International Society of Experimental Linguistics

ExLing 2021

Proceedings of 12th International Conference of Experimental Linguistics

11-13 October 2021
Athens, Greece

Edited by Antonis Botinis

National and Kapodistrian
University of Athens

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Foreword

Welcome to the 12th International Conference of Experimental Linguistics ExLing 2021. Even this time, due to the COVED-19 pandemic uncertainty, we will restrict ourselves to a virtual conference, much like the ExLing 2020 conference last year.

Our Society is defined by a collective commitment to understanding language through the development of experimental methods in Linguistics. It is an established and international forum for generations of linguists, where new and established researchers, participate and discuss developments in linguistic research and diverse developments of experimental methodologies.

It began in 2006 in Athens with the first ExLing Conference, at the time an International Speech Communication Association (ISCA) ExLing Workshop; subsequently, it was hosted in places such as Paris, Saint Petersburg, Heraklion, Lisbon and since 2019 has been established as the annual International Conference of Experimental Linguistics.

ExLing 2021 has a repeated connection to the first one, as it takes place in Athens, but it goes virtually, exploring how technology would facilitate online language interaction of our members without losing the natural interpersonal communication that our Society has in high regard. To promote this interaction, this time, members of the ExLing Society have free access to the conference, so that the online presentation opens up to a wider audience.

This volume includes the proceedings of ExLing 2021. In addition to the main conference, ExLing 2021 hosts two special sessions encompassing diverse and energetic research domains that focus on experimental methods and current topics in Language Education and Language Pathology.

We would like to thank all ExLing 2021 participants and our keynote speakers, Edward Gibson, Robert J. Hartsuiker, Charles Hulme, Kathy Rastle, Martin Pichering, as well as colleagues from the International Advisory Committee and the Review Committee for their contribution to the successful outcome of the Conference.

Antonis Botinis
ExLing Society

Contents

Extracting word-like units when two concurrent regularities collide: Electrophysiological evidence

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Abstract

Statistical learning (SL) is a fundamental skill assumed to play a central role in the acquisition of the rule-governed aspects of language. Despite evidence that SL is present from early infancy to support the extraction of sound patterns in speech, the nature of the computations involved is unclear. Here we collected electrophysiological data while preschool children were exposed to an auditory stream in which two concurrent regularities were embedded, firstly, under accidental (implicit), and, subsequently, under intentional (explicit) conditions. Results showed that the extraction of sound patterns was enhanced by the effect of explicit instructions and, critically, that under this conditions, children seem to rely on the computation of syllable frequency rather than on transitional probabilities to extract word-like units.

Keywords: statistical learning, transitional probabilities, syllable frequency, implicit learning, explicit learning

Introduction

We live in a world full of regularities. Language, for example, can be described by a set of rules that determine how sounds are combined into words and words into meaningful sentences. Statistical learning (SL) is a general term used in Cognitive Science to describe the action of multiple mechanisms that allow the extraction of those regularities in time and space, such as the sound patterns present in speech to determine where one word ends and the next begins.

Although most SL studies have focused on examining the sensitivity of young children to speech regularities, such as the probability of one segment (e.g., a syllable) to follow another segment, a statistic known as transitional probability (TP; Saffran et al., 1996), others have also demonstrated that children are sensitive to other statistics, such as the frequency with which each exemplar is presented in the input. For instance, Maye et al. (2002) showed that 6- and 8-months infants exposed to a bimodal distribution of the [ta-da] continuum treated exemplars occurring between the center and the endpoints of the distribution as belonging to different phonetic categories, while those exposed to a unimodal distribution of the same continuum treated these exemplars as belonging to the same category. Although all these studies demonstrate that, from a very young age, children are sensitive to different statistics, knowledge about how the sensitivity to those regularities emerge and how the conditions under which they were presented (implicit vs. explicit) affected the reliance in one or another is limited.

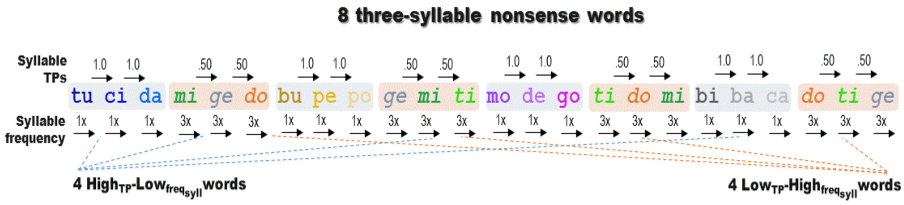
Method

Participants

Twenty-four children (13 female, M_{age} = 5;7; range 5;1 to 6;5) from Portuguese kindergarten institutions participated in the study. All participants were native speakers of European Portuguese, with normal hearing and no history of language disabilities. Written informed consent was obtained from the parents. The study was approved by the local Ethics Committee (SECSH 028/2018).

Stimuli

Thirty-two auditory European Portuguese CV syllables were drawn from Soares et al.'s (2020) study to create the 16 three-syllable nonsense words used in the implicit and explicit versions of the SL tasks (8 'words' per task). Syllables were produced and recorded by a native speaker of European Portuguese with a duration of 300 ms each. In each task, 4 of the nonsense words presented high TPs (1.0) but low frequent syllables, and the other 4 low TPs (.50) but high frequent syllables (see Fig. 1). For instance, the nonsense word '*tucida'* correspond to the High TP-Low frequency syllable 'words' as the syllables they entail only appear in those 'words', hence making these 'words' to present a TP = 1.0, but a syllable frequency that is three times less than presented by the Low TP-High frequency syllable 'words' such as '*migedo*', which entail syllables that appear in three different 'words' at different syllable positions ('*gemiti*', '*tidomi*', '*gotige*') - see Soares et al., 2020 for details.



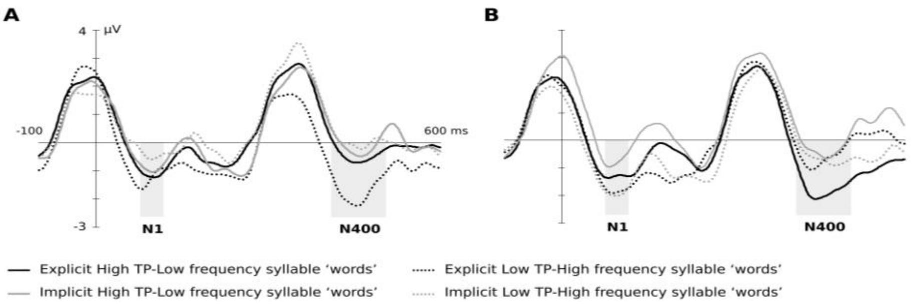
In each SL task, the nonsense words were concatenated in a continuous stream of 8.4 min with the Audacity® software with a 50 ms interval between syllables. Each 'word' was presented 60 in random order with the restriction that the same 'word' cannot be repeated twice in a row. The stream was edited to include ~10% of the syllables a superimposed sound (a 0.1 s sawtooth wave sound from 450 to 1,450 Hz).

Procedure

Data were collected in a shielding cabin at the Psychological Neuroscience Lab (School of Psychology, University of Minho). Participants were firstly presented with the implicit version of the SL task and, subsequently, with the explicit version of an analogous SL task. In the implicit version, participants were instructed to pay attention to the auditory stream presented at 60 dB SPL via binaural headphones, because occasionally a deviant sound (a click) would appear, and their task would be to detect it as soon and accurately as possible, which functioned as a cover task to ensured adequate attention to the stimuli. After a brief interval, participants underwent the explicit version of the SL task that mimicked the previous one, except that each of the new 'words', drawn from the syllabary not used in the implicit version, was presented and participants were asked to repeat each one correctly before the familiarization phase began. The procedure took about 90 min per participant. EEG data were recorded with a 64 channels BioSemi Active-Two system according to the international 10-20 system and digitized at a sampling rate of 512 Hz. Electrode impedances were kept below 20 kΩ. EEG was re-referenced off-line to the algebraic average of mastoids. Data were filtered with a bandpass 0.1-30 Hz filter. Epochs were time-locked to the onset of the 'words'.

Results

EEG data processing was conducted with the Brain Vision Analyzer 2.1.1. Four participants were excluded due to artifact rejection. Mean amplitudes were calculated for the 80-120 ms (N1) and 400-500 ms event-related potentials (ERPs) taken as the neural signatures of words' segmentation in the brain (see Soares et al., 2020) in the topographical regions where amplitudes were maximal (fronto-central and central regions, respectively). Repeated-measures ANOVAs were conducted in the 27.0 IBM-SPSS® software based on the three within-subject factors: SL task (implicit vs. explicit), Type of 'word' (High TP-Low frequency syllable vs. Low TP-High frequency syllable), and Time (first half vs. second half of the SL task) to further analyse how neural responses changed as exposure to the auditory stream unfolds. Figure 2 depicts the neural responses per condition in the first (A) and second-half (B) of the SL tasks.



In the N1 component, results showed a main effect of Time, $F(1,19) = 5.22$, $p = .034$, $\eta_p^2 = .215$, indicating larger amplitude in the second than in the first half of the SL tasks. In the N400 component, the results showed a main effect of task, $F(1,19) = 8.23$, $p = .010$, $\eta_p^2 = .302$, indicating larger amplitude in the explicit than in the implicit version of the SL tasks. The three-fold SL task*type of 'word'*time interaction was also significant, $F(1,19) = 4.65$, $p = .044$, $\eta_p^2 = .197$. This effect revealed larger amplitude in the first half of the explicit SL task for the Low TP-High frequency syllable 'words' ($p = .030$), and in the second half of the explicit SL task for the High TP-Low frequency syllable 'words' ($p = .027$). Moreover, it also revealed that the Low TP-High frequency syllable 'words' elicited larger amplitude in the first half than in the second half of the explicit SL task ($p = .022$), and that in the first half of the explicit SL task the Low TP-High frequency syllable 'words' elicited larger amplitude than the High TP-Low frequency syllable 'words' ($p = .041$).

Conclusion

The enhancement in the N1 component observed in the last part of the SL tasks, suggest this ERP component to index transient effects arising from the extraction of the regularities embedded in the input stream as the exposure unfolds. The results in the N400 component, taken as a putative 'marker' of words' segmentation in the brain, indicate that the extraction of word-like units was enhanced by the effect of explicit instructions and, critically, that under these conditions, children seem to rely on the computation of syllable frequency rather than syllable TPs to extract word-like units. Future research should further explore this issue by analysing how the complexity of the stream used (8 nonsense words) might have contributed to these results.

Acknowledgements

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