had largely influenced my early investigations and some of my theoretical perspectives. However, N. Chomsky, J. Fodor and E. Lenneberg were the mentors who had influenced me most in my choice of the subject area, namely language. Moreover, my current fascination with the study of neonates and hoping to go even younger is predictable given my earlier influences. Indeed, in hindsight it is not too surprising that my work focuses on very young infants to disentangle the innate endowment of our species. However, at the time when I was travelling often to Brussels I was sufficiently influenced and tried to contribute, albeit modestly to the superb

work by the Brussels group on how learning changes the awareness of the speech segments of the native language.

In the late seventies in Paris we had already run some studies showing that literate adults are excellent to detect the first syllable of a multisyllabic word when having to match a target presented before they listen to a word – *ergo* a task that is not necessarily relevant for unpacking the notion of phonemic awareness. French participants react as if they were using syllables (Mehler, Dommergues, Frauenfelder, & Segui, 1981) whereas this is not the case for speakers of all languages, as demonstrated in Cutler, Mehler, Norris, and Segui (1983). In these studies we were using on-line stimuli rather than a meta-linguistic task, as the “awareness” report must be considered. These results led me to consider the term “phonological awareness” as a re-description of a highly intriguing phenomenon; for many years I was hoping to be able to understand the underlying mechanisms that produced such behaviours. Some decades later we all agree that this is not an easy task. Nevertheless, José’s findings about syllables, phones, and literacy are solid and there are no indications that the facts will soon be shelved. Rather, I take it that the Morais et al. (1986; 1979) findings must be placed into a broader and explicit theoretical framework. This might require a broad theoretical perspective which includes the acquisition of phonological regularities of different languages, the neuropsychological notions that have become available in the last years including imaging evidence, the organisation of the acquisition of lexical items and how this depends on the model of speech production (see Levelt, 1989), the emergence of morpho-syntactic regularities, etc. Notice that many of those aspects have been addressed and explored at ULB, which was not always the case in many of the other groups that began to contribute to the reading literature with a more strictly applied perspective.

What Morais and his colleagues (1986) managed to do is to generate a shake-up of the speech perception scene during the second half of the twentieth century. Indeed, acoustic-phonetic research in the mid-seventies focused almost exclusively upon features. This assertion can be validated by perusing the speech section of JASA as well as other journals also publishing speech perception studies. In fact, the twentieth century scene was in many ways behind what Aristotle (1996, for an edition in English) was claiming well over 2000 years ago, namely, that the syllable is a construct that is more than the sum of its constituents, see Nespor (1993).

The syllable is a resilient construct that was revisited when Savin and Bever (1970) pleaded for the non-perceptual reality of phonemes. The authors showed that the latency to individuate a syllable is shorter than to individuate its first phoneme. This result reminded the authors of work showing analogous results that had been obtained in the visual domain, e.g., participants are faster to individuate whether the expression of a human face,

presented as an outline sketch, is sad or happy. The only difference between the happy and the sad face is that the mouth is curved either in a convex or in a concave orientation. Of course, it was rather speculative to argue from Savin and Bever's results that phonemes are perceptually non-real. The authors were criticised, and eventually revised their claims. Nonetheless, others continued to explore similar ideas, e.g., that the syllable is a basic speech unit and possibly the entrance level to the attentional system or the first one that is accessed during development. For instance, several researchers used children's games to compare how easy it is for very young children to individuate syllables and phonemes or phones. Many arrived to the conclusion that syllables have a very special status as compared to its components, e.g., phonemes and features.

Syllables, speech and development

The EHESS-CNRS "Laboratoire de Science Cognitive et Psycholinguistique" published a paper in which the authors discovered, using syllable-monitoring, that the syllable plays a very important role in speech segmentation. French speakers respond significantly faster when the instruction is to respond to PA, and the targets are words like PALACE than when they are words like PALMIER, whereas they respond faster to PAL in PALMIER as compared to words like PALACE (see Mehler et al., 1981). This result triggered a very active collaboration between the researchers working in Paris and those working in Cambridge, UK's group of Cutler and Norris. The upshot of this collaboration was that the speech properties of different languages determine variegated "gestalt-like" speech constituents or maybe drive our "awareness" to constituents that are specific to that language. This is not as surprising as some of us thought in the eighties. Indeed, the languages spoken around the world can have very different phonological properties. Still they all honour a number of universal properties.

How does one determine if the aforementioned universals apply to all languages, at least when they are being learned at a very young age? We decided that the most profitable path to follow would be to study how the very young infant would process speech signals. A number of studies, which assessed infant speech perception, with infants who were one month old or older, were published following Eimas, Siqueland, Jusczyk, and Vigorito (1971) pioneering paper. In Paris we adapted a non-nutritive sucking device and began investigate if there are properties of speech processing that can be detected in neonates. Of course, given that language is uniquely human we turned to study the neonate. Interestingly José Morais and Isabelle Peretz co-authored one of the first papers we published after we began working at

the Baudeloque maternity (Bertoncini, Morais, Bijeljac-Babic, McAdams, Peretz, & Mehler, 1989). This study uncovered that the neonates' functional lateralization resembles that of adults.

Bijeljac-Babic, Bertoncini, and Mehler (1991) explored whether human neonates process speech segments and if so whether features, phonemes, syllables and higher constituents play an equally salient role. The authors demonstrated that syllables play a central role in how neonates process speech signals. Using a non-nutritive sucking procedure the authors proceeded to habituate healthy neonates to synthetic bi-syllabic "words". After the end of habituation infants were tested with several different test-items. Neonates failed to react to new bi-syllabic "words" whereas they readily reacted to a test in a test list with only tri-syllabic items. In a series of control experiments the authors evaluated whether physical properties that distinguish the two test-lists could have caused the neonates aforementioned behaviours. Bijeljac-Babic et al. (1991) reported that neither the duration nor the rate of speech could have played a determinant role to explain the results. In another control the authors demonstrated that whereas syllables arise almost at birth, the number of phonemes of items in a novel habituation list generate the same results if all items are bi-syllabic even if now the items have six phonemes rather than the four phonemes as in the original habituation list described above.

The above results revealed that day-old infants engage in parsing a speech stream in terms of syllables or properties that correlate with the number of syllables, e.g., number of vowels per item. Do we have to consider this result as an analogue to some of the archaic reflexes, as for instance the walking reflex? The latter disappears completely at about the eighth week of age. These results, as well as those reported in the Bijeljac-Babic et al.'s study (1991) tend to trigger the question of whether the archaic reflex is, in one way or another, related to the behaviours that can be observed in more developed infants. We know that illiterates fail to display phoneme-awareness in Bertelson and Morais experiments, clearly they are also extracting feature-properties of some phonemes, as shown by Berko (1958), otherwise they would fail to extract morphological regularities which is clearly not the case, (for instance extraction of plurals in English, i.e., cat \rightarrow cats but dog \rightarrow dogz). This early learning competence was postulated in a recent paper, suggesting that it takes place early because it concerns edges of words, see Endress, Nespore, and Mehler (2009), and Endress and Mehler (2009). Endress et al. (2009) indeed propose that speech processing might recruit previously existing perceptual "primitives" and use their outputs to feed abstract linguistic computations. It has long been known that sequence edges are particularly salient positions, facilitating perception, learning, and recall of elements in those positions. This might be related to why languages show a universal

preference for word-initial and word-final morpho-syntactic processes as opposed to word-internal ones. Indeed, infixing is very rare. My view of syllables is that they also are a kind of perceptual primitive that may have a double role since they may also be a production primitive.

In other neonates experiments, we demonstrated that syllables tend to act as the units of speech perception (Bertoncini & Mehler, 1981). A strong confirmation came from an experiment (Bertoncini, Bijeljac-Babic, Blumstein, & Mehler, 1987) which explored the ability of neonates to discriminate consonantal place of articulation and vowel quality using shortened CV syllables similar to those used by Blumstein and Stevens (1980), without vowel steady-state information. The results show that the initial 34-44 ms of CV stimuli provide infants with sufficient information to discriminate place of articulation differences in stop consonants ([ba] vs. [da], [ba] vs. [ga], [bi] vs. [di], and [bi] vs. [gi]) and following vowel quality ([ba] vs. [bi], [da] vs. [di], and [ga] vs. [gi]). These results suggest that infants can discriminate syllables on the basis of the onset properties of CV signals, suggesting that the syllable can be viewed as a gestalt-like object.

Syllables and revisionism

During the last decade, or rather during the last fifteen years, I have been confronted to an interesting paradox. Syllables are, *par excellence* the "entrance unit" to the awareness system. Syllables also play a very salient role in many psycholinguistic experiments that used online methods to test processing. As we mentioned above, only speakers of some languages display syllable effects during processing. However, the paradox that I am referring was identified mainly through the study of development.

Neonates can learn. As a matter of fact, being able to discriminate linguistic rhythm is one of the very first abilities that newborns display. Linguistic rhythm is also relatively easy to perceive for adults, see Ramus and Mehler (1999). Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, and Amiel-Tison (1988) showed that newborns are able to discriminate their future native language from a rhythmically different language, even if both are low-pass filtered, suppressing phoneme identity. Moreover, Nazzi, Bertoncini, and Mehler (1998) showed that rhythmical differences were sufficient for language discrimination whereas familiarity with the maternal languages was not required. These authors found that French newborns discriminate between low-pass filtered English and Japanese utterances, two languages they had never heard before. These results established that rhythm might serve as an initial cue to language discrimination.

Ramus, Nespor, and Mehler (1999) proposed an operational definition

for rhythm and used it to establish a language classification as a function of three acoustic parameters: %V, the proportion of vocalic space relative to the total length of an utterance; ΔV , the variability in the length of vocalic spaces, and ΔC , the variability in the length of consonant clusters. The formulation of this definition of linguistic rhythm did not take into consideration the syllable as such but its sub-components, the vowels and the consonant clusters that are attested.

The authors found that natural languages cluster into groups similar to the rhythmical classes traditionally postulated on the basis of intuition. Nespor (1990) and Dauer (1987) had postulated that rhythm arises as a function of the types of syllables a language licenses. Now we have serious ground to argue that linguistic-rhythm is one of the first and most basic acquisitions observed in the course of precocious language learning. However, as mentioned above, further studies with older infants argue that we have to be less all-encompassing and accept that other parts of speech also play central roles during acquisition.

Ten to fifteen years ago psycholinguists began to be interested in the mechanisms through which humans learn language. Basically two mechanisms were invoked: rule learning and extraction of distributional information by means of which the environment is encoded and processed. Traditionally, theorists agreed that distributional information must be useful to discover all kinds of properties. An experimental demonstration that this might be the case was published in the early seventies (Hayes & Clark, 1970). The authors proposed that conditional probabilities are helpful to segment an “artificial speech analogue”. A quarter of a century later a group of colleagues working at Rochester University published a study in which they were able to demonstrate that eight month olds segment an artificial grammar which had only four “pseudo-words”. The pseudo-words have high transition probabilities between adjacent syllables while the last syllable of any item and the first syllable of the following item have a low transition probability, see Saffran, Aslin, and Newport (1996). A few years ago Marcus and colleagues at NYU (Marcus, Vijayan, Bandi Rao, & Vishton, 1999) published a paper showing that seven months olds extract rules when they are confronted to items that share a property, namely, that a syllable duplicates or occupies salient edges in the tri-syllabic items. The latter probability cannot be computed by a statistical mechanism. It seems to conform, according to Marcus, to a rule-like conjecture.

Peña, Bonatti, Nespor, and Mehler (2002) were concerned with the interaction of statistics and rules, whereas Newport and Aslin (2004) and Newport, Hauser, Spaepen, and Aslin (2004) were exploring whether humans are capable of extracting non-adjacent segments. Peña et al. (2002) used non-adjacent syllables, i.e., $A_i x^* B_i$ where A_i and B_i denote the first and the last

syllable of the three words used in most of the experiments. X^* indicates the middle syllable that is variable although all the syllables in the speech stream had the same structure, namely they were CV syllables. The participants in the experiments run by Peña et al. (2002) segment the speech stream on the basis of the A_i and B_i statistical dependencies despite the intervening middle syllable. Indeed, participants readily segmented tri-syllabic words from the artificial stream when they were defined by high TPs between the first and the last syllables ($A_i X C_j$). However, Peña et al. (2002) also discovered that participants failed to generalise the rule to novel items that conform to the rule except when (subliminal) segmentation cues were inserted into the stream. These results suggest that cues in the signal, for example, pauses, act as triggers for different processing mechanisms, for example, statistics versus rule generalisation.

In the aforementioned work, Newport and Aslin (2004; Newport et al., 2004) report results that are at odds with the results of Peña et al. (2002). They asked adult participants to segment their stream in which the only dependencies available arose between non-adjacent syllables. Thus, the two experiments were very similar, and some could have seen them as a failure to replicate the experiments reported in Peña et al. (2002). The authors report that they failed to verify that learners acquired “regular relations among non-adjacent syllables, even when the patterns are objectively quite simple” (Newport & Aslin, 2004, p. 127). In subsequent experiments the Rochester group demonstrated that learners are quite capable of acquiring patterned relations among non-adjacent segments that are adjacent in some abstract representation, i.e., Cs in the consonant-grid and Vs in the vowel-grid. They showed that both non-adjacent consonants (with an intervening vocalic segment that is unrelated) and non-adjacent vowels (with an intervening consonantal segment that is unrelated) provide very salient information to segment a speech stream, even when the syllables do not provide statistical information. Surprisingly, in Newport et al. (2004) the authors found that tamarin monkeys are able to exploit transition probabilities between vowels but not between consonants. This result is difficult to understand unless one considers that the tamarins were just responding to the more noisy parts of speech without having representations of either vowels or phonemes as such.

One of the problems with the Cs and Vs experiments carried out at Rochester is that the authors failed to prune the repetition of adjacent words occurring in the stream. Endress, Scholl, and Mehler (2005) and Endress, Dehaene-Lambertz, and Mehler (2007) showed that repetitions are “perceptual primitives” that entail entirely different kinds of processing. Bonatti, Peña, Nespor, and Mehler (2005) studied in detail the units or representations onto which statistical computations may apply. They observed that adults readily segment a stream using the TPs existing consonants whereas

they failed to extract favourable distributional information over nonadjacent vowels. In a related experiment Mehler, Peña, Nespor, and Bonatti (2006) confirmed Bonatti's studies and suggested that Baruch Spinoza (1677, modern edition: 1968) had got things right when he wrote that "les Hébreux disent que 'les voyelles sont l'âme des lettres'... et les lettres sans voyelles sont des 'corps sans âme'". An approximate translation would be that vowels are the soul of speech and consonants without vowels are bodies without a soul.

The differing role played by Cs and Vs was confirmed by Toro, Nespor, Mehler, and Bonatti (2008) who conducted a series of artificial grammar experiments to show that consonants and vowels preferentially trigger different kinds of learning mechanisms. Both consonants and vowels results are in harmony with a theory first proposed by Nespor, Peña, and Mehler (2003). Thus participants performed well using the C-tier, but not the V-tier when the task was to segment a stream, and were able to extract a rule exemplified in the V-tier and failed to extract the rule when it was carried by the C-tier.

Taken together, these studies indicate that not all linguistic representations are used to trigger the same mechanisms. Rather, there are innate dispositions to use two speech categories for different purposes. Thus, statistical learning becomes a very interesting mechanism when identifying the kinds of information over the categories that trigger it. From the above results we infer that young infants use syllables to compute distributional regularities and are also able to extract syllabic structures implemented by their language, primarily to determine the rhythm and word length. Such processing relies on the strict analysis of the basic categories of speech, namely Vs and Cs.

What I would like to stress is that developmental psycholinguistics is again a very active field. José Morais was one of the founding members of this enterprise and we want to thank him for his contributions. We must admit that today many of the issues are under debate but we have many methods that were totally unsuspected three decades ago. I hope that our students and ourselves will continue to explore this fascinating area of knowledge. Bravo José Morais and bravo also for his collaborators and his family members who were so supportive.

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