



Formulário Relatório final - Componente Científica

1. Identificação do projeto

Número do projeto : PTDC/LLT-LIN/29338/2017

Designação : PLOs - Preditores de Desenvolvimento de Perturbações da Linguagem e Comunicação

Investigador Responsável : Sónia Marise de Campos Frota

Instituição Proponente : Faculdade de Letras da Universidade de Lisboa (FL/ULisboa)

Entidade(s) copromotoras : *Não aplicável*

Data de início : 14-06-2018 Data de fim : 13-06-2022

Financiamento concedido : € 227.473,02

Financiamento FEDER concedido : € 90.989,21

Financiamento nacional concedido : € 136.483,81

Financiamento próprio : € 0,00

2. Trabalhos desenvolvidos e desvios à proposta aprovada

2.1. Sumário (em inglês)

The development of language and communication abilities is critical to meet the needs and challenges of inclusive societies. Low language abilities at the age of 4 tend to persist through childhood and adulthood and are linked to academic, social-emotional, behavioral and psychosocial functioning difficulties [1,2,3]. Early identification of risk for language and communication impairments is vital to foster early intervention and diagnosis, improve language outcomes and minimize socioeconomic, health and educational impacts [4,5]. Predictors of later language outcomes in the first two years of life play a key role in a better understanding of the underpinnings of language acquisition and the developmental trajectories of typical and at-risk groups. In particular, auditory and visual processing in early speech perception seem to lay the foundational skills with cascading effects on language outcomes [6,7,8], with speech discrimination and processing abilities affecting speech segmentation, word learning and phrase level processing. Given that learning a language implies a native-language attunement that is achieved early in the 1st year for many language domains [9,B], predictors of language outcomes are potentially language-specific. The PLOs project aims to contribute to fill the gap in the empirical evidence base of predictors of language outcomes in the yet largely unstudied early acquisition of European Portuguese (EP). With a prospective study design, it focuses on high-probability at-risk groups for language and communication impairments and uses a combination of non-invasive methods (eye gaze, eye-tracking, brain measures, parental reports) to examine several language domains at the word and phrase levels (word stress discrimination, word segmentation, word learning, intonation, prosodic boundaries). To attain its central goal of identifying predictors of risk for language and communication impairments, PLOs combines a set of innovative features: (1) prospective, experimentally controlled study following at-risk infants/toddlers longitudinally from 5-6 to 30 months (and to pre-school years in a subsample); (2) inclusion of early measures and later assessment of language abilities for several at-risk groups enabling cross-group comparisons;

(3) combination of experimental online measures with parental reports and standardized tests; (4) use of a previously set network for participant recruitment, tested experimental paradigms, instruments developed/adapted for EP, and norming or reference data for typically developing EP-learning infants; (5) use of comparable methods to previous related studies in the same lab by the same core multidisciplinary team, facilitating the potential for clinical translation of research findings and outputs. The combined scientific and clinical expertise within PLOs offers a timely opportunity to promote more effective methods of screening, prevention, early intervention and diagnosis of language impairments.

2.2. Resumo dos trabalhos

Descrição sucinta das atividades desenvolvidas no período em apreço e dos resultados alcançados. De referir, em concreto, as tarefas que tiveram execução no período a que se reporta o relatório.

The PLOs Project is the first large scale prospective longitudinal study on the early acquisition of European Portuguese (EP) focusing on typically developing infants and several groups of infants at risk for language and communication impairments. It combined language assessment tools and experimental measures directed to different linguistic domains, covering low-risk and high-risk cohorts and following the same systematic approach, a combination that is innovative in the recently growing field of prospective longitudinal studies. PLOs had to underlying goals: (i) to identify early predictors of later language outcomes, thus contributing to a better understanding of the underpinnings of language acquisition and its trajectories in typically developing and clinical populations; (ii) to link the identification of early signs for language and communication impairments to ways of fostering early screening, diagnosis and intervention towards improving language outcomes, and minimizing health, educational and socioeconomic impacts. The two fundamental goals have been successfully accomplished, as described below (and in the PLOs detailed description file), by (a) gathering new knowledge that contributed to fill the gap in the empirical evidence base of the early acquisition of EP and to establish similarities and differences in the development of early language abilities across groups, and (b) developing tools for e-health that facilitate the early screening and monitoring of language and communication abilities which, through outreach and translational research activities implemented within PLOs, promise to have impacts beyond the project in clinical practice and the educational field. The project has produced the following deliverables (among others), which go beyond the outputs initially planned: 6 papers in peer-reviewed journals (Applied Psycholinguistics, Frontiers in Psychology, Brain Sciences, Journal of Portuguese Linguistics), 2 journal special issues (Brain Sciences, Frontiers in Psychology), 4 papers in international peer-reviewed proceedings, 2 PhD and 1 MA theses defended, 1 computational tool and two apps for different platforms, 25 presentations in international conferences with peer-review. A book chapter is in press (Language Science Press) and another submitted (Routledge), a journal article accepted (Frontiers in Psychology) and two in progress, and another two PhD theses are in progress. Seven papers were published in the scientific domains of RIS3, as planned in the project application. The core team of PLOs has organized two major international conferences in the fields of laboratory phonology and speech prosody, subordinated to the themes of language acquisition and language impairment: LabPhon 16 - Variation, development and impairment: Between phonetics and phonology (2018) (<http://labfon.letras.ulisboa.pt/LabPhon16/index.html>); Speech Prosody 2022 - Getting the prosody right: Acquisition, Impairment, Interventions, and Beyond (<http://labfon.letras.ulisboa.pt/sp2022/index.html>). Moreover, two project workshops were organized (NeuroDWELL 2019 and NeuroDWELL 2022), promoting the integration of

research findings into advanced training, and especially translational research through the involvement of professionals from the health and education sectors. The advanced training endeavor was further pursued by the participation in the organization and lecturing of advanced schools in experimental methods (STEM V, STEM VI and vTEM). The commitment to dissemination and outreach to professionals and practitioners, among other stakeholders, was also pursued through lectures, talks and informal meetings at clinical events, public hospitals, private health care institutions (see 4.3 in the Outputs file). A protocol was signed between the Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) and the Lisbon Baby Lab. A large community of psychologists, pediatricians, speech therapists, and educators has started to use the e-health tools produced, in particular the CDI-EP App. Dissemination and outreach, including the large community of parents and educators, were also achieved through the project website (<http://labfon.letras.ulisboa.pt/babylab/PLOS/>) and the social media (Lisbon Baby Lab Facebook, Instagram and Twitter). The PLOs Project and its research were on the news in a major daily newspaper (Público), in the Facebook channel Saúde+ and in the YouTube channel The Dissenter. PLOs included 6 tasks: (1) Recruitment and early assessment of participants for inclusion in the PLOs study; (2) Tools for e-health: scoring programs and app for early screening and monitoring; (3) Looking while listening experimental tasks: sounds and faces; (4) ERP tasks; (5) Longitudinal assessment of language abilities; (6) Prospective evidence for predictors of language outcomes. The prospective longitudinal design and research protocol was approved by the Comissão de Ética para a Investigação da FLUL (13_CEI2019). In the first year of the project (Y1), there was a major focus on task 1, giving its underlying relevance for all the other tasks. Infant and toddler data collection started for the tasks 1 to 5, including the CSBS DP normative data (task 1). For tasks 3 and 4, the experimental paradigms, previously used in other projects, were revised and tested again prior to data collection. Meetings with the project consultants were key to launch the project's activities. Y1 was also a period of intense dissemination and outreach activity. In Y2 there was an increasing focus on tasks 2 to 5. The sample to be collected for the CSBS normative data was enlarged to include around 600 children to match the requirements of a large number of children per age, and thus data collection continued beyond Y2. The EP-CDI SFs automatic scoring program was released (task 2). For tasks 3 and 4 (the core experimental part of the project), data collection proceeded although with adjustments and delays due to the pandemic. The language and communication abilities of the infants tested in the experimental tasks were measured at different subsequent points in time, following the prospective longitudinal design (task 5), leading to the first studies on early language and communicative development profiles across groups. The activities related to task 6 started with a systematic review of early predictors of language impairments and the first attempts to explore early measures of language abilities and eye gaze patterns as predictors. Dissemination and outreach to the health sector were another focus of Y2. In Y3 the focus was on tasks 2 to 6, despite the pandemic. The data collection for the CSBS-DP norming study was concluded (task 1). The development of the EP-CDI app was concluded and the app was released (task 2). Many of the experimental studies included in tasks 3 and 4 advanced significantly. Data collection was finished for the segmentation and word learning experiments. To understand the potential effects of mask use and other factors related to the pandemic, new audio and audiovisual experiments were implemented. A new mask exposure questionnaire was administered, and the database of measures of language development was significantly increased (task 5). Statistical models to explore early measures of later language outcomes (task 6) started to be implemented looking at gestures and prosodic development as potential predictors of later vocabulary development. In the final year, a total number of 159 high-risk and 412 low-risk infants was reached. The CSBS DP norming study was concluded (task 1), and the CSBS DP automatic scoring app was finished, being under test (task 2). Most experimental tasks reached

a good enough sample of included infants. Short-term and long-term predictors of later language outcomes were proposed as markers of risk for language impairments and presented to the scientific and health care communities.

2.3. Desvios dos trabalhos face à proposta aprovada

No caso de se terem registado desvios face ao programa de trabalho aprovado, incluindo a sua calendarização, solicita-se a identificação e descrição dos referidos desvios, bem como uma breve justificação para os mesmos.

No caso de se terem observado dificuldades na execução do plano de trabalhos aprovado, solicita-se a identificação e descrição das referidas dificuldades, bem como a forma de as ultrapassar / como foram ultrapassadas.

The job positions planned within the project were not fulfilled during its first year, given that the PhD researcher position could only start after May, 2019, as reported to FCT by the host institution. The hiring and beginning of activity of the grantees was dependent on the beginning of the activity of the PhD researcher. This required that several adjustments had to be made in the development of the scientific activities of the project and respective milestones, as noted in the Project report for Y1. The two grantees only started their activities, respectively, in December 2019 and January 2020, with impacts on task 1 (namely, the CSBS DP norming study), task 2 (tools for e-health), and task 4 (with delays in the implementation of the experiments and data collection). Y2 and Y3 were pandemic years. The two years of the pandemic were a tremendous challenge for the prospective longitudinal design of the project that the research team had to face and surmount through (re)adjustments, flexibility, huge efforts and time commitment further than the initially planned, and the extension of the scientific activities beyond the 3 regular years of the project. During Y2, the baby lab was closed for nearly 4 months, and thus all the activities of data collection stopped with major direct impacts on tasks 3 and 4, and consequent implications for tasks 1, 5 and 6. The lockdown and following restrictive measures due to COVID-19 led recruitment efforts to pursue beyond Y2. The pandemic mostly affected the recruitment of at-risk babies, given that the partner institutions from the health sector were overwhelmed with the public health situation. In Y3, the baby lab was closed again for almost 3 months (between January and April) and thus data collection had to stop again. The situation during Y2 and Y3 led to inevitable data loss in several time points of the longitudinal data collection plan, with major impacts on tasks 5 and 6. Even with the lab open, the data collection for the Griffiths Scales was especially affected as this is a long procedure that requires an extended contact between the child and the researcher, which parents were not keen to accept. The pandemic also led to the need to understand the potential effects of mask use and other COVID-related effects on early language development. Thus, new eye gaze and eye-tracking experiments were implemented and a new mask exposure questionnaire was built and administered. During Y3 (on 21-10-2021), the PI requested an extension of 15 months to FCT and POR Lisboa so that the research team had the minimum conditions necessary to face the challenges imposed by the one year delay in the hiring of the human resources needed for the project together with the serious and demanding consequences of the COVID-19 pandemic, and thus minimize their impact on data collection and related project activities and deliverables. FCT and POR Lisboa decided to provide an extension of 12 months maximum (decision issued on 12-01-2021). After contestation of this decision by the project team (on 20-01-2021), and the reiterated explanation that the increased activity and efforts already in place could not cover the delays and missing points in data collection due to the longitudinal nature of the project (in simple terms, data collection is made at specific ages

of the babies, and thus time is needed for the babies to grow and reach the designated data collection time points), the team was informed that the decision was final. Therefore, all efforts were made in the time available to recruit new infants, and intensify data collection and analysis. The two research grants within the project were extended and the project's financial resources were directed to human resources. Two research assistants were hired by the lab, with independent funding, to help in the project's activities. The final project workshop, which started to be organized in April-June, could only take place in August 29, 2022, due to external circumstances that constrained the best timing of the event, namely the organization of Speech Prosody 2022 in May, the participation in WILD 2022 in June, and the personal availability of the members of the organizing and scientific committees, the keynote speakers and one of the project's consultants. All the planned deliverables were attained (communications and publications in national conferences/journals were replaced by international forums). However, not all participants provided data for all time points and the models for data analyses were chosen to deal with missing data. Moreover, the samples for some of the experimental tasks (namely, the EEG tasks) were not completed for the at-risk children. The data collection for the EEG tasks for the at-risk children is still ongoing and will continue beyond the official end date of the project. Similarly, the data collection for the Griffiths, the final assessment planned at the end of all the other data collection, will continue beyond the project for all the children included in the longitudinal data collection of PLOs. These activities will be supported by independent funding. The wealth of data provided by the PLOs project will nourish not only the ongoing studies by the project's team but further studies on early language development and later language outcomes, including outcomes at (pre)school age, as well as a refined post-hoc analysis once the diagnosis of the at-risk children made by the clinicians is available.

2.5. Orçamento

Descrição sucinta do orçamento, incluindo os principais itens de investimento aprovados e investimento por entidade beneficiária. No caso de se terem registado desvios face ao orçamento aprovado, solicita-se a identificação e descrição dos referidos desvios, bem como uma breve justificação para os mesmos.

O projecto PLOs teve como rubrica de investimento principal a de Recursos Humanos, a qual, para além de comportar bolsas de investigação, incluiu um contrato de trabalho para um investigador doutorado júnior por 36 meses (DL57/2016). Tendo em conta os custos elevados destas componentes, a execução desta rubrica teve um peso de cerca de 65% em relação ao total do projecto. Para além desta, há a destacar a de Equipamento, visto que o projecto fez um investimento relevante (parcial, em conjunto com outros projectos) na aquisição de um Eye Tracker, central para as actividades de investigação desenvolvidas. Os desvios que temos a assinalar são os seguintes: - 2019 - ajuste necessário a nível orçamental na rubrica de Recursos Humanos, uma vez que uma alteração legislativa no período que mediou entre a submissão da candidatura e o início do projecto levou a que os custos relacionados com o contrato de trabalho do doutorado imputado fossem bastante superiores ao previsto. O projecto conseguiu através de um ajuste entre rubricas fazer face a esta contingência sem implicações para a execução das actividades científicas. - 2021 – reforço a nível orçamental na rubrica de Recursos Humanos, para possibilitar a renovação das bolsas de investigação de forma a fazer face aos efeitos da pandemia da COVID-19 nas actividades do projecto. - 2021/2022 - reforço necessário a nível orçamental na rubrica de Aquisição de Bens e Serviços, para se poder ultimar a ferramenta electrónica CSBS DP - Questionário do bebé para o Português Europeu automatic scoring program - e para fazer face à reformulação e à actualização do website do projecto.

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3. Indicadores

Indicar os valores do projeto até ao fim do período a que corresponde o presente relatório. Devem apenas ser indicadas concretizações efetivas. Não incluir publicações submetidas para publicação, nem teses que ainda não tenham sido discutidas.

3.1. Quadro de indicadores do projeto

Indicadores de realização física	Propostos	Realizados	% de execução
A - Publicações científicas			
B - Comunicações			
E - Formação avançada			
O - Patentes			
Livros ou capítulos de livros	0	0	n.a.
Artigos em revistas internacionais	3	12	400 %
Artigos em revistas nacionais	4	1	25 %
Comunicações em encontros científicos internacionais	6	25	417 %
Comunicações em encontros científicos nacionais	6	1	17 %
C - Relatórios	3	4	133 %
D - Organização de seminários e conferências	3	4	133 %
Teses de doutoramento	2	2	100 %
Teses de mestrado	1	1	100 %
Outras	0	0	n.a.
F - Modelos	0	0	n.a.
G - Aplicações computacionais	2	1	50 %
H - Instalações piloto	0	0	n.a.
I - Protótipos	0	0	n.a.
J - Produtos	2	2	100 %
K - Produções/criações artísticas	0	0	n.a.
L - Processos inovadores	0	0	n.a.
M - Bases de dados curadas	0	0	n.a.
N - Integração do conhecimento em atividades de formação superior	2	3	150 %
Patentes EPO	0	0	n.a.
Outras patentes	0	0	n.a.
Indicadores de resultados	Propostos	Realizados	% de execução
51 - Publicações científicas em domínios científicos enquadráveis na RIS3	7	7	100 %
52 - Pedidos de patentes europeias (EPO)	0	0	n.a.

4. Publicações e outras ações públicas de disseminação dos resultados do projeto

Note: References in gray shades refer to outputs in progress by the end of the project, and presented before the submission of the final report.

A – Publicações/Publications

Edições de revistas/Journal editions (Contabilizado em 3.1 como 'Artigo em Revista Internacional')

Accepted - **Filipe**, M., Carvalhais, L., Abbeduto, L., & **Frota**, S. (Accepted). Article collection on the Research Topic "Language Across Neurodevelopmental Disorders", section "Language Sciences". *Frontiers in Psychology*. Accepted in September 29, 2021. <https://www.frontiersin.org/research-topics/27065/language-across-neurodevelopmental-disorders>

Published – **Frota**, S., Esteve-Gibert, N., Molnar, M., & **Vigário**, M. (2022). Article collection on the Research Topic "Language Development Behind the Mask", section "Language Sciences". *Frontiers in Psychology*. February. <https://www.frontiersin.org/research-topics/19821/language-development-behind-the-mask>

Published - Lowit, A., **Frota**, S., & **Vigário**, M. (Eds.) (2021). Special Issue "Motor Speech Disorders and Prosody". *Brain Sciences* (ISSN 2076-3425), section Sensory and Motor Neuroscience. https://www.mdpi.com/journal/brainsci/special_issues/Motor_Speech_Disorders

Capítulos de livro/Book chapters

In prep - Jahanshahi, K., Gussenhoven, C., & **Frota**, S. (in prep). The acquisition of prosody: Stress and intonation. In Falahati, R. (Ed.), *Handbook of phonetics and phonology of modern iranian languages*. Springer Publications.

Submitted – **Frota**, S. & Santana Santos, R. (submitted). Aquisição da Prosódia no Português. In D. da Hora & C. Matzenau (Eds.), *Da aquisição à variação da fonologia do Português*. London, Routledge.

In press - **Frota**, S., **Filipe**, M., Lousada, M., Vidal, M. M., & **Vigário**, M. (in press). Capítulo 8. Desenvolvimento da prosódia infantil: Avaliação e intervenção. In M. J. Freitas, M. Lousada & D. C. Alves (Eds.), *Linguística Clínica: Modelos, Avaliação e Intervenção*. Berlin: Language Science Press. June 8.

Atas de conferências internacionais /Proceedings of international meetings (Contabilizado em 3.1 como 'Artigo em Revista Internacional')

Published – **Frota**, S., **Cruz**, M., & **Vigário**, M. (Eds.). (2022) *Proceedings of the 11th International Conference on Speech Prosody 2022*. May 23-26. <https://doi.org/10.21437/SpeechProsody.2022>

Published - **Sousa**, R., Silva, S., & **Frota**, S. (2022). Early Prosodic Development Predicts Lexical Development in Typical and Atypical Language Acquisition. *Proceedings of the 11th International Conference on Speech Prosody 2022*, Portugal, 387-391. May 23-26.

<https://doi.org/10.21437/speechprosody.2022-79> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published - **Frota, S., Pejovič, J., Severino, C., & Vigário, M.** (2020). Looking for the edge: Emerging segmentation abilities in atypical development. *Proceedings of the 10th International Conference on Speech Prosody 2020*, 814-818. <https://doi.org/10.21437/SpeechProsody.2020-166> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published - **Frota, S., Butler, J., Severino, C., Uysal, E., & Vigário, M.** (2019). Infant perception of prosodic boundaries without the pause cue: an eye-tracking study. In S. Calhoun, P. Escudero, M. Tabain & P. Warren (Eds.), *Proceedings of the 19th International Congress of Phonetic Sciences*, Melbourne, Australia 2019 (pp. 3160-3164). Canberra, Australia: Australasian Speech Science and Technology Association Inc. https://icphs2019.org/icphs2019-fullpapers/pdf/full-paper_733.pdf

Atas de conferências nacionais /Proceedings of national meetings (Contabilizado em 3.1 como 'Artigo em Revista Nacional')

Published - Vidal, M.M., Lousada, M., & **Vigário, M.** (2021). A influência da música no desenvolvimento da consciência fonológica aos 3 anos de idade. *Revista Portuguesa de Terapia da Fala*, 12(14). December 2021. <https://www.aptf-rptf.com/cópia-volume-11-1>

Artigos em revistas internacionais/Papers in international journals

In prep - **Filipe, M., Severino, C., Vigário, M., & Frota, S.** (in prep). Adaptation and validation of the European Portuguese Communication and Symbolic Behavior Scales Infant-Toddler Checklist. *International Journal of Language and Communication Disorders*.

In prep – Pejovic, J., Severino, C., Vigário, M., & Frota, S. (in prep). How sound patterns shape early word learning in typical and atypical development. *Child Development*.

Accepted - **Filipe, M., Cruz, S., Veloso, A., & Frota, S.** (accepted). Early predictors of language outcomes in Down Syndrome: A mini-review. *Frontiers in Psychology*. Accepted in May 16, 2022. [Publicação científica em domínios científicos enquadráveis na RIS3]

Published — **Frota S., Pejovic, J., Cruz, M., Severino, C., & Vigário, M.** (2022). Early Word Segmentation Behind the Mask. *Frontiers in Psychology*, 13, 879123. <https://doi.org/10.3389/fpsyg.2022.879123> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published - Pejovic, J., **Cruz, M., Severino, C., & Frota, S.** (2021). Early Visual Attention Abilities and Audiovisual Speech Processing in 5–7 Month-Old Down Syndrome and Typically Developing Infants. *Brain Sciences* 11(7), 939, Special Issue Down Syndrome: Neuropsychological Phenotype across the Lifespan). <https://doi.org/10.3390/brainsci11070939> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published – **Cruz, M., Butler, J., Severino, C., Filipe, M., & Frota, S.** (2020). Eyes or mouth? Exploring eye gaze patterns and their relation with early stress perception in European Portuguese. *Journal of Portuguese Linguistics*, 19(1), 4. In E. Albano & D. Demolin (Eds.), Special Collection *Laboratory Approaches to Portuguese Phonology*. <http://doi.org/10.5334/jpl.240>

Published - **Frota, S., Butler, J., Uysal, E., Severino, C., & Vigário, M.** (2020). European Portuguese-Learning Infants Look Longer at Iambic Stress: New Data on Language Specificity in Early Stress Perception. *Frontiers in Psychology, 11*, 1890. <https://doi.org/10.3389/fpsyg.2020.01890> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published - Vidal, M. M., Lousada, M., & **Vigário, M.** (2020). Music effects on phonological awareness development in 3-year-old children. *Applied Psycholinguistics, 41*, 299–318. <https://doi.org/10.1017/S0142716419000535> [Publicação científica em domínios científicos enquadráveis na RIS3]

Published - Silva, S., **Vigário, M.**, Fernandez, B.L., Jerónimo, R., **Alter, K., & Frota, S.** (2019). The sense of sounds: Brain responses to phonotactic frequency, phonological grammar and lexical meaning. *Frontiers in Psychology 10*, 681, March 28. <https://doi.org/10.3389/fpsyg.2019.00681> - [Publicação científica em domínios científicos enquadráveis na RIS3]

B – Comunicações e pósteres/Talks and posters

Comunicações em encontros internacionais/Talks in international meetings

In progress – **Frota, S., Pejovic, J., Severino, C., Sousa, R., Cruz, M., Paulino, N., & Vigário, M.** (2022). Predictors of Language Outcomes: a preliminary prospective longitudinal study in infants with low-risk and high-risk of developing language impairments. Talk presented at *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

In progress – **Sousa, R., Silva, S., & Frota, S.** (2022). Early Predictors of Language Outcomes: Prosody and Gestures. Talk presented at *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

In progress – **Frota, S., Pejovic, J., Cruz, M., Severino, C., & Vigário, M.** (2022). COVID – 19 related effects on early language development. Talk presented at *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

In progress – Pejovic, J., **Severino, C., Vigário, M., & Frota, S.** (2022). Predictive role of early word learning ability for lexical development in typically developing toddlers and toddlers at risk for language impairment. Talk presented at *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

Accepted – **Frota, S.** (Accepted). Developing prosody in typical and atypical language acquisition. Talk to be presented at the *The 4th International Symposium on Applied Phonetics (ISAPh 2022)*, Lund University, Sweden, September 14, 2022. Accepted in December 14, 2021.

Presented – Silva, S., **Severino, C., Vigário, M., & Frota, S.** (2022). Lexicality is processed before phonological grammar in 19-month-olds. Talk presented at the *Workshop on Infant Language Development (WILD)*, San Sebastian, Spain.

Presented – **Frota, S., Pejovic, J., Cruz, M., Severino, C., & Vigário, M.** (2022). Early word segmentation behind the mask. Talk presented at the *Workshop on Infant Language Development (WILD)*, San Sebastian, Spain.

Presented - **Alter**, K. (2021). The sense of sounds: Brain responses to phonotactic frequency, phonological grammar and lexical meaning. Talk presented at the *Seminar on Phonetics and Phonology*, March 2, 2021, University of Cambridge, UK.

Presented - **Frota**, S. (2021). Early Perception of Prosody is Language Specific. Invited talk presented at the *Third Experimental Portuguese Linguistics Workshop* (online), April 24, 2021.

Presented – **Frota**, S., Pejovic, J., **Severino**, C., & **Vigário**, M. (2021). How phonological knowledge shapes early word learning in (a)typical development: An eye-tracking study. Talk presented at *PaPE 2021 – Phonetics and Phonology in Europe* (online), June 21-23, 2021.

Presented - Pejovic J., **Severino**, C., **Vigário**, M., & **Frota**, S. (2021). The role of sound patterns on early word learning in typical and atypical infants. An eye-tracking study. Talk presented at *ISP XV – XV International Symposium of Psycholinguistics* (online), June 22-25, 2021.

Presented - **Filipe**, M., & **Frota**, S. (2020). A systematic review of early predictors of language impairments in neurodevelopmental disorders. Talk presented at the *28th Annual World Congress on Learning Disabilities* (online), September 4-5, 2020. [http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Apresentacao_Filipe_Frota%20\(2020\).pdf](http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Apresentacao_Filipe_Frota%20(2020).pdf)

Presented - **Frota**, S., Pejović, J., **Severino**, C., & **Vigário**, M. (2020). Looking for the edge: Emerging segmentation abilities in atypical development. Talk presented at the *10th International Conference on Speech Prosody 2020* (online), May 25-28, Tokyo, Japan. <https://www.youtube.com/watch?v=Kvp8jVrcRFc>

Presented - **Frota**, S., Pejović, J., **Severino**, C., & **Vigário**, M. (2020). Emerging word segmentation skills in atypical development. Talk presented at the *28th Annual World Congress on Learning Disabilities* (online), September 4-5, 2020. http://labfon.letras.ulisboa.pt/babylab/PLOS/files/LDW_Frota_et_al_2020.pdf

Presented - **Vigário**, M., **Filipe**, M., **Severino**, C., **Paulino**, N., **Sousa**, R., & **Frota**, S. (2020). Early language and communicative development profiles in Down Syndrome and in children at risk for language impairments. Talk presented at the *28th Annual World Congress on Learning Disabilities* (online), September 4-5, 2020. http://labfon.letras.ulisboa.pt/babylab/PLOS/files/LDW_Vigarario_et_al_2020_F.pdf

Presented - **Frota**, S. (2019). Early markers of language development in typically and atypically developing infants and toddlers. Invited talk presented at the *Workshop on Language and the Brain (WoLB 2019)*, October 3-4, Vigo, Spain. <https://tv.uvigo.es/video/5dd4fa601e19c03d1649a7cc>

Presented - Pejovic, J., **Cruz**, M., **Severino**, C., & **Frota**, S. (2019). Selective attention to audiovisual communicative cues in infants with Down syndrome. An eye-tracking study. Talk presented at *NeuroD-WELL – Workshop on Early Language in Neurodevelopmental Disorders*, November 8, Lisbon, Portugal. http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Pejovic,%20Cruz,%20Severino%20%20Frota_2019.pdf

Presented - **Vigário**, M., **Paulino**, N., **Severino**, C., & **Frota**, S. (2019). Early language development in European Portuguese-learning infants and toddlers with Down Syndrome measured with the CDI. Talk presented at *NeuroD-WELL - Workshop on early language in neurodevelopmental disorders*. November 8, Lisbon, Portugal.

Presented - **Vigário**, M., **Butler**, J., **Severino**, C., Uysal, E., & **Frota**, S. (2019). Infants discriminate utterances with and without internal prosodic boundaries: An eye-tracking study

with delexicalized speech. Talk given at *LCICD 2019 - The 4th Lancaster Conference on Infant and Early Child Development*, August 21-23, Lancaster, UK. http://labfon.letras.ulisboa.pt/files/Vigario_et_al_2019.pdf

Comunicações em encontros nacionais/Talks in national meetings

Presented - **Paulino, N., & Frota, S.** (2019). Measuring early development of language skills in infants and toddlers learning Portuguese and an Additional Language: Implications for language assessment in Bilinguals. Talk given at *XXXV Encontro Nacional da Associação Portuguesa de Linguística*, October 9-11, 2019, UMinho, Braga, Portugal. http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Paulino%20%20Frota_APL2019_Final.pdf

Pósteres em encontros internacionais/Posters in international meetings (Contabilizado em 3.1 como 'Comunicações em encontros científicos internacionais')

In progress – Pejovic, J., **Cruz, M., Vigário, M., & Frota, S.** (2022, August 29). Meet a new project: Does the face help to say what the ear listens? [Poster presentation]. *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

In progress – **Filipe, M., Cruz, S., Veloso, A., & Frota, S.** (2022, August 29). Early predictors of language in Down Syndrome: A systematic review [Poster presentation]. *Second Workshop on Early Language in NEUROdevelopmental Disorders (NeuroD-WELL)*, Lisbon, Portugal, August 29, 2022.

Presented - **Sousa, R., Silva, S. & Frota, S.** (2022, June 9-11). Early predictors of language outcomes: Prosody and gestures [Poster presentation]. *Workshop on Infant Language Development (WILD)*, San Sebastian, Spain.

Presented – Lu, S., **Severino, C., Vigário, M. & Frota, S.** (2022, June 9-11). An electrophysiological study on stress discrimination by European Portuguese – learning infants [Poster presentation]. *Workshop on Infant Language Development (WILD)*, San Sebastian, Spain.

Presented - **Cruz, M., Pejovic, J., Severino, C., Vigário M., & Frota S.** (2022, May 23-26). Auditory and visual cues in face-masked infant-directed speech [Poster presentation]. *11th International Conference on Speech Prosody*, Lisbon, Portugal. <http://dx.doi.org/10.21437/SpeechProsody.2022-130>

Presented - **Sousa, R., Silva, S., & Frota, S.** (2022, May 23-26). Early Prosodic Development Predicts Lexical Development in Typical and Atypical Language Acquisition [Poster presentation]. *11th International Conference on Speech Prosody*, Lisbon, Portugal. https://www.researchgate.net/publication/363215242_Early_Prosodic_Development_predicts_Lexical_Development_in_typical_and_atypical_language_acquisition

Presented – Pejovic, J., **Severino, C., Vigário, M., & Frota, S.** (2021, August 25-27). The role of sound patterns on early word learning and language development in typical and atypical toddlers [Poster presentation]. *LCICD 2021 – The 6th Lancaster Conference on Infant and Child Development (online)*. UK, Lancaster University.

Presented - **Cruz, M., Pejovic, J., Severino, C., & Frota, S.** (2020, November 5-8). Eye-gaze patterns in early infancy and later language and communication outcomes [Poster presentation]. *45th Boston University Conference on Language Development (BUCLD)* (online). <https://www.youtube.com/watch?v=WJvoWVplEHQ>

Presented - **Cruz, M., Pejovic, J., Severino, C., & Frota, S.** (2020, July 6-9). Eye-gaze patterns to communicative cues in early infancy and later language and communication outcomes [Poster presentation]. *vICIS 2020 Congress – Virtual International Congress on Infant Studies* (online). http://labfon.letras.ulisboa.pt/babylab/PLOS/files/ICIS_2020_poster_Cruz%20et%20al_QR_code.pdf

Presented - **Frota, S., Pejović, J., Severino, C., & Vigário, M.** (2020, July 6-9) Prosody facilitates word segmentation in infants at risk for language impairment [Poster presentation]. *vICIS 2020 Congress – Virtual International Congress on Infant Studies* (online). https://www.researchgate.net/publication/342747583_Prosody_facilitates_word_segmentation_in_infants_at_risk_for_language_impairment

Presented - **Frota, S., Vigário, M., Alter, K., Cruz, M., Severino, C. & PLOs Research Team** (2019, November 8) The PLOs project: Predictors of Language Outcomes in infants and toddlers at risk for language impairment [Poster presentation]. *NeuroD-WELL – Workshop on Early Language in Neurodevelopmental Disorders*, Lisbon, Portugal. http://labfon.letras.ulisboa.pt/NeuroD-WELL/files/PLos_Frota_et_al_NeuroD-WELL.pdf

Presented - Czeke, N., Zahner, K., Rimpler, J., Braun, B., & **Frota, S.** (2019, June 13-15). German infants do not discriminate Portuguese rising vs. falling contours [Poster presentation]. *4th Workshop on Infant Language Development (WILD)*, Potsdam, Germany. http://labfon.letras.ulisboa.pt/files/Czeke_et_al_2019.pdf

Presented - **Frota, S., Butler, J., Severino, C., Uysal, E., & Vigário, M.** (2019, August 4-10). Infant perception of prosodic boundaries without the pause cue: An eye-tracking study [Poster presentation]. *ICPhS 2019 – XIX International Congress of Phonetic Sciences*, Melbourne, Australia. http://labfon.letras.ulisboa.pt/files/Frota_et_al_2019.pdf

C – Relatórios/Reports

Relatório Final do Projeto PLOs (PTDC/LLT-LIN/29338/2017).

Relatório de Progresso 3 do Projeto PLOs (PTDC/LLT-LIN/29338/2017).

Relatório de Progresso 2 do Projeto PLOs (PTDC/LLT-LIN/29338/2017).

Relatório de Progresso 1 do Projeto PLOs (PTDC/LLT-LIN/29338/2017).

D – Organização de seminários, cursos, conferências, workshops.../Organization of seminars, courses, conferences, workshops...

In progress - *NeuroD-WELL 2022, Workshop on Early Language in Neurodevelopmental Disorders*, August 29, 2022, Faculdade de Letras, Universidade de Lisboa. Organizing committee (members of PLOs project): **S. Frota** (Chair), **M. Vigário** (Co-Chair), **C. Severino**,

M. Cruz, M. Filipe, N. Paulino, R. Sousa. <http://labfon.letras.ulisboa.pt/NeuroD-WELL2/index.html>

Concluded - *Speech Prosody 2022*. Theme: Getting the prosody right: Acquisition, Impairment, Interventions, and Beyond. May 23-26, 2022, Lisbon, Portugal. Organizing committee (members of PLOs project): S. Frota (Chair), M. Vigário (Co-Chair), C. Severino, M. Cruz, M. Filipe, N. Paulino, R. Sousa. <http://labfon.letras.ulisboa.pt/sp2022/index.html>

Concluded - *NeuroD_WELL*. *Workshop on early language in neurodevelopmental disorders*. November 8, 2019. Lisbon, Portugal. Organizing committee (members of PLOs project): S. Frota (chair), M. Vigário (co-chair), C. Severino, M. Cruz. <http://labfon.letras.ulisboa.pt/NeuroD-WELL/index.html>

Concluded - Vigário, M. & Frota, S. (Org.) (2019) *FALAS NO LABFON*. Working sessions of Laboratório de Fonética e Fonologia & Lisbon BabyLab (CLUL), October 9, Lisbon, Portugal. http://labfon.letras.ulisboa.pt/files/Falas_no_Labfon_OUT_2019.pdf

Concluded - LabPhon 16. Variation, development and impairment: Between phonetics and phonology, University of Lisbon, June 19-23, 2018. Organizing committee (members of PLOs project): S. Frota (Chair), M. Vigário (Co-Chair), J. Butler, C. Severino, M. Cruz, M. Filipe, N. Paulino, R. Sousa <http://labfon.letras.ulisboa.pt/LabPhon16/index.html>

E - Formação avançada/Advanced Training

Teses de Doutoramento/PhD Theses

In progress – Paulino, N. (in progress). *Effects of prosodic systems in bilingual acquisition of sandhi* [Unpublished doctoral thesis]. Faculdade de Letras, Universidade de Lisboa. (started February 2019)

Funded by Fundação para a Ciência e a Tecnologia - SFRH/BD/138535/2018.

Supervisor: Sónia Frota; Co-supervisors: Tjerk Hagemeijer & Laura Bosch.

In progress – Guimarães, E. (in progress). *Aquisição da Prosódia da Língua Gestual Portuguesa* [Unpublished doctoral dissertation]. Faculdade de Letras, Universidade de Lisboa. (started August 2021)

Funded by Fundação para a Ciência e a Tecnologia – UIDP/00214/2020

Supervisor: Marina Vigário; Co-supervisor: Marisa Cruz.

Defended - Matos, N. (2021). *Medir o Tempo: Um estudo sobre os padrões duracionais em Português Europeu nos primeiros três anos de idade* [Unpublished doctoral thesis]. PhD Dissertation defended in December 2021, Faculdade de Letras, Universidade de Lisboa.

Funded by Fundação para a Ciência e a Tecnologia - SFRH/BD/82710/2011

Supervisor: Sónia Frota.

Defended - Vidal, M. M. (2019). The influence of music in the development of phonetics, phonology and phonological awareness in 3-year-olds with typical development and 3- to 6-year-olds with speech and language disorder [Unpublished doctoral thesis]. Dissertation defended in December 2019, Faculdade de Letras, Universidade de Lisboa (started 2014)

Funded by Fundação para a ciência e a Tecnologia - SFRH/BD/98841/2013. Supervisor: Marina Vigário.

Teses de Mestrado/Ma Theses

Defended - **Sousa, R.** (2022). *Early Predictors of Language Outcomes: Prosody and Gestures* [Unpublished master's thesis]. Faculdade de Letras, Universidade de Lisboa.
Supervisor: Sónia **Frota**; Co-supervisor: Susana Silva

G – Aplicações computacionais/Computational applications

Published - **Frota, S. Cruz, M., & Vigário, M.** (2020). *MacArthur-Bates CDI para o Português Europeu Formas Reduzidas: Programa de Cotação Automática*. Software for Windows and Macintosh OS. ISBN 978-989-54771-0-4.

J – Produtos (Produções/Criações artísticas)/Products

Published - **Frota, S., Cruz, M., Silva, P., & Filipe, M.** (2022). *CSBS-DP App: Aplicação online para cotação automática da CSBS DP Infant-Toddler Checklist – Adaptação para o Português Europeu (Questionário do bebé das Escalas de Desenvolvimento da Comunicação e Comportamento Simbólico)*. <http://csbs-dp-pe-app.lettras.ulisboa.pt/>

Published - **Frota, S., Cruz, M., Silva, P. & Vigário, M.** (2020). *CDI-PE App: Aplicação online para avaliação de competências de linguagem e seu desenvolvimento baseada no MacArthur-Bates CDI para o Português Europeu Formas Reduzidas*. ISBN 978-989-54771-1-1. <https://cdi-pe-app.lettras.ulisboa.pt/>

N – Integração do conhecimento em atividades de formação superior/Integration of acquired knowledge in advanced training activities

In progress - **Cruz, M. & Vigário, M.** (Coordinator). *vTEM II -Virtual Training in Experimental Methods*, University of Lisbon, Portugal, online, September 2-30, 2022. Scientific coordination: M. **Cruz** & M. **Vigário**. Organizing committee (members of PLOs project): S. **Frota**, C. **Severino**, N. **Paulino**, R. **Sousa**. <http://labfon.lettras.ulisboa.pt/virtualschool/2022/en/program.html>

Concluded – **Cruz, M. & Vigário, M.** (Coordinator). *vTEM -Virtual Training in Experimental Methods*, University of Lisbon, Portugal, online, March 15-April 16, 2021. Scientific coordination: M. **Cruz** & M. **Vigário**. Organizing committee (members of PLOs project): S. **Frota**, C. **Severino**, N. **Paulino**, R. **Sousa**. <http://labfon.lettras.ulisboa.pt/virtualschool/en/program.html>

Concluded - **Frota, S. & Martins, F.** (Coordinator). *STEM VI - Summer Training in Experimental Methods*, University of Lisbon, Portugal, online, September 7-9, 2020. Labfon Summer School, Organization and monitors involved (members of PLOs team): S. **Frota**, M. **Vigário**, M. **Cruz**, C. **Severino**, N. **Paulino**, R. **Sousa**. <http://labfon.lettras.ulisboa.pt/summerschool/2020/index.html>

Concluded – **Frota, S., & Martins, F.** (Coordinator) *STEM V – Summer Training in Experimental Methods*, September 2-7, 2019. Organization and monitors involved (members of PLOs team): S. **Frota**, M. **Vigário**, M. **Cruz**, C. **Severino**, N. **Paulino**, R. **Sousa** <http://labfon.lettras.ulisboa.pt/summerschool/2019/index.html>

Training activities

CuttingEEG 2021, October 4-7, 2021. University of Aix-Marseille, Aix-En-Provence, France (with the participation of a PLOs research team member)

Deep Dive into ERPs Technique Online Course, May-June, 2021, by Sciencebeam (with the participation of a PLOs research team member)

Statistical analysis workshop - An introduction to “R”, March 5-April 7, 2020. Powered by the Medical School, University of Lisbon, Portugal (with the participation of PLOs research team members)

EEG and Language Crash Course, June 6-7, 2019. Heriot-Watt University, Edinburgh, Scotland (with the participation of a PLOs research team member)

4.3. Ações públicas de disseminação dos resultados do projeto (22)

Comunicações em encontros nacionais/Talks in national meetings

Presented - **Frota, S. Cruz, M., & Vigário, M.** (2020) E-health: screening language and communication development in early infancy. Demo presented at *Encontro Ciência 2020*, November 2-4, Lisbon, Portugal. <https://www.youtube.com/watch?v=zEF2BTNesJg>

Presented - **Frota, S., Severino, C., Pejovič, J., Paulino, N., Cruz, M., Sousa, R., & Vigário, M.** (2020). Early language development in Down Syndrome: Basic and translational research. Talk presented at *Encontro Ciência 2020*, November 2-4, Lisbon, Portugal. <https://www.encontrociencia.pt>

Presented - **Frota, S., Severino, C., Pejovič, J., Paulino, N., Cruz, M., Sousa, R., & Vigário, M.** (2020). Desenvolvimento da linguagem nos dois primeiros anos de vida: Marcadores precoces. Talk presented at *XXVI Jornadas de Pediatria do Centro Hospitalar Universitário Lisboa Norte* (Theme: *Pediatria Translacional 2020*), February 13-14, 2020, Lisbon, Portugal. http://labfon.lettras.ulisboa.pt/babylab/PLOS/files/Jornadas_Pediatria2020_Frota_et_al_sent.pdf

Presented - **Frota, S.** (2019). Desenvolvimento da linguagem na trissomia 21: sinais precoces. Invited talk presented at *Trissomia 21: 3 Décadas a fazer a Diferença*, October 26, Auditório do IPDJ, Lisbon, Portugal.

Presented – **Frota, S.** (2019). Escuta bebé! Descobrir a língua antes da fala. Invited talk given at *2as Jornadas do Centro de Estudos do Bebê e da Criança do Hospital Dona Estefânia*, May 20, Lisboa, Portugal. http://labfon.lettras.ulisboa.pt/files/Frota_2019.pdf

Presented - **Vigário, M., Severino, C., Cruz, M., Filipe, M., Butler, J., & Frota, S.** (2018). Marcadores precoces de desenvolvimento da comunicação e linguagem. Talk given at *Ciência 2018 – Encontro com a Ciência e Tecnologia*, July 2-4, Lisboa, Portugal http://labfon.lettras.ulisboa.pt/files/Ciencia2018_Vigarior_et_al_Publish.pdf

Pósteres em encontros nacionais/Posters in national meetings

Presented - **Frota, S., Severino, C., Pejović, J., Butler, J., & Vigário, M.** (2019, November 16). *Competências de segmentação de palavras em bebês com Trissomia 21* [Poster presentation]. 2nd Lusíadas Clinical Summit (online), Estoril, Portugal. http://labfon.letras.ulisboa.pt/babylab/horizon21/files/Clinical_Summit_Segmentacao_Palavras_Frota_et_al.pdf

Presented - **Frota, S., Cruz, M., Severino, C., Pejovic, J., Sousa, R., & Vigário, M.** (2019, November 16). *Projeto PLOs: Preditores de Desenvolvimento de Perturbações da Linguagem e Comunicação* [Poster presentation]. The 2nd Lusíadas Clinical Summit – The Circle of Life, Centro de Congressos do Estoril, Estoril, Portugal. http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Clinical_Summit_PLOs_Frota_et_al_final.pdf

Presented - **Vigário, M., Paulino, N., Pejovic, J., Cruz, M., Severino, C., Sousa, R., João, V., & Frota, S.** (2019, November 16). *Avaliação do desenvolvimento da linguagem: Questionários do Desenvolvimento Comunicativo para o Português Europeu (CDI-PE FR)* [Poster presentation]. The 2nd Lusíadas Clinical Summit – The Circle of Life, Centro de Congressos do Estoril, Estoril, Portugal. https://labfon.letras.ulisboa.pt/babylab/horizon21/files/Clinical_Summit_CDI_Vigario_et_al_final.pdf

Media

Language acquisition, prosody, and the Lisbon Baby Lab. Prof. Sónia **Frota** interviewed for a Youtube channel – The Dissenter, 7 January 2022. <https://www.youtube.com/watch?v=fxffd8Mgkj4>

Experimentar a fala: bebês e crianças. Visit to the Lisbon BabyLab (CLUL/FLUL) included in the program of Semana C&T 2021, organized by Agência Ciência Viva, 22-28 November 2021. Coordinator: M. **Vigário**. https://www.cienciaviva.pt/semanact/2021/eventos.php?acao=showactivities&id_activity=1392

TV program ‘Tenho um bebé. E agora? (Canal Saúde+), news and interview on *As Perturbações do Espectro do Autismo (e o Projeto PLOs)*, December, 2019. <https://www.saudemais.tv/video/140112-tenho-um-bebe-e-agora-t05-e011-02?fbclid=IwAR1wzYMG-Luj9-Jt2HBM6VO64UwhcHyKuhfCdnDvDpYMPdW5zMHf6yPtBzw%20%20target=>

Lisbon Baby Lab na série documental "Outra Escola" dedicada ao mundo dos bebês e as aprendizagens dos 0 aos 3 anos (RTP2, 15 Dez 2019). <https://www.rtp.pt/play/p6335/e445094/outra-escola%20target=>

Newspaper article “Como é que os bebês comunicam antes de começar a falar”, published in *O Público*, May 24, 2019. <http://labfon.letras.ulisboa.pt/babylab/PLOS/files/jornadas.pdf>

Newsletters

Newsletter no. 4 of Lisbon Baby Lab, 2018/2019. http://labfon.letras.ulisboa.pt/babylab/pt/files/news/Newsletter_4_2019.pdf

Reuniões/Meetings

Closing meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) - July 2022.

Virtual meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) - November 2020.

Meetings held with the project consultant Dr. Miguel Palha, as well as with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital). The CEBC was established as a regular collaborator of PLOs and the Lisbon Baby Lab, and a protocol was signed. Meetings also held with the heads of the Pediatric Department and the Neurodevelopment unit of Hospital Santa Maria to foster collaboration among the different parties – October 2019.

Meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) - May 2019.

Meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) - December 2018.

Meetings held to achieve the collaboration of the Neurodevelopment unit of Hospital Santa Maria and the Center for the Study of the Baby and Child (Centro de Estudos do Bebê e da Criança) of Hospital D. Estefânia - July 2018.

Meetings with the consultants Prof. Catherine Best and Dr. Miguel Palha – June 2018.

5. Ficheiros anexos (opcional)

Neste item poderão incluir-se, se necessário, ficheiros em formato PDF ou Excel, que tenham sido referidos ao longo do presente relatório, como, por exemplo, gráficos, esquemas e/ou fotografias.

O conjunto dos ficheiros (em número máximo de cinco) ou o arquivo a submeter não poderão exceder 10MB.

PLOs_Detailed_description.pdf

Ponto do presente relatório a que respeita: 2.2. Resumo dos trabalhos

Descrição: Detailed description of research activities

Final Report (September, 2022)
Detailed description of research activities

1. Introduction

A detailed description of the research activities developed within the PLOs project is presented in this document. The research plan was implemented through six tasks that are at the core of the research activities developed by the project team, under the broader goal of studying early language acquisition in typical and atypical development focusing on the identification of early signs for language and communication impairments.

- (1) Tasks
1. Recruitment and early assessment of participants for inclusion in the PLOs study (Task 1)
 2. Tools for e-health (Task 2)
 3. Looking while listening experimental tasks (Task 3)
 4. ERP tasks (Task 4)
 5. Longitudinal assessment of language abilities (Task 5)
 6. Prospective evidence for predictors of language outcomes (Task 6)

Task 1 was central to all others. It established the participants' initial database of the project as well as the early screening procedures. Participant recruitment turned out to be an ongoing and challenging task along the project, mostly due to the COVID-19 pandemic. Task 1 also included the data collection of the CSBS DP normative data. Task 2 was devoted to the development of new tools for e-health, promoting the general widespread use of the language and communication assessment tools mostly used within the project through the availability of electronic applications that make health monitoring and intervention in the early development field highly flexible and possible in a rich variety of contexts and users, namely in clinical settings. Tasks 3 and 4 were directed to experimental data collection, using a combination of non-invasive methods. The languages abilities of each infant/toddler that participated in Tasks 3 and 4 were measured concurrently and later on, at different time points in development, according to the longitudinal plan defined in Task 5. Tasks 3, 4 and 5 thus ensure a massive data collection using a multi-methodology approach that combines looking time measures, eye-tracking measures, ERP measures, and language and communication assessment measures (e.g., CDI, CSBS DP, Griffiths, DCQ). The research activities of these three tasks converge on an integrated database of early language development measures that is the focus of analysis in Task 6 with the central goal of identifying prospective evidence for predictors of language outcomes, and thus early signs of risk for language and communication impairments. Crucial to the understanding of language development trajectories in atypical/at-risk groups is the characterization of typical development for the same set of language and communication abilities. In the case of ERP measures, the absence of adult studies in the relevant domains requires that such studies also needed to be conducted.

The activities specific to each task are described in section 2. According to the initial planning, the accomplishment of data collection for task 5 depends on the moment and age of the infant/toddler as he/she entered the research. So, for some participants, data collection is

ongoing as they have not yet reached 30 months of age. Furthermore, we are following a subgroup of participants beyond 30 months of age (the PLOs-EBELa, and also a subgroup of PLOs participants), ideally until 6 years of age as indicated in the application. This follow-up is still in progress and will feed further analyses on the identification of early predictors of language outcomes as signs of risk for language and communication impairment.

Other activities developed within the project, namely the organization of workshops, conferences, and other outreaching activities are described in section 3. In section 4 we highlight the main outputs of the project, and comment on the ongoing research and networking activities that were founded within the project and will persist beyond it.

2. Research activities by task

Task 1. Recruitment and early assessment of participants for inclusion in the PLOs study

A recruitment procedure was established that included the network of institutions collaborating with PLOs, the social media, and access to birth registries was available from the second year of the project onwards. The protocol signed between the Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital) and the Lisbon Baby Lab was key for the recruitment of at-risk infants. Clinicians directed the families of infants at risk for language and communication impairment to the Lisbon Baby Lab where the PLOs project was presented to caregivers. A total number of 412 low-risk or typically developing children (TD) and 159 high-risk children (AR) was recruited (30 other AR children were recruited, but 22 were bilingual or bidialectal and for 8 the AR profile was not confirmed, thus not meeting the inclusion criteria; therefore, the final AR sample is 21 infants less than the initial target number, that had to be adjusted given the new pandemic context). The AR groups are represented in the sample as follows: 67 infants/toddlers with familial risk for neurodevelopmental disorders; 48 preterm infants; 12 infants with low birth weight as the only known risk factor; 17 infants/toddlers with other risk factors (e.g., low APGAR score, motor or global developmental delay, neurodegenerative genetic conditions); 15 late talkers.

The time points for data collection in the PLOs prospective longitudinal design for typically developing (TD) and at-risk children (AR) are shown in Figure 1. Table 1 shows the total number of data points collected for the experimental tasks (i.e., overall, 647 experiments were run with TD children and 241 with AR children), and for the initial screening and longitudinal language assessment (i.e., overall, 2325 for TD and 735 for AR). There was an average of 7 data points per TD participant and 6 data points per AR participant. Tables 2 and 3 respectively detail the numbers of participants per language and communication assessment tool and experimental task. In Table 3, the number of infants and toddlers successfully tested in the experimental tasks is also given.

The data collection for the EEG tasks for the at-risk children is ongoing (see Task 4 below), as well as the data collection for the Griffiths and the DCQ (in the latter case mostly for the extended sample of older children between 3 and 6 years of age; see Task 5 below). These activities will be supported by independent funding from the research group.

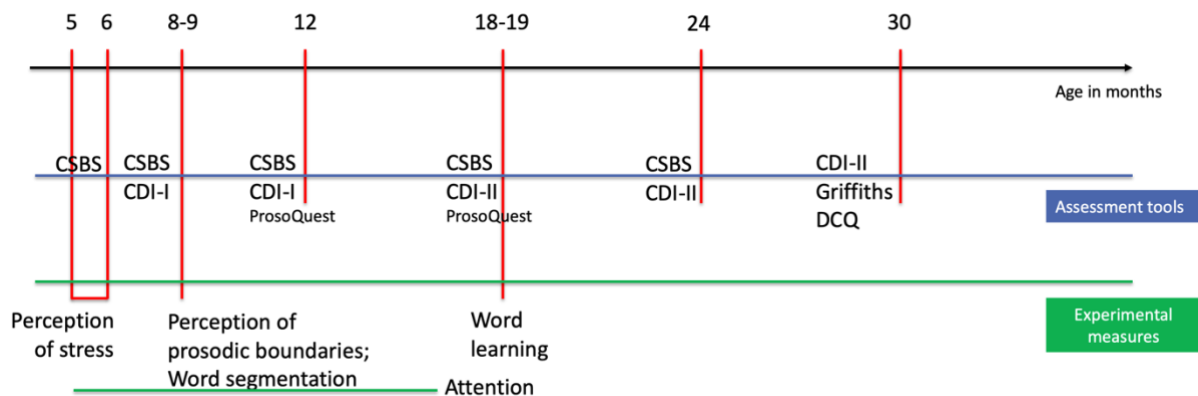


Figure 1. Prospective longitudinal design for the PLOs sample

Table 1. Total of data points collected for TD and AR: experimental tasks and assessment tools

Data points / Groups	TD	AR
Attention task	114	77
Looking while listening		
Looking time	123	88
Eye-tracking	89	60
ERP	141	16
Parental reports (completed)	2291	723
Griffiths	34	12
Total	2792	976

Table 2. Parental reports completed per group

Groups	TD	AR
Parental reports (completed)		
CSBS DP	940	280
CDI-I	480	105
CDI-II	190	96
ProsoQuest	462	181
DCQ	219	61

Table 3. Experimental tasks run in the different language domains under analysis

	Tested		Successfully tested	
	TD	AR	TD	AR
Looking...				
Word segmentation	111	72	98	62
Intonation	12*	16	12*	15
Eye-tracking				
Stress	31	14	24	14
Prosodic boundaries	27	17	25	15
Word learning	37	33	31	29
Total	218	152	190	135
ERP				
Stress	42	0	33	0
Prosodic boundaries	55	5	47	3
Word learning	44	11	42	11
Total	141	16	122	14

*Data from 40 TD infants had been previously analyzed and was used as the main reference for comparison with the AR infants' performance (cf. Frota, Butler & Vigário, 2014).

A major outcome of task 1 was the completion of the normative data for the CSBS DP screening tool. The sample to be collected for the CSBS normative data was enlarged to include around 600 children to match the requirements of a large number of children per age to feed the norming study. In the end, data from 611 children between 6 and 24 months were included in the norming study (journal article in preparation). The norms were key to the implementation of one of the e-health tools developed.

Task 2. Tools for e-health

Three tools were planned to be developed within the project to enable the automatic scoring of two highly relevant instruments for the screening and assessment of early language and communication abilities: the Portuguese Communicative Development Inventory (CDI) Short forms (EP-CDI SFs) and the EP version of the CSBS DP infant-toddler checklist. A further crucial goal was making health monitoring and intervention in this field highly flexible and possible in a rich variety of contexts and users, thus promoting its widespread use.

Three tools were developed. Two of them provide automatic versions of the EP-CDI SFs. The EP-CDI SFs were already publicly available together with the respective normative tables on the Portuguese CDI website (<http://labfon.letras.ulisboa.pt/babylab/pt/CDI/>). However, no scoring program was yet available, unlike for other languages. A scoring program was developed for Windows and Mac operating systems (Figure 2). The program calculates scores and percentiles, by age and gender, for all the key variables of the EP-CDI SFs: receptive and expressive vocabulary for Level I (8-18 months); expressive vocabulary, production of complex words, and production of word combinations for Level II (16-30 months). As additional features, the program also generates an individual child report, and letter templates that may be customized by users, as well as tables or spreadsheets that can be imported to other applications (e.g., databases, spreadsheets).



Figure 2. MacArthur-Bates CDI for European Portuguese Short Forms: Automatic Scoring Program.

Besides the automatic scoring program, the EP-CDI App, an online multiplatform application was also produced (Figure 3; <https://cdi-pe-app.letras.ulisboa.pt>). Unlike the scoring program that requires a computer to run, the app is always available in any platform (e.g., computer, tablet, smartphone) and thus more accessible allowing a quick screening and assessment in a variety of clinical, educational and home environments. The app was developed in interaction with our clinical partners, that commented on the features of the app, made suggestions of changes/additions and tested the app in clinical settings. Thus, the app includes other relevant features: (i) three child profiles can be chosen (monolingual child, bilingual child, child with Down Syndrome), based on the normative data for TD monolingual children, for TD children acquiring Portuguese and one additional language (i.e., bilinguals), and for children with Down Syndrome; (ii) two user profiles can be chosen (caregiver and professional). The caregiver profile offers on screen information together with a report letter. The professional profile offers additional features, such as a technical report and the ability to track the development of a given child over time (Figure 4). A video presentation of the EP-CDI App is available at <https://www.youtube.com/watch?v=zEF2BTNesJg> .

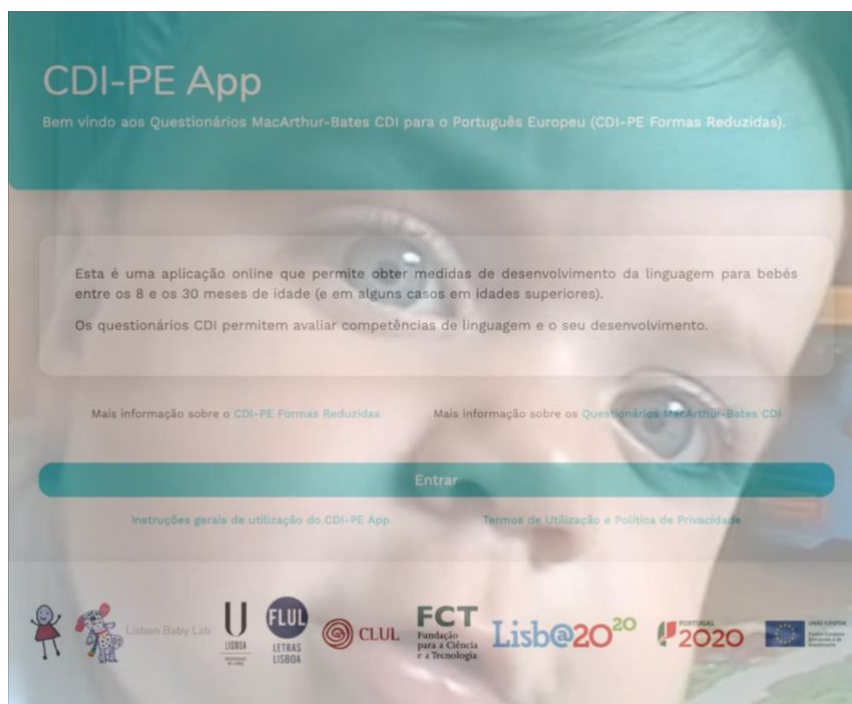


Figure 3. EP-CDI App: online application

Given the high receptivity to the EP-CDI app, the automatic scoring for the CSBS DP was implemented in a similar way through the CSBS DP App (Figure 5). The CSBS norming study for EP developed within the project was crucial to the creation of this tool. The CSBS DP checklist offers measures of emotion and eye gaze, communication, gestures, sounds, words, understanding and object use, which have been related to language and communication development. The CSBS DP App allows the automatic scoring for all measures, together with a number of other features similar to those available in the EP-CDI App.

The CDI and the CSBS DP cover a wide range of abilities, and these tools may constitute an important step in routine developmental screening for early language and communication in children.

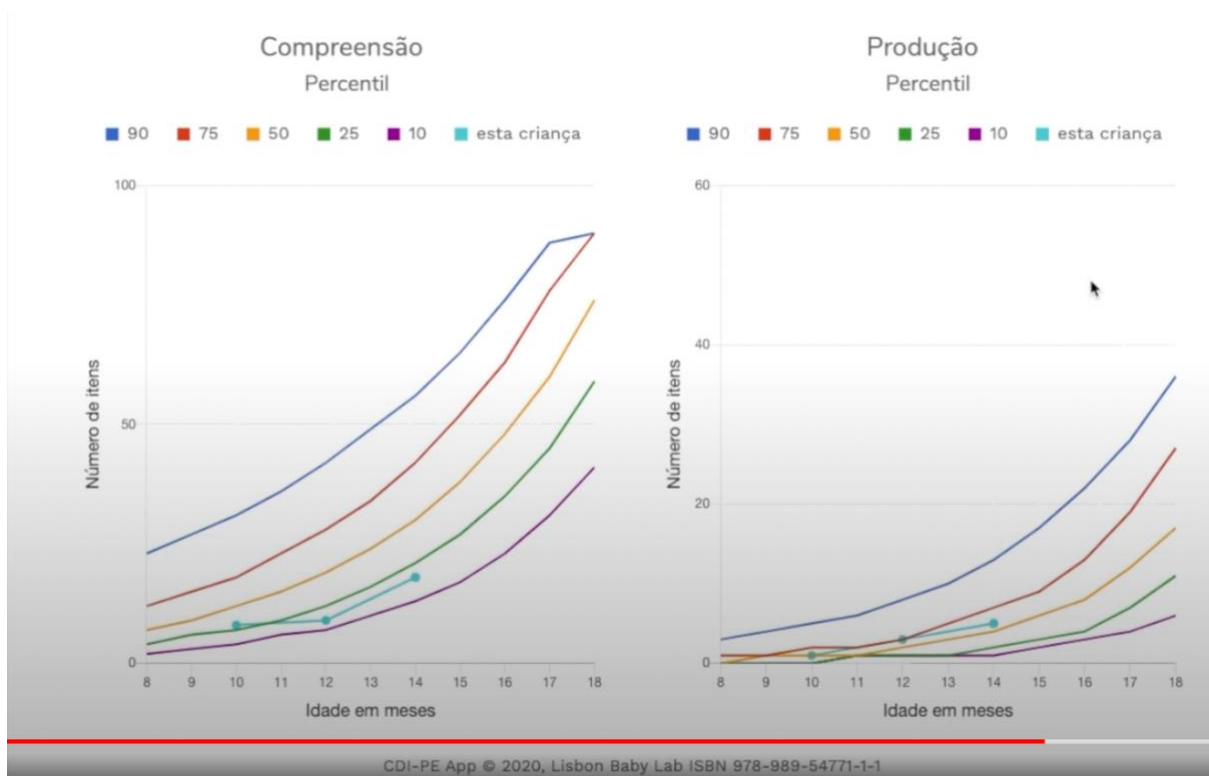


Figure 4. EP-CDI App: Tracking child development over time

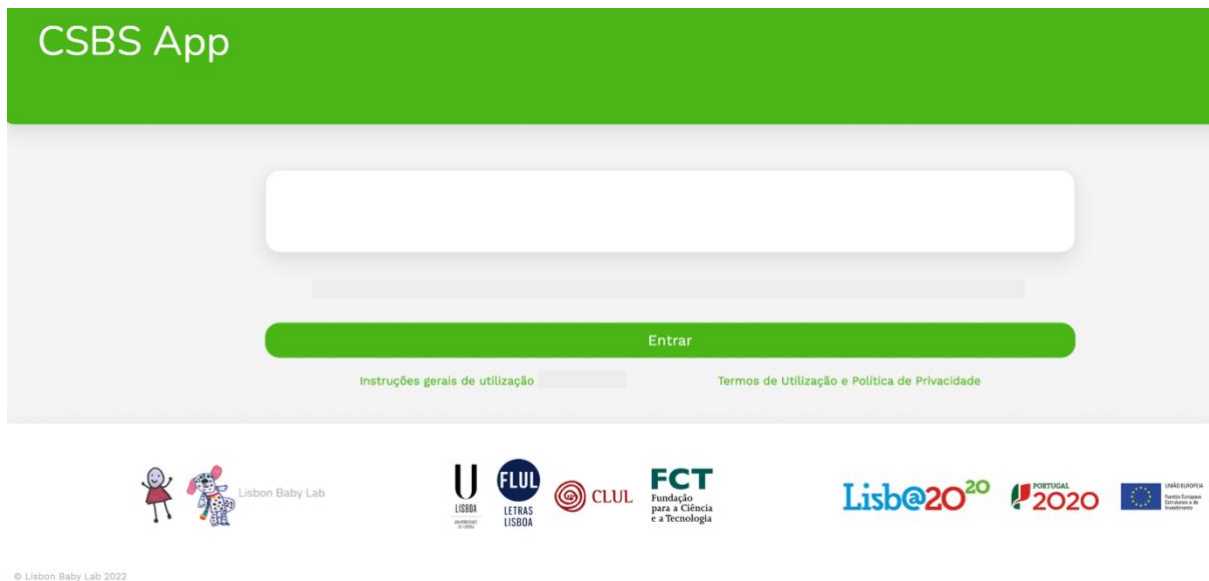


Figure 5. CSBS DP App: online application

Task 3. Looking while listening experimental tasks

The experimental paradigms for the 5 experiments, that had been previously used in other projects, were revised and tested again prior to data collection. An attention experiment with a shift of visual attention task (also previously used) was added to the experimental set, to ascertain the developing attention skills and their relation to language development. Giving the pandemic context in which most of the data collection had to take place, it was decided to prioritize the looking while listening experiments for the AR infants/toddlers. The AR participants were a more sensitive sample, that was not only demanded more intensive

recruitment efforts involving partnerships with the clinical sector, but was also more constrained by the restrictions imposed by the pandemic. This decision was made to ensure that enough data was collected for this set of tasks, for which the studies with TD children were already more advanced.

The versions of the visual habituation paradigm and visual familiarization paradigm used to test intonation discrimination and word segmentation in the TD infants proved effective with AR infants. As for eye-tracking (ET), an anticipatory looking paradigm was used to test stress perception both in TD and AR infants. Processing of prosodic boundaries was measured with an ET version of the visual fixation paradigm implementing a familiarization phase using accumulated visual fixation. The word learning experiment used a visual choice paradigm. Eye gaze patterns to talking faces were a further measure offered by the experimental materials used.

A proceedings paper on early word segmentation abilities in typical and atypical development was published. The comparison between the TD and AR groups showed that the latter exhibit similar patterns to the TD, although utterance-medial segmentation seems to be delayed (Figure 6). Thus, unlike infants and toddlers with Down Syndrome, AR infants and toddlers seem to show a similar, albeit delayed, developmental trajectory of this crucial ability for language development. Importantly, segmentation abilities for the AR children were correlated with their receptive vocabulary measured with the CDI, suggesting a possible link between early word segmentation and vocabulary development also in AR children similarly to reports for TD children. This paper provided the first evidence suggesting different developmental paths for low-risk and high-risk infants, with the latter showing differences between infants with familial risk and preterm birth on the one hand, and infants with Down Syndrome on the other hand.

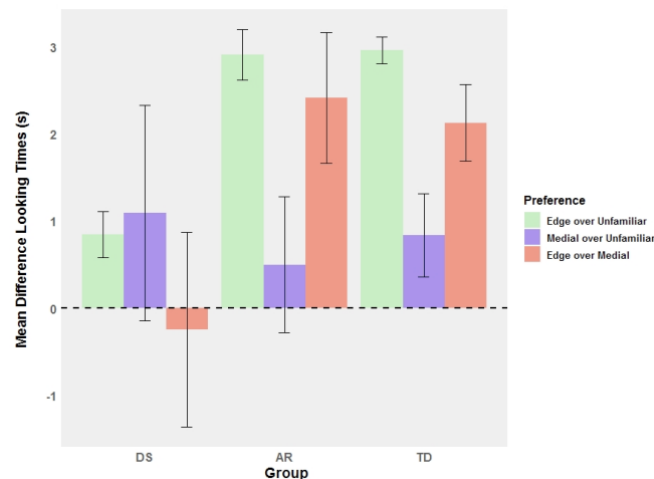


Figure 6. Mean difference looking times (s) for the segmentation conditions edge over unfamiliar, medial over unfamiliar and edge over medial, across groups. Error bars represent standard error of the mean (+/-1). From Frota, Pejovic, et al., (2020).

The intonation discrimination abilities for AR infants were compared to findings from the Frota et al., (2014) study for TD infants. It was found that at 6 months of age, AR infants discriminate the intonation patterns of statements and questions in a similar way as TD infants, with no significant differences between groups. These findings will be presented at *ISAPh2022* in September, 14.

A journal paper on stress perception in TD infants was published, reporting the earliest evidence in the literature for sensitivity to stress patterns in the presence of segmental variability (i.e., by 5-6 months of age), that was manifested by a preference for iambic stress (Figure 7). These findings set the reference for the performance of the at-risk infants in this task. Unlike TD, same age AR infants showed no evidence for distinguishing the iambic and trochaic patterns. In addition, AR infants differ from TD peers in showing longer looking times overall. These findings will be also presented at *ISAPh2022*.

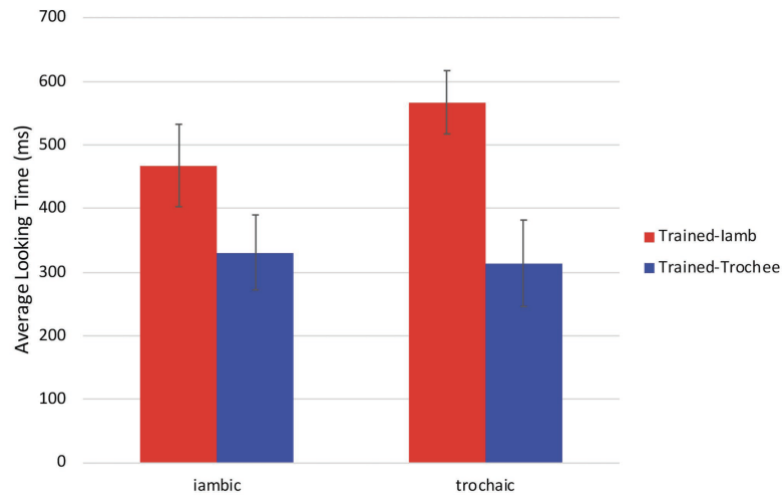


Figure 7. Average looking times (in milliseconds) to the iambic and trochaic trained side during iambic and trochaic test trials. Error bars indicate the standard error of the mean (+/-1). From Frota, Butler, et al., (2020).

A proceedings paper has been published on the perception of prosodic boundaries by typically developing infants, also using eye-tracking (Frota et al., 2019). It was found that TD infants discriminate between delexicalized utterances without and with an internal intonational phrase boundary. The performance of AR infants in the same task has been analysed and compared to that of TD infants. Unlike TD, AR infants showed no evidence for discrimination (Figure 8). Together with the findings for word segmentation, discrimination of intonation and discrimination of stress, the set of results for AR children suggest that different language abilities, which are mostly linked to prosody, develop differently in AR children. This pattern of acquisition may inform early intervention strategies for this population.

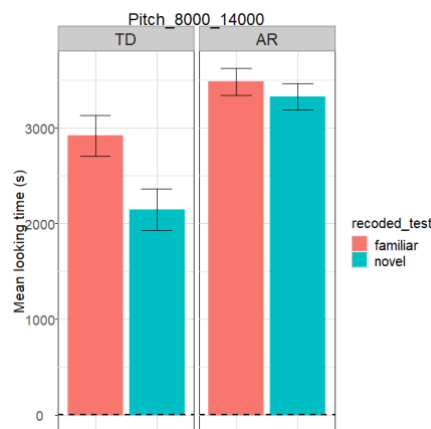


Figure 8. Mean looking times (ms) to familiar and novel for TD and AR. Error bars indicate the standard error of the mean. From Frota (2022), in *ISAPh 2022*.

Early eye-gaze patterns to talking faces and their relation to language abilities and later outcomes were explored, with two journal papers published and several presentations at international conferences. For TD infants, it was found that eye-gaze to the mouth (and the face) was related to the ability to discriminate stress patterns, with more attention to the mouth in those infants that do not show a preference for iambic stress (Cruz et al., 2020). Moreover, attention to the mouth was found to be recruited by 5-6 month-old infants with later lower receptive vocabulary, whereas attention to the mouth at 8-10 months of age correlates with later higher expressive vocabulary. Early visual attention abilities and audiovisual speech processing abilities were found to differ in typical and atypical development (Pejovic et al., 2021), and thus the eye-gaze patterns of AR infants and toddlers might be informative of their developmental trajectories related to language acquisition. The data for AR children is currently being analysed.

Word learning abilities were also examined for TD and AR toddlers. Only TD toddlers showed an ability to learn target words with high frequency sound combinations (Figure 9). However, the performance of AR toddlers in the word learning task correlated positively with their later vocabulary development, suggesting that the absence of the phonotactic frequency effect was either due to a phonological delay or a different developmental path.

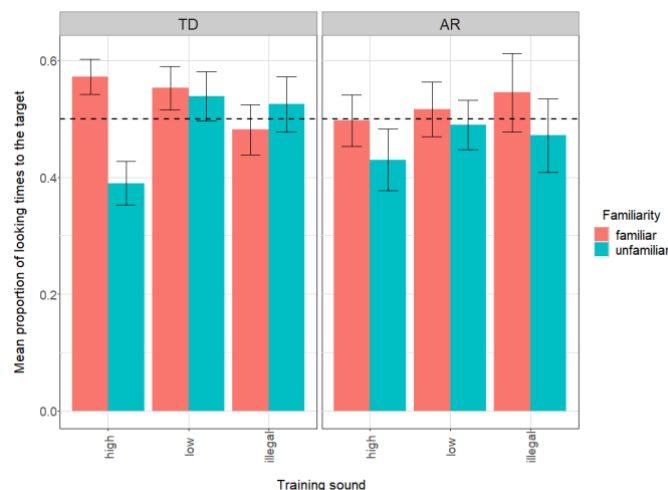


Figure 9. Mean proportion of looking times to the target in test trials, across groups, for familiar (labeled) and unfamiliar (unlabeled) objects, across the three training conditions (high, low, and illegal). Error bars represent standard error of the mean (± 1). The dashed line represents chance level. From Pejovic et al. (in prep).

Finally, to understand the potential effects of mask use and COVID-19 related changes new audio and audiovisual experiments on word segmentation were implemented (at 7-9 months of age) and their findings related to later language outcomes (Frota et al., 2022). It was found that word segmentation abilities are delayed in TD infants born during the pandemic, and that their later vocabulary development was affected at least until they were 15 months of age. These results point to the need of screening and monitoring of the language development of infants born between early 2020 and late 2021.

By and large, the deliverables specifically related to this task include 4 journal papers published, 1 book chapter in press and another one submitted, 2 proceedings papers published, 16 presentations at international conferences, and one journal special issue. A journal paper and a book chapter are in preparation.

Task 4. ERP tasks

The experimental paradigms for the 3 ERP experiments, that had been previously used in other projects, were revised and tested again prior to data collection. Given the absence of adult ERP studies, a journal paper on adults' processing of words, that was lacking as a control for children performance in the word learning ERP study was published (Silva et al., 2019). Findings show that phonological grammar, phonotactic frequency and lexicity, in this order, define the time course of word processing. Toddlers' performance at this task yield different results, suggesting that, unlike adults, TD toddlers are driven to process lexicity first, that is sound-meaning relations, over the phonological properties of sound sequences (Figure 10).

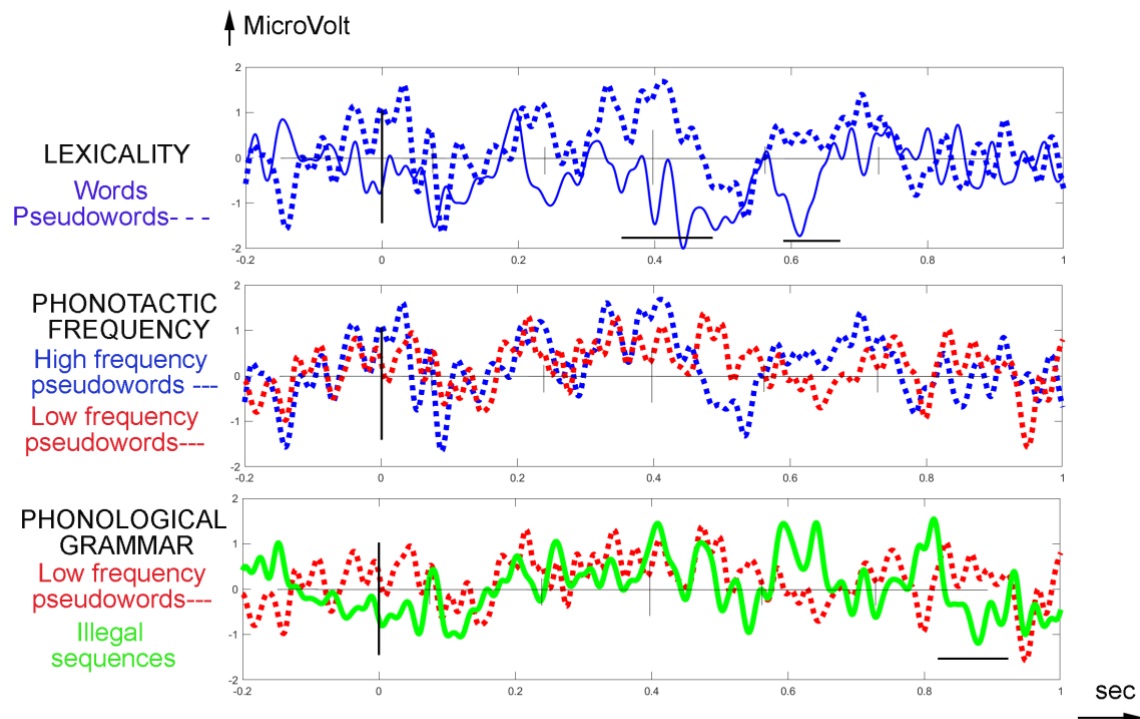


Figure 10. ERP waveforms for lexicity, phonotactic frequency and phonological grammar contrasts in electrodes of interest. From Silva et al., 2022, in *WILD2022*.

Adult performance on a stress discrimination MMN task (Lu et al., 2018) had established that EP speakers were able to perceive stress contrasts at the pre-attentive stage and demonstrated a processing advantage for the iambic stress pattern. Data from 6-month-old infants although not showing a significant MMN, showed differences in a later time window and a significant late negativity for the iambic condition only, suggesting a processing advantage for the iambic stress pattern (Figure 11). This result is partially consistent with the adult EEG pattern and fully in line with the infant eye-tracking study on stress perception (Frota, Butler, et al., 2020).

The TD infants' data for the processing of prosodic boundaries is under analysis.

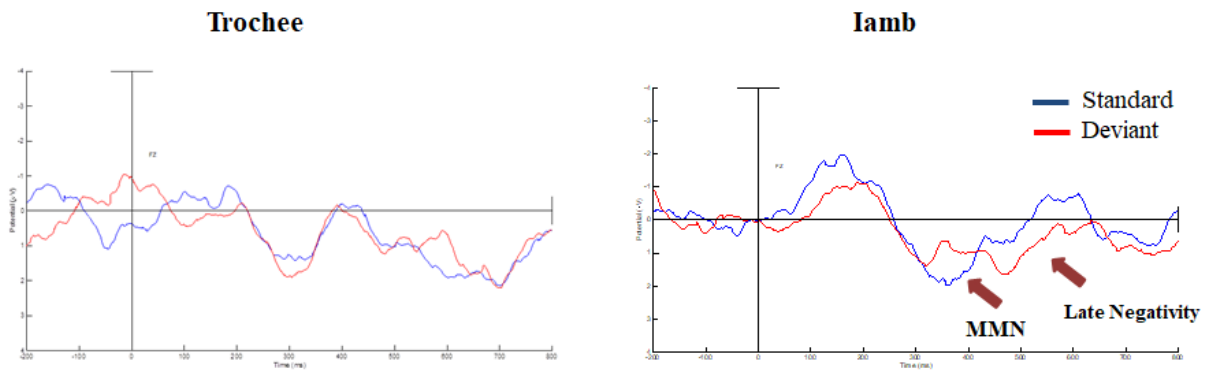


Figure 11. Difference wave for trochee and iamb. From Lu et al., 2022, in *WILD2022*.

The data collection for the EEG tasks for the at-risk children is ongoing, giving that data collection for the looking while listening experiments for the AR infants/toddlers was prioritized due to the reasons explained earlier in this detailed report.

Deliverables directly related to task 4 include one journal paper published and 3 presentations at international conferences.

Task 5. Longitudinal assessment of language abilities

The language and communication abilities of the infants tested in the experimental tasks are measured at the moment the task is performed and at different subsequent points in time, following the waves defined in the flowcharts of the prospective longitudinal design. Data was completed for the parental questionnaires CSBS DP, CDI, DCQ, as initially planned. The parental questionnaire ProsoQuest was added to the data collection giving its added value in the characterization of developing prosodic abilities (see Figure 1 above). A global measure of development is obtained with the Griffiths Scales.

The CSBS DP and CDI longitudinal measures were the basis of a study of language and communicative development profiles. It was found that the TD and AR children have similar developmental onsets for the CSBS DP, but different developmental trajectories (as shown in Figure 12 for the Speech component). A similar result was found for the CDI-I measure of expressive vocabulary (Figure 13). The findings suggest that performance of AR children is delayed for some language and communication abilities, and becomes worse over time for other language and communication abilities.

The wealth of data collected is under analysis, feeding the assessment of later outcomes database. The later outcomes data was already related to performance in the perception of prosodic boundaries (Frota et al., 2019), word learning abilities (Pejovic et al., in prep), early word segmentation (Frota et al., 2022), and eye-gaze patterns to talking faces (Cruz, Pejovic et al., 2020). The data collection for the Griffiths and the DCQ is ongoing (in the latter case mostly for the extended sample of older children between 3 and 6 years of age). Thus, the analyses performed have not yet included the DCQ and Griffiths outcomes.

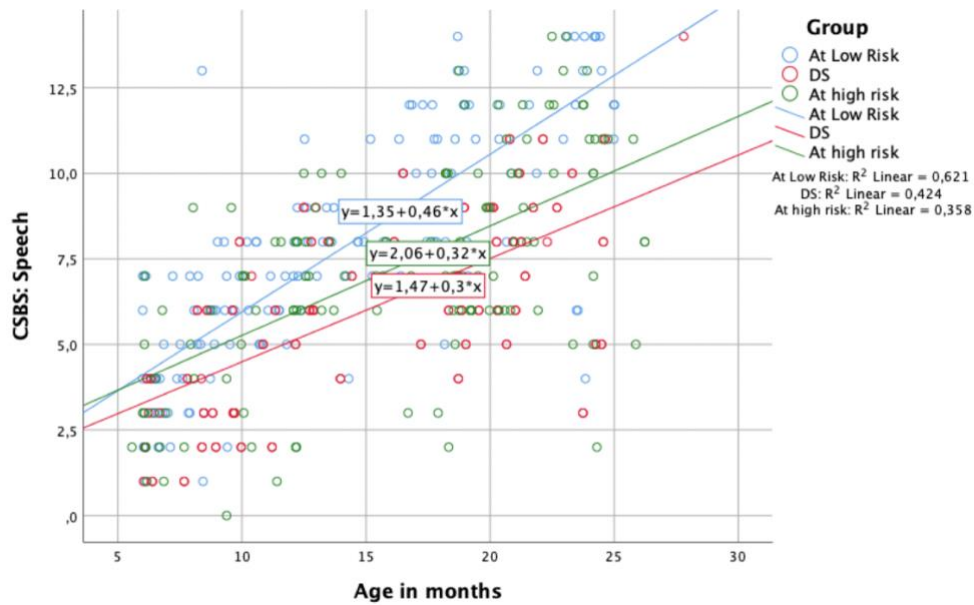


Figure 12. Developmental profile for low risk children (TD), high risk children (AR) and children with Down Syndrome (DS) based on the CSBS DP Speech component. From Vigário et al., (2020), in the 28th Annual World Congress on Learning Disabilities.

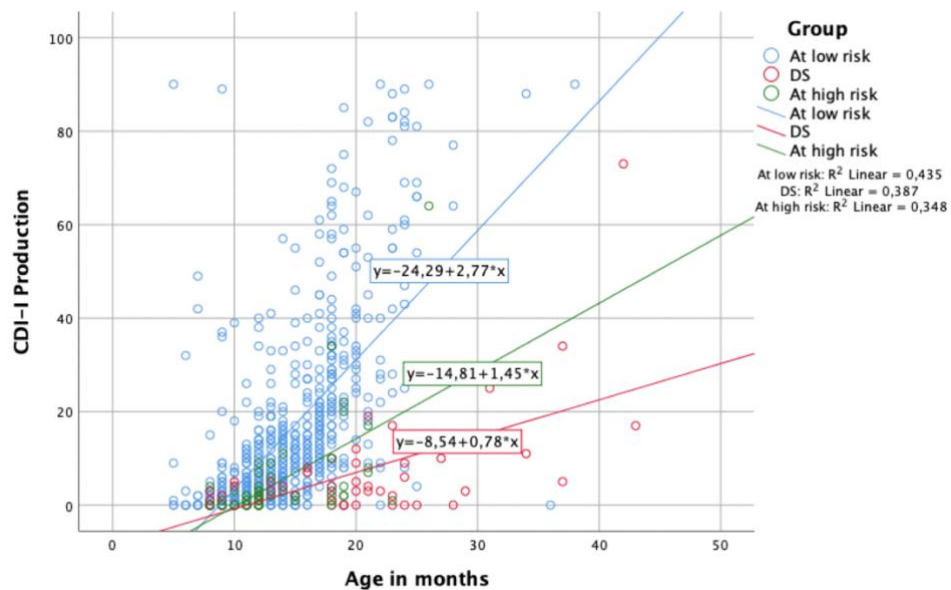


Figure 13. Developmental profile for low risk children (TD), high risk children (AR) and children with Down Syndrome (DS) based on the CDI-I measure of expressive vocabulary. From Vigário et al., (2020), in the 28th Annual World Congress on Learning Disabilities.

Deliverables related to Task 5 include 2 papers published (see also task 3) and 1 paper in progress, and 5 presentations at national and international conferences. Moreover, 2 PhD thesis were developed that add to the understanding of developing language abilities by measuring longitudinal early production data in 1 to 3 year-olds, and assessing the development of phonetics and phonology at age 3 in TD children and between 3 and 6 years of age in children with language disorder.

Task 6. Prospective evidence for predictors of language outcomes

Systematic reviews of early predictors of language outcomes were produced and presented and discussed at international conferences (1 journal paper has been accepted for publication). With this background, statistical analyses explored to what extent early measures provided by the screening and assessment tools, as well as by the experimental tasks, could be identified as predictors of language outcomes and thus early signs of risk for language and communication impairments. Linear regression models looked at each potential predictor and multilinear regression models pointed to the most promising sets of early signs of language development.

The findings already obtained to the CDI vocabulary measures at 12 months, the ProsoQuest measures of early prosodic abilities and the CSBS DP total measure as good predictors of later outcomes for the AR group. The CDI by itself was found to explain 45% of the variance. These findings will be presented and discussed in the final workshop of the project (<http://labfon.lettras.ulisboa.pt/NeuroD-WELL2/index.html>).

The early development of gestures and prosodic development as potential predictors of later language development, in particular receptive and expressive vocabulary, were explored in depth in an MA Thesis. Both gestures (measured with the social component of the CSBS DP) and early prosodic skills (measured with ProsoQuest) were found to be significant predictors of receptive and expressive vocabulary for typically developing and atypical developing children (as illustrated in Figure 14).

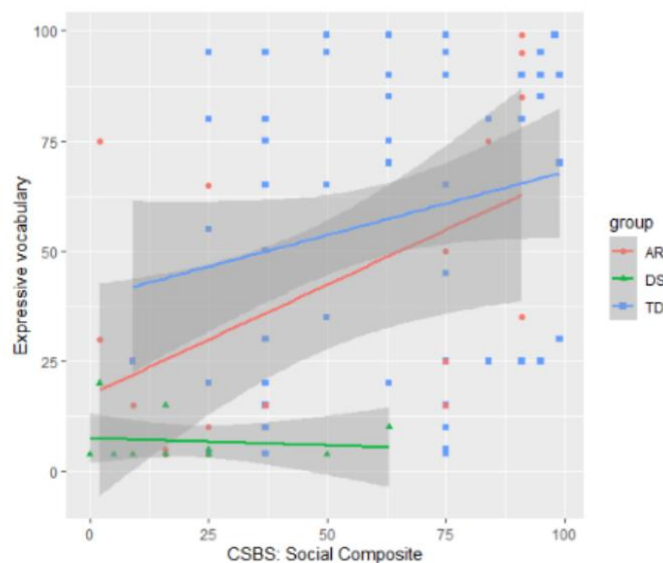


Figure 14. Regression lines for the prediction of expressive vocabulary by CSBS Social Composite in the three different groups (TD = Typical development; AR = At Risk; DS = Down syndrome). The Y axis shows the obtained percentile for expressive vocabulary of each infant, and the X axis shows the obtained percentile of the Social Composite Percentile. From Sousa, 2022.

The results so far indicate that the CDI, CSBS DP and ProsoQuest may offer a set of early markers of risk to be used as critical information for approaches to screening, prevention, and designing early interventions to support language and communication outcomes. Importantly, these tools are quick and easy to administer, and for the CDI and CSBS DP there are online multiplatform applications freely available to the larger health and educational communities. The relevance of current findings to inform clinical/educational decisions towards proactive measures (prevention) and early intervention will be discussed at the final workshop of the project.

Upon the closing of the full longitudinal assessment, final analyses that take into account the Griffiths results and further information at (pre)school age will add to current findings on predictors of later language outcomes for TD and AR children.

Deliverables related to Task 6 include 1 paper accepted for publication and one journal special issue, one proceedings paper published, and 3 presentations at international conferences and 3 other presentations in progress. Moreover, a MA Thesis was produced and defended.

3. Other activities

In this section, we describe other activities developed within the project, such as the organization of workshops, conferences, and other outreaching activities, as well as advanced training activities.

(i) Consultant's meetings

- First consultant meeting, on site. June, 18, 2018

Working session with Prof. Catherine Best (Western Sydney University).

Invited talk, within *LabPhon16*, by Catherine Best: *Natural phonetic variation and early word recognition: Toddler's recognition of familiar words across unfamiliar regional accents.*

- Second consultant meeting, on site. October, 2019

Meeting with Dr. Miguel Palha.

- Second consultant meeting, on site. November, 8, 2019

Meeting with Dr. Miguel Palha and members of the clinical team of *Diferenças*.

- Other contacts occurred online or through e-mail, during the project's execution.

(ii) Networking with the clinical sector

- Meetings with the Neurodevelopment unit of Hospital Santa Maria and the Center for the Study of the Baby and Child (Centro de Estudos do Bebê e da Criança) of Hospital D. Estefânia in July 2018.

- Meeting held with the extended team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital), December 2018.

- Meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital), May 2019.

- Meetings held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital). The CEBC was established as a regular collaborator of PLOs and the Lisbon Baby Lab. Meetings also held with the heads of the Pediatric Department and the Neurodevelopment unit of Hospital Santa Maria to foster collaboration among the different parties. October 2019.

- Virtual meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital), November 2020.

- Closing meeting held with the team from Centro de Estudos do Bebê e da Criança (CEBC) of Hospital D. Estefânia (Lisbon's pediatric hospital), scheduled to July 2022.

(iii) Organization of workshops and conferences

- *LabPhon 16 - Variation, development and impairment: Between phonetics and phonology*, University of Lisbon, June 19-23, 2018. Organizing committee (members of PLOs project): S. **Frota** (Chair), M. **Vigário** (Co-Chair), J. **Butler**, C. **Severino**, M. **Cruz**, M. **Filipe**, N. **Paulino**, R. **Sousa**

<http://labfon.letras.ulisboa.pt/LabPhon16/index.html>

The Project co-organized the 16th *International Conference on Laboratory Phonology – LabPhon16*, with the theme *Variation, development and impairment: Between phonetics and phonology*. The conference was a major opportunity for discussion of language development and language impairment.

- *FALAS NO LABFON*. Working sessions of Laboratório de Fonética e Fonologia & Lisbon BabyLab (CLUL), October 9, Lisbon, Portugal, organized by M. Vigário and S. Frota.

http://labfon.letras.ulisboa.pt/files/Falas_no_Labfon_OUT_2019.pdf

The Project contributed to this session, that included a talk on infant audiovisual speech processing.

- *NeuroD_WELL. Workshop on early language in neurodevelopmental disorders*. November 8, 2019. Lisbon, Portugal. Organizing committee (members of PLOs project): S. **Frota** (chair), M. **Vigário** (co-chair), C. **Severino**, M. **Cruz**. <http://labfon.letras.ulisboa.pt/NeuroD-WELL/index.html>

The first workshop of the project, NeuroD-WELL, issued an open call for papers. It brought together researchers and practitioners working on language development and neurodevelopmental disorders, from a multidisciplinary perspective (Clinical Linguistics, Cognitive Science, Linguistics, Neurolinguistics, Psycholinguistics, Psychiatry, Psychology, Pediatrics, Speech and Hearing Sciences, Speech Therapy, among others). It included two invited speakers, Thierry Nazzi (Université Paris Descartes) with a talk on atypical populations including at-risk infants, and Vesna Stojanovik (University of Reading) with a talk on Down Syndrome, as well as oral and poster sessions.

- *Speech Prosody 2022*. Theme: *Getting the prosody right: Acquisition, Impairment, Interventions, and Beyond*. May 23-26, 2022, Lisbon, Portugal. Organizing committee (members of PLOs project): S. **Frota** (Chair), M. **Vigário** (Co-Chair), C. **Severino**, M. **Cruz**, M. **Filipe**, N. **Paulino**, R. **Sousa**. <http://labfon.letras.ulisboa.pt/sp2022/index.html>

The Project co-organized the 11th *International Conference on Speech Prosody – Speech Prosody 2022*, with the theme *Acquisition, Impairment, Interventions, and Beyond*. The theme nicely fits the research program of PLOs, and thus the conference was an excellent forum for discussion of language acquisition in typical and atypical populations.

- *NeuroD-WELL 2022, Workshop on Early Language in Neurodevelopmental Disorders*, August 29, 2022, Faculdade de Letras, Universidade de Lisboa. Organizing committee (members of PLOs project): S. **Frota** (Chair), M. **Vigário** (Co-Chair), C. **Severino**, M. **Cruz**, M. **Filipe**, N. **Paulino**, R. **Sousa**. <http://labfon.letras.ulisboa.pt/NeuroD-WELL2/index.html>

The second workshop of the project, NeuroDWELL 2022, is scheduled for August 29. An open call for papers was issued. The main focus is the early development of language in individuals with neurodevelopmental disorders, or at risk of developing language impairments due to familial risk or other risk factors. The two invited speakers are specialists in the field. The workshop also includes a session on the PLOs project, and will count with the active participation of attendees from the healthcare sector, namely pediatricians, psychologists and speech therapists.

(iv) Advanced training activities

The research team was involved in training activities for the academia and general public, within the STEM Summer school and the vTEM virtual school. The project also provided the means for advanced training of junior team members in EEG and advanced statistics.

- EEG and Language Crash Course, June 6-7, 2019 Heriot-Watt University, Edinburgh, Scotland (with the participation of a PLOs research team member)

- *STEM V – Summer Training in Experimental Methods*, September 2-7, 2019. **Frota, S.**, & Martins, F. (Coordinators). Organization and monitors involved (members of PLOs team): **S. Frota, M. Vigário, M. Cruz, C. Severino, N. Paulino, R. Sousa** <http://labfon.lettras.ulisboa.pt/summerschool/2019/index.html>

- Statistical analysis workshop - An introduction to “R” March 5 - April 7, 2020 Powered by the Medical School, University of Lisbon, Portugal (with the participation of PLOs research team members)

- *STEM VI - Summer Training in Experimental Methods*, University of Lisbon, Portugal, online, September 7-9, 2020. **Frota, S.** & Martins, F. (Coordinators). Organization and monitors involved (members of PLOs team): **S. Frota, M. Vigário, M. Cruz, C. Severino, N. Paulino, R. Sousa**. <http://labfon.lettras.ulisboa.pt/summerschool/2020/index.html>

- *vTEM -Virtual Training in Experimental Methods*, University of Lisbon, Portugal, online, March 15-April 16, 2021. Scientific coordination: **M. Cruz & M. Vigário**. Organizing committee (members of PLOs project): **S. Frota, C. Severino, N. Paulino, R. Sousa**. <http://labfon.lettras.ulisboa.pt/virtuelschool/en/program.html>

- Deep Dive into ERPs Technique Online Course, May - June, 2021, by Sciencebeam (with the participation of a PLOs research team member)

- CuttingEEG 2021, October 4 - 7, 2021. University of Aix-Marseille, Aix-En-Provence, France (with the participation of a PLOs research team member)

(v) Other outreaching activities

Spreading of the project research goals and results for the larger (non-)scientific community was achieved through talks and lectures, posters, newsletters, lab visits, as well as interviews and news reports featured in the media, in addition to the project’s website as an information hub and the social media platforms.

Talks, lectures and posters:

Vigário, M., Severino, C., Cruz, M., Filipe, M., Butler, J., & Frota, S. (2018). Marcadores precoces de desenvolvimento da comunicação e linguagem. Talk given at *Ciência 2018 – Encontro com a Ciência e Tecnologia*, July 2-4, Lisboa, Portugal http://labfon.lettras.ulisboa.pt/files/Ciencia2018_Vigarior_et_al_Publish.pdf

Frota, S. (2019). Escuta bebé! Descobrir a língua antes da fala. Invited talk given at *2as Jornadas do Centro de Estudos do Bebê e da Criança do Hospital Dona Estefânia*, May 20, Lisboa, Portugal. http://labfon.lettras.ulisboa.pt/files/Frota_2019.pdf

Frota, S. (2019). Desenvolvimento da linguagem na trissomia 21: sinais precoces. Invited talk presented at *Trissomia 21: 3 Décadas a fazer a Diferença*, October 26, Auditório do IPDJ, Lisbon, Portugal.

Vigário, M., Paulino, N., Pejovic, J., Cruz, M., Severino, C., Sousa, R., João, V., & Frota, S. (2019, November 16). *Avaliação do desenvolvimento da linguagem: Questionários do Desenvolvimento Comunicativo para o Português Europeu (CDI-PE FR)* [Poster presentation]. The 2nd Lusíadas Clinical Summit – The Circle of Life, Centro de Congressos do Estoril, Estoril, Portugal.

https://labfon.letras.ulisboa.pt/babylab/horizon21/files/Clinical_Summit_CDI_Vigario_et_al_final.pdf

Frota, S., Cruz, M., Severino, C., Pejovic, J., Sousa, R., & Vigário, M. (2019, November 16). *Projeto PLOs: Preditores de Desenvolvimento de Perturbações da Linguagem e Comunicação* [Poster presentation]. The 2nd Lusíadas Clinical Summit – The Circle of Life, Centro de Congressos do Estoril, Estoril, Portugal.

http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Clinical_Summit_PLOs_Frota_et_al_final.pdf

Frota, S., Severino, C., Pejović, J., Butler, J., & Vigário, M. (2019, November 16). *Competências de segmentação de palavras em bebés com Trissomia 21* [Poster presentation]. 2nd Lusíadas Clinical Summit (online), Estoril, Portugal.

http://labfon.letras.ulisboa.pt/babylab/horizon21/files/Clinical_Summit_Segmentacao_Palavras_Frota_et_al.pdf

Frota, S., Severino, C., Pejovič, J., Paulino, N., Cruz, M., Sousa, R., & Vigário, M. (2020). *Desenvolvimento da linguagem nos dois primeiros anos de vida: Marcadores precoces*. Talk presented at *XXVI Jornadas de Pediatria do Centro Hospitalar Universitário Lisboa Norte (Theme: Pediatria Translacional 2020)*, February 13-14, 2020, Lisbon, Portugal.

http://labfon.letras.ulisboa.pt/babylab/PLOS/files/Jornadas_Pediatria2020_Frota_et_al_sent.pdf

Frota, S., Severino, C., Pejovič, J., Paulino, N., Cruz, M., Sousa, R., & Vigário, M. (2020). *Early language development in Down Syndrome: Basic and translational research*. Talk presented at *Encontro Ciência 2020*, November 2-4, Lisbon, Portugal.

<https://www.encontrociencia.pt>

Frota, S. Cruz, M., & Vigário, M. (2020) *E-health: screening language and communication development in early infancy*. Demo presented at *Encontro Ciência 2020*, November 2-4, Lisbon, Portugal. <https://www.youtube.com/watch?v=zEF2BTNesJg>

Newsletter:

Newsletter no. 4 of Lisbon Baby Lab, 2018/2019.

http://labfon.letras.ulisboa.pt/babylab/pt/files/news/Newsletter_4_2019.pdf

Open days/Lab visits:

Experimentar a fala: bebés e crianças. Visit to the Lisbon BabyLab (CLUL/FLUL) included in the program of *Semana C&T 2021*, organized by Agência Ciência Viva, 22-28 November 2021. Coordinator: M. **Vigário**.

https://www.cienciaviva.pt/semanact/2021/eventos.php?acao=showactivities&id_activity=1392

Interviews and news reports featured in the media:

Newspaper article “Como é que os bebés comunicam antes de começar a falar”, published in *O Público*, May 24, 2019.

Lisbon Baby Lab na série documental "Outra Escola" dedicada ao mundo dos bebés e as aprendizagens dos 0 aos 3 anos (RTP2, 15 Dez 2019).

<https://www.rtp.pt/play/p6335/e445094/outra-escola%20target=>

TV program 'Tenho um bebé. E agora?' (Canal Saúde+), news and interview on *As Perturbações do Espectro do Autismo (e o Projeto PLOs)*, December, 2019.

<https://www.saudemais.tv/video/140112-tenho-um-bebe-e-agora-t05-e011-02?fbclid=IwAR1wzYMG-Luj9-Jt2HBM6VO64UwhcHyKuhfCdnDvDpYMPdW5zMHf6yPtBzw%20%20target=>

Language acquisition, prosody, and the Lisbon Baby Lab. Prof. Sónia **Frota** interviewed for a Youtube channel – The Dissenter, 7 January 2022.

<https://www.youtube.com/watch?v=fxffd8Mgkj4>

Other platforms for dissemination:

Lisbon Baby Lab Facebook (<https://pt-pt.facebook.com/LisbonBabyLab/>)

Lisbon Baby Lab Instagram (<https://www.instagram.com/p/BvRgegDHv88/>)

Lisbon Baby Lab Twitter (<https://twitter.com/lisbonbabylab?lang=en>)

The PLOs Project on Research Gate (<https://www.researchgate.net/project/Predictors-of-Language-Outcomes-PLOs>)

4. Outputs

In this final section, we highlight the main outputs of the project related to research facilities, resources for early language development in research, educational, clinical settings and for the general public, advanced training positions, and publications. This section concludes with a comparison between the planned outputs and the outputs actually produced.

Research facilities

Updated eye-tracking equipment

Resources for early language development in typical and atypical populations

Tools for e-health:

Frota, S. Cruz, M., & Vigário, M. (2020). *MacArthur-Bates CDI para o Português Europeu Formas Reduzidas: Programa de Cotação Automática*. Software for Windows and Macintosh OS. ISBN 978-989-54771-0-4.

Automatic scoring program for the EP-CDI SFs. Windows and Mac operating systems.

Frota, S., Cruz, M., Silva, P. & Vigário, M. (2020). CDI-PE App: Aplicação online para avaliação de competências de linguagem e seu desenvolvimento baseada no MacArthur-Bates CDI para o Português Europeu Formas Reduzidas. ISBN 978-989-54771-1-1. <https://cdi-pe-app.letras.ulisboa.pt/>

Online multiplatform application for the EP-CDI SFs (e.g., computer, tablet, smartphone), promoting a more accessible quick screening and assessment in a variety of clinical, educational and home environments.

Frota, S., Cruz, M., Silva, P., & Filipe, M. (2022). *CSBS-DP App: Aplicação online para cotação automática da CSBS DP Infant-Toddler Checklist – Adaptação para o Português Europeu (Questionário do bebé das Escalas de Desenvolvimento da Comunicação e Comportamento Simbólico)*. <http://csbs-dp-pe-app.letras.ulisboa.pt/>

CSBS DP App for the automatic scoring for all CSBS DP measures, together with a number of other features similar to those available in the EP-CDI App. The test version of the app is already available.

CSBS DP normative data for the EP population:

Filipe, M., Severino, C., Vigário, M., & Frota, S. (in prep). Adaptation and validation of the European Portuguese Communication and Symbolic Behavior Scales Infant-Toddler Checklist. *International Journal of Language and Communication Disorders*.

The norms are already available, and the related paper publication will be submitted soon.

Information hub:

The PLOs project website, where all project-related information and all the outputs are available: <http://labfon.letras.ulisboa.pt/babylab/PLOS/en/index.html>

Advanced training

Besides the advanced training activities described in section 3, advanced training was promoted through the opening of a PhD contract position and research grants.

Advanced research positions within the project

Cátia Severino, 3-year PhD contract position

Pedro Silva, Research grant (BI) January 2020 – August 2021

Ricardo Sousa, Research grant (BI), December 2019 – April 2022

Other research training opportunities

Research training was provided to undergraduates that volunteered to work in the project and were integrated in the project research activities under the supervision of members of the research team. One of the undergraduates was later supported by a Beginners Research Grant (BII) provided through independent funding. The other two undergraduates were granted a Beginners Research Grant on June 2022, after their training within the project.

Filipe Baixinho, January 2020 – February 2021 (as volunteer); March 2021 – February 2022 (BII)

Juliane Tavares, June 2021 – May 2022 (as volunteer; June 2022 onwards, BII)

Andreia Janeiro, July 2021 – May 2022 (as volunteer; June 2022 onwards, BII)

Thesis

Two PhD and one MA theses were developed within the project and defended (and 2 other PhD are in progress)

Publications and Communications

Book chapters – 1 in press, 1 submitted, 1 in progress (international)

Papers in International Journals – 8 (plus 1 accepted, 2 in progress)

Proceedings (international) – 4

Proceedings (national) – 1

Communications in international scientific meetings – 25 (plus 1 invited talk and 6 in progress)

e.g., *The 4th Lancaster Conference on Infant and Child Development*, *The 6th Lancaster Conference on Infant and Child Development*, *45th Boston University Conference on Language Development (BUCLD)*, *WILD 2019 – 4th Workshop on Infant Language Development*, *WILD 2022 – 5th Workshop on Infant Language Development*, *vICIS 2020 Congress – Virtual International Congress on Infant Studies*, *XV International Symposium of Psycholinguistics*, *International Conference on Phonetic Sciences (ICPhS)*, *Workshop on Language and the Brain*

(WoLB 2019), Conference on Laboratory Phonology, 10th International Conference on Speech Prosody 2020, 11th International Conference on Speech Prosody 2022, Third Experimental Portuguese Linguistics Workshop, PaPE 2021 – Phonetics and Phonology in Europe, 28th Annual World Congress on Learning Disabilities, Workshop on Early Language in Neurodevelopmental Disorders

Communications in national scientific meetings – 1*

Encontro Nacional da Associação Portuguesa de Linguística

*Meetings like *Jornadas do Centro de Estudos do Bebê e da Criança - Comunicação e Linguagem na Infância*, *Jornadas de Pediatria do Centro Hospitalar Universitário Lisboa Norte*, *Lusíadas Clinical Summit*, *Jornadas de Trissomia 21: 3 Décadas a fazer a Diferença*, or *Encontro Ciência*, were listed as dissemination events for the larger (non-)scientific community.

A comparison between the planned outputs and the outputs actually produced (i.e., published, presented) is shown in Figure 15. The strong dissemination and outreach vein of the Project is shown in Figure 16.

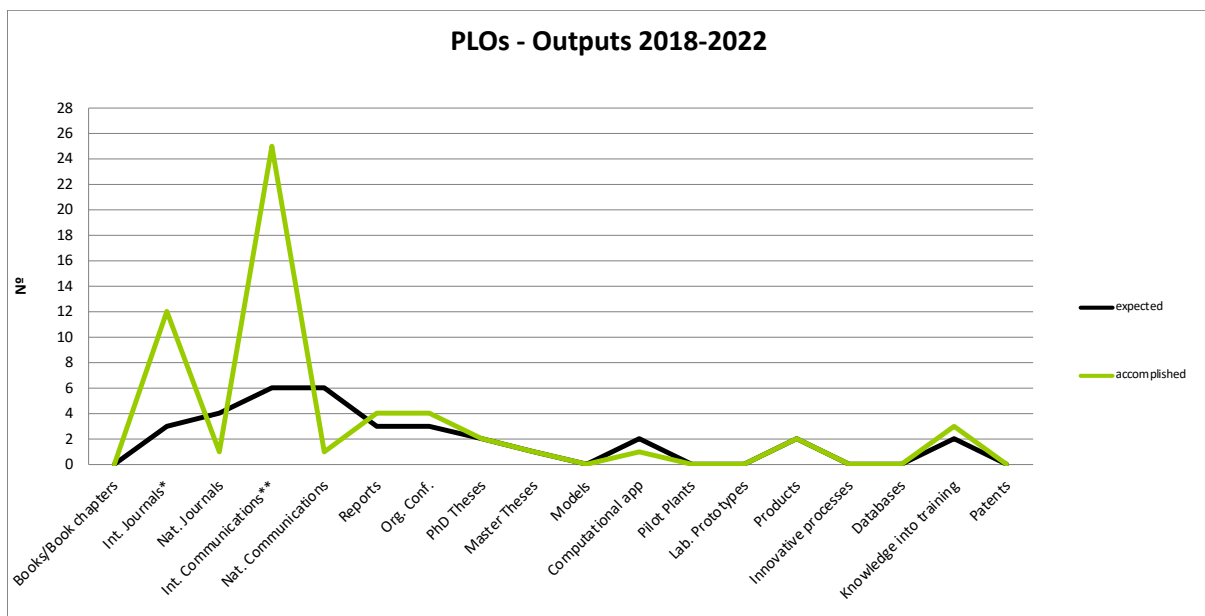


Figure 15. Outputs produced according to the types defined in Table 3. Indicadores de Realização Física. *Includes international proceedings and edition of journal special issues. **Includes talks and posters.

In all output categories, with two exceptions (national journals and national communications), the outputs produced outnumber the outputs initially planned in the application. These exceptions are explained by the strategic decision to produce mostly international publications. The many national communications produced were in dissemination events directed to the larger (non-)scientific community, listed under the dissemination and outreach activities. The mismatch in the computational applications category is only apparent, given that the planned applications were 3 and 3 applications were indeed produced. However, they were by mistake replicated under computational applications and products. The scientific publications within the scientific domains of RIS3 that were initially planned (n=7) were indeed produced (n=7; cf. Outputs file).

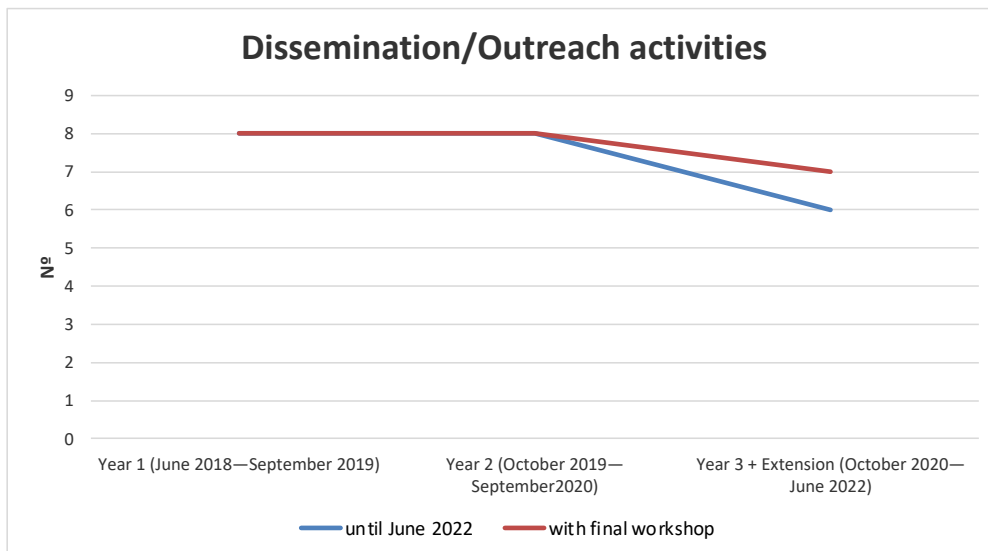


Figure 16. Dissemination and outreach along the project's execution period.

The most important output of all was the strong collaboration between researchers and clinicians, and research centers and healthcare units, which has laid solid and fruitful opportunities for translational research. The knowledge gathered and tools produced (in particular, the e-health tools) have started to be implemented in early screening, as well as early assessment of intervention strategies. This is a first step towards the implementation of routine developmental screening for early language and communication in children, especially in neurodevelopment and developmental psychology consultation and speech therapy. Continued future collaboration and networking is secured to further refine and strengthen the applied dimensions of the research conducted.