**Referência do projeto**
Project reference

EXCL/MHC-LIN/0688/2012 **(Lacrado a 02-05-2012 às 12:01)**

## 1. Identificação do projeto
1. Project description

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**Domínio Científico**
Scientific Domain

Ciências Sociais e Humanidades

**Área científica principal**
Main Area

A Mente Humana e a sua Complexidade - Linguística

**Área científica Secundária**
Secondary area

*(Vazio)*
*(Void)*

**Acrónimo**
Acronym

EBELa

**Título do projeto (em português)**
Project title (in portuguese)

Do Olhar ao Cérebro – Marcadores Precoces no Desenvolvimento da Linguagem

**Título do projeto (em inglês)**
Project title (in english)

Eyes and Brain – Early Markers of Language Development

**Financiamento solicitado**
Requested funding

266.767,00€

| **Palavra-chave 1** | **Keyword 1** |
|---|---|
| Desenvolvimento da Linguagem | Language Development |
| **Palavra-chave 2** | **Keyword 2** |
| Perturbações da Linguagem | Language Impairment |
| **Palavra-chave 3** | **Keyword 3** |
| Registo do Movimento dos Olhos | Eye-tracking |
| **Palavra-chave 4** | **Keyword 4** |
| Potenciais Evocados | Event-related Potentials (ERPs) |
| **Data de início do projeto**<br>Starting date | **Duração do projeto em meses**<br>Duration in months |
| 01-04-2013 | 36 |

## 2. Instituições envolvidas
2. Institutions and their roles

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**Instituição Proponente**
Principal Contractor

**Faculdade de Letras da Universidade de Lisboa (FL/UL)**

Alameda da Universidade
1600-214Lisboa

**Descrição da Instituição**

The Faculty of Arts of the University of Lisbon is broadly based, interdisciplinary and internationally oriented. Graduate courses are strongly interweaved with research centers, and graduate students amount to one third of the Faculty students. The Centre of Linguistics (CLUL) is committed to theoretical, theoretically oriented, descriptive and experimental research leading to novel gap-filling contributions to linguistic analysis, language development and language processing, targeting

both adult and child grammars. Presently, the Center hosts 6 research groups (circa 65 researchers), including a Psycholinguists Lab, a Phonetics Lab and a Baby Lab, participates in scientific seminars/graduation programs being the host institution for 30 PhD students, and hosts/participates in 30 Research grants (including 1 European Research Council Advanced Grant). In 2011, CLUL researchers have published 92 papers and books.

**Instituição Participante**
Participating Institution

*(Vazio)*
*(Void)*

**Unidade de Investigação**
Research Unit

**Centro de Linguística da Universidade de Lisboa (CL/FUL/UL)**
Avenida Professor Gama Pinto - 2
1649-003Lisboa

**Unidade de Investigação Adicional**
Additional Research Unit

*(Vazio)*
*(Void)*

**Instituição de Acolhimento**
Host Institution

**Faculdade de Letras da Universidade de Lisboa (FL/UL)**
Alameda da Universidade
1600-214Lisboa

## 3. Componente Científica
3. Scientific Component

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### 3.1. Sumário
3.1 Abstract

### 3.1.a Em português
3.1.a In Portuguese

A investigação sobre marcadores precoces de desenvolvimento da linguagem usando medidas behavioristas e potenciais evocados (ERPs) tem incidido num número muito reduzido de línguas, em especial línguas Germânicas (Inglês e Alemão). Sendo a aquisição da linguagem caracterizada por um progressivo compromisso com a língua nativa [1], é fundamental o estudo de marcadores de aquisição da linguagem em línguas com propriedades fonológicas e prosódicas diferentes. Tais estudos podem dar um contributo decisivo para se compreender como é aquirida a linguagem, já que o confronto entre dados de diversas línguas é muitas vezes determinante na escolha entre explicações para os mesmos factos baseadas em capacidades perceptivas/cognitivas gerais ou em aspectos particulares das línguas. Este tipo de pesquisa é também de elevada relevância social: há evidência de que marcadores precoces de aquisição da linguagem são preditores do desenvolvimento linguístico subsequente, quer no caso de crianças com desenvolvimento típico com diferentes velocidades [2,5], quer no caso de crianças com perturbações da linguagem [6,7]. Este projecto visa contribuir para este campo de investigação, centrando-se na aquisição inicial do Português Europeu (EP), largamente por explorar deste ponto de vista, numa abordagem multi-metodológica, em que um conjunto de marcadores precoces potenciais é avaliado usando medidas de movimento dos olhos (ET) e de ERPs.
Na sua Variedade Standard, o PE é uma língua especialmente interessante neste contexto pelas suas propriedades fonológicas e prosódicas. Diferentemente das línguas Germânicas, combina propriedades de ritmo acentual e silábico; a distribuição do acento correlaciona-se menos com o início de palavra; é uma língua proclítica. O PE afasta-se também de outras línguas Românicas devido às suas propriedades rítmicas; à redução vocálica em posição átona; à baixa co-variação entre entoação e acento de palavra; e ao tamanho dos sintagmas entoacionais [8,9,10]. Com propriedades fonológicas e prosódicas nuns casos de tipo Germânico, e noutros de tipo Românico, o PE permite levantar questões pertinentes para a aquisição da linguagem, especialmente no quadro da hipótese do bootstrapping prosódico [11].
Com o objectivo central de estabelecer marcadores precoces de desenvolvimento da linguagem,

investigaremos 4 domínios linguísticos, em 2 grupos de bebés (e um grupo de adultos): bebés sem factores de risco para Perturbações do Espectro do Autismo (PEA) e/ou Perturbações Específicas do Desenvolvimento da Linguagem (PEDL) e bebés com factores de risco para PEA e PEDL. Os 4 domínios em estudo são: (1) discriminação fonética; (2) discriminação de padrões acentuais; (3) processamento do pitch como pista para fronteira prosódica; (4) aprendizagem de palavras. O desenvolvimento linguístico dos bebés testados em (1)-(4) será medido posteriormente usando o Inventário de Desenvolvimento Comunicativo (CDI) para Português. Com base no descrito na literatura (fundamentalmente para o Inglês e o Alemão), a nossa hipótese geral é a de que a presença e/ou desempenho relativamente a marcadores precoces de aquisição da linguagem se correlaciona com desempenhos linguísticos subsequentes. Contudo, espera-se que tanto o tipo de marcadores precoces a encontrar, como a natureza exacta da correlação num dado momento do desenvolvimento subsequente, sejam modulados pelas propriedades específicas do PE. Por exemplo, as propriedades específicas do acento no PE (distintas das do Inglês, Alemão ou Francês) podem promover um efeito precoce particular nas medidas de ERP nesta língua; sendo a marcação de Sintagmas Entoacionais (IP) um traço saliente no PE, com a maior parte da variação entoacional concentrada junto aos limites de IP, é também de esperar uma sensibilidade precoce às fronteiras de IP nesta língua, mesmo sem pausas.
Com base neste estudo prospectivo, pretende-se determinar qual o impacto no desenvolvimento da linguagem de cada tipo de resposta neuronal e de movimento dos olhos, tanto no caso do desenvolvimento típico, como no caso das PEA e PEDL, esperando-se identificar marcadores precoces de risco para PEA e PEL.
O projecto junta uma equipa multidisciplinar proveniente de 4 instituições (Centro de Linguística, Universidade de Lisboa; LaPso, ISCTE; Centro de Psicologia, Universidade do Porto; Faculdade de Psicologia, Universidade de Lisboa) e explora recursos já existentes, designadamente equipamento (ET, EEG) e know-how acumulado pelos membros da equipa, com trabalho anterior nas áreas da fonologia, fonética, aquisição da linguagem, perturbações da linguagem e neurofisiologia [A,B,C,D,E,8,9,10,22,23,24]. Conta também com a colaboração de uma rede de instituições de cuidados sociais, de educação e de saúde (e.g. Unidade de Desenvolvimento do Centro Hospitalar Lisboa-Norte, Unidades de Ensino Estruturado dos Agrupamentos de Escolas da rede pública, Centro de Desenvolvimento Infantil LogicaMentes, EMIIP).

### 3.1.b Em inglês
3.1.b In English

Research on early markers of language development, both using standard behavioral measures and ERP measures, has largely been centered on a very few languages and especially on Germanic languages (English and German). Given that the infant's task in learning a language is characterized by a stronger commitment to the native language as development proceeds [1], it is crucial to study markers of early language acquisition in languages with different phonological and prosodic properties. Such studies have the potential of making a strong contribution to our understanding of how language is acquired, as cross-language data is many times decisive to choose between perceptually general explanations and more language-specific explanations for the same facts. In addition, such studies have great social relevance: markers of early language acquisition have been shown to predict later language development, either in the case of normally developing children with varying pace in development [2-5], or in the case of later language impairment [6, 7]. This project aims at contributing to this field of research by focusing on the yet largely unstudied early acquisition of European Portuguese (EP), and providing a multi-methodology approach to a set of potential early markers, using both eye-tracking (ET) and ERP measures.

EP, in its standard variety, is a language of special interest for the study of early language acquisition, given its phonological and prosodic properties. Unlike Germanic languages, it combines properties of stress- and syllable-timed rhythm; the distribution of word stress is less correlated with the beginning of the lexical word; and the language is proclitic. On the other hand, EP is unlike other Romance languages, due to rhythmic properties and vowel reduction in unstressed position [8, 9]. EP intonation also stands out from other Romance languages due to low co-variation between pitch accent and stress, and size of intonational phrases [10]. The presence of both Romance and Germanic-like properties in the phonology and prosody of EP raises challenging questions for language acquisition, especially under the prosodic bootstrapping hypothesis [11].

With the main goal of establishing early markers of language development in EP, we will examine four linguistic domains and focus on two groups of subjects (plus a control adult group):

infants/toddlers with no known risk for Autism Spectrum Disorder (ASD) and/or Specific Language Impairment (SLI), and infants/toddlers with high risk for ASD and SLI. The four domains under study are: (1) phonetic discrimination; (2) stress pattern discrimination; (3) pitch processing as a prosodic boundary cue; (4) word learning. The language abilities of the infants and toddlers tested for (1) to (4) will be measured later, in intervals of 6 months up to 30 months of age, using the Portuguese Communicative Development Inventory (CDI). On the basis of previous findings reported in the literature (mostly on English and German), our general hypothesis is that presence of and/or performance relative to early markers of language acquisition is correlated to later language outcomes. However, both the kind of early markers to be found and the exact nature of that correlation at a given timepoint in later development are expected to be modulated by the language-specific properties of EP. For example, the particular properties of stress in EP (which are distinct from either English and German or French) may promote an early language-specific effect in the ERP measures for Portuguese. As Intonation Phrase (IP) marking is a very prominent feature of the EP prosodic system, with most intonational variation packed close to IP-edges, we expect early sensitivity to IP boundaries in EP, even if a pause is not present.

Importantly, on the basis of this large prospective study, we aim to provide the impact of each type of eye movement and neural responses in language development, both in the case of normal development, and in the case of ASD and SLI. In the latter case, early markers of risk for ASD and SLI are expected to be defined.

The project joins a multidisciplinary team from 4 institutions (Center of Linguistics, University of Lisbon; LaPso, ISCTE; Center of Psychology, Oporto University; Psychology Faculty, University of Lisbon), and explores and combines resources already available, namely equipment (ET and EEG) and evaluation tools. It builds on prior work of the members of the research team in the fields of phonology, phonetics, language acquisition, language impairment and neurophysiology [A,B,C,D,E,8,9,10,22,23,24]. This research has the collaboration of a network of private and public institutions in the social, educational and health care fields, such as Unidade de Desenvolvimento do Centro Hospitalar Lisboa-Norte, Unidades de Ensino Estruturado dos Agrupamentos de Escolas da rede pública, Centro de Desenvolvimento Infantil LogicaMentes, EMDIIP (IPSS).

**3.1.c Para publicação - Em português**

3.1.c For publication - In Portuguese

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Específicas do Desenvolvimento da Linguagem (PEDL) e bebés com factores de risco para PEA e PEDL. Os 4 domínios em estudo são: (1) discriminação fonética; (2) discriminação de padrões acentuais; (3) processamento do pitch como pista para fronteira prosódica; (4) aprendizagem de palavras. O desenvolvimento linguístico dos bebés testados em (1)-(4) será medido posteriormente usando o Inventário de Desenvolvimento Comunicativo (CDI) para Português. Com base no descrito na literatura (fundamentalmente para o Inglês e o Alemão), a nossa hipótese geral é a de que a presença e/ou desempenho relativamente a marcadores precoces de aquisição da linguagem se correlaciona com desempenhos linguísticos subsequentes. Contudo, espera-se que tanto o tipo de marcadores precoces a encontrar, como a natureza exacta da correlação num dado momento do desenvolvimento subsequente, sejam modulados pelas propriedades específicas do PE. Por exemplo, as propriedades específicas do acento no PE (distintas das do Inglês, Alemão ou Francês) podem promover um efeito precoce particular nas medidas de ERP nesta língua; sendo a marcação de Sintagmas Entoacionais (IP) um traço saliente no PE, com a maior parte da variação entoacional concentrada junto aos limites de IP, é também de esperar uma sensibilidade precoce às fronteiras de IP nesta língua, mesmo sem pausas.
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**3.1.d Para publicação - Em inglês**

3.1.d For publication - In English

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With the main goal of establishing early markers of language development in EP, we will examine four linguistic domains and focus on two groups of subjects (plus a control adult group): infants/toddlers with no known risk for Autism Spectrum Disorder (ASD) and/or Specific Language Impairment (SLI), and infants/toddlers with high risk for ASD and SLI. The four domains under study are: (1) phonetic discrimination; (2) stress pattern discrimination; (3) pitch processing as a prosodic boundary cue; (4) word learning. The language abilities of the infants and toddlers tested

for (1) to (4) will be measured later, in intervals of 6 months up to 30 months of age, using the Portuguese Communicative Development Inventory (CDI). On the basis of previous findings reported in the literature (mostly on English and German), our general hypothesis is that presence of and/or performance relative to early markers of language acquisition is correlated to later language outcomes. However, both the kind of early markers to be found and the exact nature of that correlation at a given timepoint in later development are expected to be modulated by the language-specific properties of EP. For example, the particular properties of stress in EP (which are distinct from either English and German or French) may promote an early language-specific effect in the ERP measures for Portuguese. As Intonation Phrase (IP) marking is a very prominent feature of the EP prosodic system, with most intonational variation packed close to IP-edges, we expect early sensitivity to IP boundaries in EP, even if a pause is not present.

Importantly, on the basis of this large prospective study, we aim to provide the impact of each type of eye movement and neural responses in language development, both in the case of normal development, and in the case of ASD and SLI. In the latter case, early markers of risk for ASD and SLI are expected to be defined.

The project joins a multidisciplinary team from 4 institutions (Center of Linguistics, University of Lisbon; LaPso, ISCTE; Center of Psychology, Oporto University; Psychology Faculty, University of Lisbon), and explores and combines resources already available, namely equipment (ET and EEG) and evaluation tools. It builds on prior work of the members of the research team in the fields of phonology, phonetics, language acquisition, language impairment and neurophysiology. This research has the collaboration of a network of private and public institutions in the social, educational and health care fields, such as Unidade de Desenvolvimento do Centro Hospitalar Lisboa-Norte, Unidades de Ensino Estruturado para Educação Especial, Centro de Desenvolvimento Infantil LogicaMentes, EMDIIP (IPSS).

## 3.2. Descrição Técnica
### 3.2 Technical Description

### 3.2.1. Revisão da Literatura
#### 3.2.1. Literature Review

Research on early markers of language development, both using behavioral measures and ERP measures, has largely been centered on a very few languages (and especially on Germanic languages). Two influential hypotheses have guided most of this research: the prosodic bootstrapping hypothesis [11] and the Native Language Neural Commitment hypothesis (NLNC) [1,2]. Both point to the early development of speech segmentation strategies based on native language patterns, which bootstrap word segmentation, word learning and syntactic processing. Infant phonetic discrimination develops from an initial universal to a language-specific stage by the end of the first year [12], and this fundamental transition predicts later language development [2,3]: discrimination of phonetic units permits the sensitivity to distributional properties of sounds that is crucial to segment words. This research has shown a good correlation between behavioral (Conditioned HPP) and ERP (MMN, P150-250, N250-550) measures of phonetic discrimination.
Word stress is known to be a strong cue for word segmentation in stress-timed languages. Stress pattern discrimination is an ability developed early by infants learning variable stress languages [13,14], and performance in stress discrimination predicts language skills later in development, such as expressive vocabulary [4]. Stress discrimination seems to emerge earlier in ERP measures (MMN) than in behavioral studies (HPP, familiarization-preference/visual habituation procedures).
Prosodic cues have been shown to be relevant to language processing not only at the word but also at the sentence level [15]. Infants are sensitive to these cues (as measured by Conditioned HPP, ET and ERPs), and again cross-language variation has been found [16,17]. We know of no studies correlating processing of intonation features and later language development, but the role of Intonation Phrase boundaries for both lexical and syntactic segmentation suggests promising results.
If infant speech perception, both segmental and prosodic, is crucial for word learning, the words the infant learns guide him/her in later language development (of the lexicon, phonology and syntax) [1]. The beginnings of sound-meaning associations have been studied by both behavioral (Switch task, visual choice paradigm) and ERP measures (N400), and were shown to correlate with other markers of development (better performance at the task/larger vocabularies) [5,18].

Impaired discrimination abilities for different speech contrasts have been shown for various kinds of language impairment. Many children with SLI have auditory speech specific discrimination problems [19], and early markers of risk for SLI have been identified in the neural correlates of segmental and prosodic discrimination [6, 20]. Although there are less studies on speech perception for ASD, impaired phonetic discrimination and stress perception have also been found [7, 21]. Interestingly, intonation processing has been suggested to differentiate SLI from ASD, as well as qualitative differences in word learning.

In short, a number of predictive measures of later language abilities (whether typical or impaired) have been established in the literature, on the basis of a small number of languages. Given that the infant's task in learning a language is characterized by a stronger commitment to the native language as development proceeds [1], it is crucial to study markers of early acquisition in languages with different phonological and prosodic properties. EP, in its standard variety, is a language of special interest for the study of early acquisition, as it clusters properties not usually found together in other languages. Unlike Germanic languages, it combines properties of stress- and syllable-timed rhythm; the distribution of word stress is less correlated with the beginning of the lexical word; and the language is proclitic. On the other hand, EP is unlike other Romance languages, due to rhythmic properties and vowel reduction in unstressed position [8, 9]. EP intonation also stands out from other Romance languages due to low co-variation between pitch accent and stress, and the large size of intonational phrases [10].
The presence of both Romance and Germanic-like properties in the phonology and prosody of EP raises challenging questions for acquisition. However, research on infant speech perception and early word learning in EP started only in 2010, with the set up of the first baby lab in Portugal. So far, there are no studies on infant phonetic or stress discrimination. The only two adult stress perception studies in EP show contradictory findings [22], suggesting that stress is not processed as in English/German, nor as in Spanish. The studies of adult speech processing of intonational features in EP include sentence type contrasts, and the use of prosodic cues for lexical and syntactic disambiguation [23]. A recent infant perception of intonation study has shown that the declarative/question intonation contrast is discriminated already at 5 mos and that discrimination is maintained throughout the 1st year [24]. The specific prosodic properties of the language, together with the results of these studies suggest a strong sensitivity to IP boundaries in EP (even if a pause is not present). Word learning is also a domain of early acquisition in which the language specific interpretation of phonetic features is crucial. A recent word learning study with 1 to 4 year old EP learners (using visual fixation) has shown that 1-2 year olds attend to both segmental and prosodic information (stress and pitch) when learning novel words [25]. None of the few perception studies on early language acquisition in EP has addressed the issue of defining early markers of language development, or of comparing typical development and language impairment, the two central goals of the present project.

### 3.2.2. Plano e Métodos

3.2.2. Plan and Methods

The identification of early markers of language development in the acquisition of EP is the core of the EBELa project. Early markers are predictors of later language abilities, both in the case of normal development (ND) and in the case of language impairment (LI). Research on early markers requires a major focus on language-specific properties, as commitment to the native language is a critical feature in language development. We thus face the challenge of conducting a large prospective study with the goal of identifying early markers of language development for EP. This study combines fundamental and applied research. On the one hand, it contributes to our understanding of how language is acquired by offering relevant new data for cross-linguistic testing of general perceptual hypothesis versus language-specific explanations, within the NLNC and the prosodic bootstrapping frameworks [1,2,11]. On the other, it has great social relevance, as the identification of early markers is a decisive step in the promotion of more effective methods of assessment, prevention and intervention, especially in the LI cases where the benefits of early intervention are now well established, as in ASD and SLI [26,27].
Building on the knowledge gathered on the language-specific phonological and prosodic traits of EP and on the research on early markers available for other languages (including both normal and impaired development), we selected 4 linguistic domains for the study of early markers in EP as those that may provide the most relevant information either for cross-language comparisons, or for distinguishing between ND and LI. EP-learning infants, all from monolingual homes, will be tested for those 4 domains in critical learning periods established on the basis of the literature reviewed above:
(1) phonetic discrimination of a non-native contrast (tested at 11 months);

(2) stress pattern discrimination (initial and final stress, tested at 5-6 months);
(3) pitch processing (as a prosodic boundary cue, tested at 8-9 months);
(4) word learning (with pseudowords which differ from actual words segmentally or in their stress pattern, tested at 19-20 months).
Infants will be divided in two major experimental groups: those with no known risk for ASD and/or SLI (the no risk/Normally Developing Group – NDG), and those with high risk for ASD and SLI (the At Risk Group – ARG). The global prevalence of ASD in Portugal is 10 for 10.000 children [28]. There is no data for the prevalence of SLI in Portugal, but it is known to reach about 7% in the US. Risk factors, and especially genetic risk, increase these numbers substantially [26,27,28].
EBELa's 5-year research plan will be implemented through 5 tasks: recruitment and selection of participants, eye-tracking experiments, ERP experiments, assessment of later language abilities, and analysis of markers of early acquisition of EP as predictors of later language development.
Infant participants will be recruited from the Lisbon Baby Lab database, the birth certificate records of all children born in the Lisbon area from November 2011 onwards, and the information provided by the network of public and private institutions collaborating with EBELa. The criteria for inclusion in the ARG is based mainly on genetic risk, complemented with a screening tool (Autism Observation Scale for Infants, [29]) that will be adapted by the EBELa team to also cover SLI. A combination of other risk factors - sex, low birth weight, low 5' APGAR score – will also be considered [26,27]. We aim to test 240 infants in the NDG and 240 children in the ARG, 30 in each experimental task (eye-tracking: 30x4; ERP:30x4). Adult subjects will be recruited for all cases under study for which there is no EP adult data available.
A multi-methodology approach is followed, using both eye-tracking (ET) and ERP measures. This choice has 3 main motivations: (i) previous research using behavioral-based measures and/or ERPs has shown contradictory findings, with good correlation between measures in some but not all cases [2,13,14,19]; (ii) discrimination studies with ERPs (using the typical oddball paradigm), unlike those using eye-gaze, do not allow the presence of phonetically varied stimuli, that has been shown to be crucial to tapper speech processing at a more abstract, phonological level [13,14,24]; (iii) by contrast, many ERP studies do not typically require the oriented attention needed in ET studies. The use of the two methods is thus complementary, and together with a short experimental task to independently assess attention skills, it will enable us to draw more robust interpretations of the data (especially in the case of ARG, as attention deficits characterize both ASD and SLI).
Eye-tracking is a powerful tool for infant language acquisition research that has been much less used than ERPs. We will focus on the well-established visual fixation measures and the less used anticipatory looking behavior [25,30]. The use of the latter will be implemented in an ET-version of the conditioned HPP to test phonetic discrimination. The former will be used in an ET-version of the visual habituation paradigm designed to test stress discrimination and intonation processing. For these 3 domains new procedures using eye-tracking methodology will thus be developed.
ERPs have proved to be a suitable tool to investigate early markers of language acquisition, both in ND and LI [1,2,3,6,7,17,18,20]. We will focus on neurophysiological markers previously identified in the literature for the 4 domains under study (i.e., MMN, P150-250, N250-550 for speech discrimination; CPS for perception of prosodic boundaries; N400 for word learning) although the possibility of finding other effects should not be excluded beforehand. Both the presence/absence and the amplitude of the effects will be examined.
The language abilities of the infants tested for (1) to (4) with ET and ERP will be measured later, in intervals of 6 months up to 30 months of age, using the Portuguese Communicative Development Inventory (CDI), currently under development at the Lisbon Baby Lab. The CDI, initially developed for English, is now available for a number of languages as a tool to assess language development from 8 to 30 months (vocabulary comprehension and production, word combinations). This tool (or its equivalent) has been the most used in previous research on early markers of language development [2,3,6]. In order to also obtain a global measure of language, in the last screening at 30 months children will also be evaluated with the Griffiths scales.
Statistical analyses will focus on the correlations between infants' performance in each of the experimental tasks of (1) to (4) and the CDI measures at the different ages, and the Griffiths measure at 30 months. Strong correlations together with within group differences for the NDG will point to early markers of language development in the ND case. Between group differences showing significant effects separating ARG from NDG will identify early markers of risk for ASD and SLI. A revised analysis of between group differences on the basis of the Griffiths measure will attempt to corroborate the distinctions found, and contribute to establish to what extent early markers can differentially identify risk for ASD and risk for SLI. Logistic regression models taking both the CDI measures or the Griffiths measure as the dependent variable and the infants' performance in the experimental tasks as the predictors will allow the weighing of the different

factors as early markers of development. If possible, and depending on the number of children already with a formal diagnostic provided on independent grounds, a second revised analysis of between group differences will be performed targeting those children with a diagnostic of ASD and SLI, and matched controls from the NDG. This would provide a robust estimate of how effective the previously identified early markers of risk can be as an early diagnostic tool.
Our general hypothesis is that presence of and/or performance relative to early markers of language acquisition is correlated to later language outcomes. Under the NLNC, it is predicted that good discrimination of nonnative contrasts will correlate negatively with later language abilities, whereas good discrimination of native contrasts will show a positive correlation. Under the bootstrapping view, we predict that good performance at the stress discrimination and word learning tasks will have a positive impact on later vocabulary growth, and good performance at the perception of prosodic boundary task will correlate with higher vocabulary scores and more developed syntax. Crucially, both the kind of early markers to be found and the exact nature of these correlations at a given timepoint in later development are expected to be modulated by the language-specific properties of EP. For example, the particular properties of stress in EP (which are distinct from either English and German or French) may promote an early language-specific effect in the ERP measures for Portuguese; as Intonation Phrase (IP) marking is a very prominent feature of the EP prosodic system, with most intonational variation packed close to IP-edges, we expect early sensitivity to IP boundaries in EP, even if a pause is not present (and differently from findings for German). Importantly, on the basis of this large prospective study, we aim to provide the impact of each type of eye movement and neural responses in language development, both in the case of ND, and in the case of LI. In the latter case, early markers of risk for ASD and SLI are expected to be defined.
EBELa's results will thus be a major contribution to present knowledge of the early acquisition of EP, and to a more effective early identification of infants at risk for ASD and SLI with strong individual, familial and social benefits.

### 3.2.3. Tarefas
### 3.2.3. Tasks

**Lista de tarefas** (5)
**Task list** (5)

| Ordem<br>Order | Designação da tarefa<br>Task denomination | Data de início<br>Start date | Data de fim<br>End date | Duração<br>Duration | Pessoas * mês<br>Person * months |
|---|---|---|---|---|---|
| 1 | Recruitment and selection of particip... | 01-04-2013 | 31-08-2013 | 5 | 89 |

**Descrição da tarefa e Resultados Esperados**
Task description and Expected results

Infant participants will be recruited from the Lisbon Baby Lab participants database, the birth certificate records of all children born in the Lisbon area from November 2011 onwards (a request to obtain this list via an exemption in confidentiality for research entities will be filed), and the information provided by the network of public and private institutions collaborating with EBELa, such as Unidade de Desenvolvimento do Centro Hospitalar Lisboa-Norte, Unidades de Ensino Estruturado para Educação Especial, Centro de Desenvolvimento Infantil LogicaMentes, and EMDIIP. The criteria for inclusion in the ARG will be based mainly on genetic risk (one first degree family member with ASD or SLI), complemented with a screening tool (Autism Observation Scale for Infants – AOSI [29]) that will be adapted by the EBELa team to also cover SLI (similar observation scales for younger infants are not available for SLI). A combination of other risk factors - sex (male), low birth weight (< 2500 g), low 5' APGAR score – will also be considered [26,27]. Inclusion in the NDG group requires no genetic risk and an AOSI score that should exclude ASD and/or SLI. Recruitment and selection of the infant participants will thus require the following steps: (i) intensive data collection of individual and familial information; (ii) its treatment to define a first list of selected subjects; (iii) contacting the selected families; (iv) evaluation of infants with the AOSI; and (v) final list of subjects to be tested. Overall, 480 will be tested: 240 infants in the NDG and 240 in the ARG, 30 in each experimental task (ET: 30x4; ERP:30x4). Adult subjects will be recruited from the adult subject database of the Lisbon Baby Lab and the

community of university students in Lisbon, for all cases for which there is no EP adult data available. These include the ERP experiments in the 4 linguistic domains under study, and a standard discrimination task (of the AX or ABX type) to test perception of the non-native phonetic contrast. Overall, 100 adults will be tested, 20 in each experimental task (20x5).
Subjects/infants' parents will be given a detailed information sheet about the study and will be asked to sign an informed consent form. All investigations are non-invasive and safe for all infants and adults. The information and data collected will only be used for the purposes of scientific research and in no moment will the identity of subjects be disclosed. To guarantee confidentiality, all the subjects selected will be given an anonymous code as part of the output of the selection process, and thus all the data collected will be anonymized accordingly. Individual information will be stored in a safe place, under the responsibility of the principal investigator (PI). Subjects will be paid for their participation in the study.
The results of task 1 are: (i) the final list of infants to be tested in both the NDG and the ARG; (ii) the characterization of NDG and ARG on the basis of the at-risk criteria previously defined and the AOSI (adapted version) score; (iii) the adapted version of the AOSI to also cover SLI; (iv) the list of adult subjects to be tested.
Given the intensive data collection, treatment and infant evaluation to be concluded in a short period of time, human resources are needed for task 1 (100% of a BIC).

| **Ordem**<br>Order | **Designação da tarefa**<br>Task denomination | **Data de início**<br>Start date | **Data de fim**<br>End date | **Duração**<br>Duration | **Pessoas * mês**<br>Person * months |
|---|---|---|---|---|---|
| 2 | Eye-tracking experiments | 01-06-2013 | 31-07-2015 | 26 | 97 |

**Descrição da tarefa e Resultados Esperados**
Task description and Expected results

Four eye-tracking experiments are run to test the domains under study: (1) phonetic discrimination of a non-native contrast (tested at 11 months); (2) stress pattern discrimination (initial and final stress, tested at 5-6 months); (3) pitch processing (as a prosodic boundary cue, tested at 8-9 months); (4) word learning (with pseudowords which differ from actual words only segmentally or only in their stress pattern, tested at 19-20 months). 240 infants will be tested (NDG: 30x4; ARG: 30x4).
For (1), an ET-version of the conditioned head-turn procedure will be developed, exploring anticipatory looking behavior. For (2) and (3), an ET-version of the visual habituation paradigm will be designed, using accumulated visual fixation in a pre-defined area of interest (AOI). Thus new procedures using ET methodology will be developed. For (4), ET visual fixation measures in the relevant AOIs are used under the visual choice paradigm. The implementation of these experimental paradigms includes: (i) design and recording of auditory stimuli; (ii) design and implementation of the ET experiment; (iii) pilot testing; (iv) revision; and (v) running the experiment. For each infant, a short task is run just before the ET task to independently assess the infant's attention skills. In the case of (1), a discrimination task (AX or ABX) to test adult perception of the non-native phonetic contrast is run prior to the infant ET-study, to establish the adult baseline.
The SMI RED250 ET-system of the Lisbon Baby Lab (LBL)- CLUL will be used. ET data collection and analysis uses dedicated software tools, comprising video, audio and eye-movement coordinated registers, data filtering and statistical analysis. LBL is equipped to run remote ET experiments and process the data collected. EBELa's research team (which includes several LBL researchers and the LBL director) has experience in this field, both with normally developing and autistic children.
Our predictions are the following (in articulation with task 4): (1) Given the correlation between performance in non-native segmental discrimination and later language skills for several languages, we predict that better discrimination of the non-native contrast correlates with reduced later language abilities in EP, and that NDG and ARG show distinct performances; (2) Considering the literature on infant stress discrimination using phonetically varied stimuli, EP-specific stress properties and the adult data for EP, we expect not to find robust discrimination as early as 5 mos in the ET-study, contrary to the ERP study, but individual differences in performance may still correlate positively with later language abilities; (3) On the basis of the behavioral literature on prosodic processing and the EP-specific properties, we expect early sensitivity to IP boundaries in EP, and we predict that stronger effects correlate with better later language abilities, with weaker performance in the ARG as a predictor of later language impaired skills; (4) We predict that better

performance overall correlates with better later language abilities in the NDG, and expect that the ARG shows differences in performance when compared with the NDG, especially in the prosodic pseudoword condition and when having to deal with varying input (combining both segmental and prosodic information).

The expected results of task 2 are: (i) new fundamental research on ET measures of early language acquisition in normally developing infants and infants at risk for ASD and SLI; (ii) definition of early markers of language development, and early markers of risk for ASD and SLI, based on eye-movement (with tasks 4, 5); (iii) development of new procedures to study infant speech perception, using ET. Some of the outputs related to this task, namely 2 publications and 2 PhD Thesis will only be available in years 4 and 5 of the project (although indicated in year 3 below due to restrictions of the form).

| **Ordem** | **Designação da tarefa** | **Data de início** | **Data de fim** | **Duração** | **Pessoas * mês** |
|---|---|---|---|---|---|
| Order | Task denomination | Start date | End date | Duration | Person * months |
| 3 | ERP experiments | 01-06-2013 | 31-07-2015 | 26 | 145 |

**Descrição da tarefa e Resultados Esperados**

Task description and Expected results

Four ERP experiments are run to test the domains under study: (1) phonetic discrimination of a non-native contrast (tested at 11 months); (2) stress pattern discrimination (initial and final stress, tested at 5-6 months); (3) pitch processing (as a prosodic boundary cue, tested at 8-9 months); (4) word learning (with pseudowords which differ from actual words only segmentally or only in their stress pattern, tested at 19-20 months). 240 infants will be tested (NDG: 30x4; ARG: 30x4). 80 adult subjects will also be tested (20x4).
For (1) and (2), the well-known oddball paradigm is used. For (3), the common procedure to assess processing of intonation phrase boundaries is used [17]. For (4), we use the picture-word matching paradigm that is common in lexical-semantic processing studies. The implementation of these experimental paradigms includes: (i) design and recording of auditory stimuli; (ii) design and implementation of the ERP experiment; (iii) pilot testing; (iv) revision; (v) running the experiment. For each infant, a short task is run just before the ERP task to independently assess the infant's attention skills. Adults are also tested for the 4 ERP tasks to establish adult performance and examine potential developmental changes.
The EEG system of LaPSo – ISCTE will be used: Neuroscan Synamps2 and Stim2. LaPSo is equipped to run ERP experiments and process the data collected. EBELa's research team (which includes the LaPSo director and two researchers working on EEG) has experience in EEG. However, a researcher specialized in infant studies with ERP is needed in the team (BPD).

We will focus on ERP markers previously identified in the literature for the 4 domains under study (i.e., MMN, P150-250, N250-550 for speech discrimination; CPS for perception of prosodic boundaries; N400 for word learning) although the possibility of finding other effects should not be excluded beforehand. Both the presence/absence and the amplitude of the effects is examined. Our predictions are the following (in articulation with task 4): (1) Given the correlation between non-native segmental discrimination and later language skills for several languages, we predict that better discrimination of the non-native contrast correlates with reduced later language abilities in EP, and that ARG tends to show a negativity effect (N250-550) or no effect, unlike NDG that should show a positivity effect (P150-250); (2) Considering EP-specific stress properties, we expect an early language-specific effect in the ERP measures for EP, no discrimination effect (MMN) in infants with poor language skills later in development, and poor discrimination in ARG when compared with NDG; (3) On the basis of EP-specific properties, we expect early sensitivity to IP boundaries in EP, and we predict that stronger CPS effects correlate with better later language abilities, with weaker performance in the ARG as a predictor of later language impaired skills; (4) We predict that better performance overall correlates with better later language abilities in the NDG, and expect that the ARG shows differences in performance when compared with the NDG (N400), especially in the prosodic pseudoword condition and when having to deal with varying input (combining both segmental and prosodic information).

The expected results of task 3 are: (i) new fundamental research on ERP measures of early

language acquisition in normally developing infants and infants at risk for ASD and SLI; (ii) definition of early neurophysiological markers of language development, and early markers of risk for ASD and SLI (with tasks 4, 5); (iii) assessment of developmental changes in processing, by comparing infant and adult data. Some of the outputs related to this task, namely 2 publications and 1 PhD Thesis will only be available in years 4 and 5 of the project (though indicated in year 3 below due to restrictions of the form).

| **Ordem**<br>Order | **Designação da tarefa**<br>Task denomination | **Data de início**<br>Start date | **Data de fim**<br>End date | **Duração**<br>Duration | **Pessoas * mês**<br>Person * months |
|---|---|---|---|---|---|
| 4 | Assessment of later language abilities | 01-12-2013 | 31-03-2016 | 28 | 100 |

**Descrição da tarefa e Resultados Esperados**

Task description and Expected results

The language abilities of the infants tested for (1) to (4) with ET and ERP will be measured later, in intervals of 6 months up to 30 months of age, using the Portuguese Communicative Development Inventory (CDI), currently under development at the Lisbon Baby Lab. Measuring of language abilities of the 480 infants with the CDI proceeds according to the following plan:
(1) phonetic discrimination of a non-native contrast (tested at 11 months with ET and ERP, 120 infants): measured at 18, 24 and 30 months;
(2) stress pattern discrimination (tested at 5-6 months, 120 infants): measured at 12, 18, 24 and 30 months;
(3) pitch processing as a prosodic boundary cue (tested at 8-9 months, 120 infants): measured at 12, 18, 24 and 30 months;
(4) word learning (tested at 19-20 months, 120 infants): measured at 24 and 30 months.
The CDI, initially developed for English, is now available for a number of languages as a tool to assess language development from 8 to 30 months (vocabulary comprehension and production, word combinations). This tool (or its equivalent) has been the most used in previous research on early markers of language development [2,3,6]. We will use the CDI forms I and II, respectively Infant form and Infant and toddler form. In order to also obtain a global measure of mental development for each participant, in the last screening at 30 months all the children are also evaluated with the Griffiths Mental Development Scales- Extended Revised (GMDS-ER, Portuguese version based on 2006 edition).
The implementation of the measuring tasks requires: (i) contacting the infant's family each time a measuring age is reached; (ii) distributing the CDI form to parents one week before the child reaches the target age; (iii) collecting the completed CDI forms; (iv) inviting the child and parents to the baby lab for the final assessment with the Griffiths Scales. Parents will be paid for their collaboration in the study.
Upon receipt of the CDI forms, pre-processing of the data proceeds by data insertion into the assessment of later language abilities database. The full procedure (contacts, distribution and collection of the forms, data pre-processing) is run from the Lisbon Baby Lab. The final assessment with the Griffiths also uses the baby lab facilities.

We predict overall poor language abilities in ARG when compared to NDG. In articulation with tasks 2, 3 and 5, we expect later language skills to negatively correlate with non-native segmental discrimination and to positively correlate with stress discrimination, prosodic processing and word learning abilities.

The expected results of task 4 are: (i) a database of measures of language development up to 30 months of age, for the 240 normally developing children tested (NDG); (ii) a database of measures of language development up to 30 months of age, for the 240 children at risk for ASD and SLI (ARG); (iii) description of the development of language abilities for NDG and ARG. Given that this task is concluded only at month 36 of the project, all the outputs related to it (oral presentations and publications) will only be available in years 4 and 5 of the project (although indicated in year 3 below due to restrictions of the form).

| Ordem<br>Order | Designação da tarefa<br>Task denomination | Data de início<br>Start date | Data de fim<br>End date | Duração<br>Duration | Pessoas * mês<br>Person * months |
|---|---|---|---|---|---|
| 5 | Markers of early acquisition of as pr... | 01-01-2016 | 31-03-2018 | 27 | 45 |

**Descrição da tarefa e Resultados Esperados**

Task description and Expected results

The data obtained in tasks 2, 3 and 4 are analyzed to answer the two central questions of ENELa: to identify early markers of language development in the acquisition of EP, and to define early markers of risk for ASD and SLI.
Early markers are thus seen as predictors of later language abilities, both in the case of normal development (ND) and in the case of language impairment (LI). The eye movement and neural responses obtained respectively in tasks 2 and 3 for each of the 4 linguistic domains under study are the potential early markers; The CDI scores and the final Griffiths score are the language development measures to be predicted.

Statistical analyses will focus on the correlations between infants' performance in each of the experimental tasks (ET and ERP, for the 4 linguistic domains) and the CDI measures at the different ages, and the Griffiths measure at 30 months. Strong correlations together with within group differences for the NDG will point to early markers of language development in the ND case. Between group differences showing significant effects separating ARG from NDG will identify early markers of risk for ASD and SLI. A revised analysis of between group differences on the basis of the Griffiths measure will attempt to corroborate the distinctions found, and contribute to establish to what extent early markers can differentially identify risk for ASD and risk for SLI. Logistic regression models taking both the CDI measures or the Griffiths measure as the dependent variable and the infants' performance in the experimental tasks as the predictors will allow the weighing of the different factors as early markers of development. Finally, depending on the number of children already with a formal diagnostic provided on independent grounds during year 4 of the project, a second revised analysis of between group differences will be performed targeting those children with a diagnostic of ASD and SLI, and matched controls from the NDG. This would provide a robust estimate of how effective the previously identified early markers of risk can be as an early diagnostic tool. This final step in the analysis requires following the ARG subjects for an additional 12 months. Parents and/or the health care unit where they are followed will be contacted in two occasions: 6 months and 12 months after the last screening at 30 months of age.

Our general hypothesis is that performance relative to early markers of language acquisition is correlated to later language outcomes. It is predicted that good discrimination of nonnative contrasts will correlate negatively with later language abilities, whereas good discrimination of native contrasts will show a positive correlation. We also predict that good performance at the stress discrimination and word learning tasks will have a positive impact on later vocabulary growth, and good performance at the perception of prosodic boundary task will correlate with higher vocabulary scores and more developed syntax. Crucially, both the kind of early markers to be found and the exact nature of these correlations at a given timepoint in later development are expected to be modulated by the language-specific properties of EP.

The expected results of task 5 are: (i) identification of early markers of language development in the acquisition of EP; (ii) definition of early markers of risk for ASD and SLI; (iii) proposal of a set of early markers of risk to be used as an early diagnostic tool. Given that this task evolves during years 4 and 5 of the project, all the outputs related to it (oral presentations and 2 papers) will only be available in year 5 (although indicated in year 3 below due to restrictions of the form).

### 3.2.4. Calendarização e Gestão do Projeto

3.2.4. Project Timeline and Management

### 3.2.4.a Descrição da Estrutura de Gestão

3.2.4.a Description of the Management Structure

The 5 tasks in which ENELa is structured are all coordinated by the PI, assisted by a co-coordinator for each task. The coordination groups will meet monthly and are in charge of the scientific and administrative management of the project, including regular meetings between the team members involved in each task (every month), regular meetings joining all team members (every 3 months), meetings with project consultants, supervision of production of milestones and other project outputs, actions to disseminate of project's results, and writing-up of annual progress reports during the 5 years of the scientific research plan. The multidisciplinary nature of the project is reflected in its management structure: co-coordination for tasks 1 and 4 is ensured by a team member from the Psychology Faculty of Oporto University; the director of Lisbon Baby Lab – CLUL co-coordinates tasks 2, 4 and 5; the director of LaPSo – ISCTE co-coordinates task 3 (see the Adenda.pdf file). As the core of the research team is based in Lisbon, all meetings will take place at CLUL. Project consultants will meet with the whole research team at some point during the first 5 months of the project to examine and discuss in detail the goals, methods and procedures to follow. Another meeting of the whole team with the consultants is planned for the second half of year 3 to examine in detail the progress achieved and discuss the nature and implications of the research findings so far, as well the scientific plan for the remainder data collection and the analytical procedures to explore. This meeting will precede the EBELa workshop, planned as a forum for knowledge dissemination and scientific discussion and open to the research, clinical and social communities (including the network of EBELa's collaborating institutions and other interested parties). During year 5, several actions to disseminate the project's results will be promoted targeting all those interested in language development and language impairment, including researchers and professionals working on the assessment, prevention and intervention. A project website will be set up by the Lisbon Baby Lab, as a platform for knowledge dissemination, both for the scientific community and the general public.

### 3.2.4.b Lista de Milestones

3.2.4.b Milestone List

| **Data**<br>Date | **Designação da milestone**<br>Milestone denomination |
|---|---|
| 30-04-2013 | Adapted version of the AOSI |
| **Descrição**<br>Description | |
| Adapted version of the screening tool Autism Observation Scale for Infants – AOSI, to also cover SLI. | |
| **Data**<br>Date | **Designação da milestone**<br>Milestone denomination |
| 31-08-2013 | List of infant subjects included in the study |
| **Descrição**<br>Description | |
| The final list of infants selected to be included in the two major experimental groups, the normally developing group and the at risk group. | |
| **Data**<br>Date | **Designação da milestone**<br>Milestone denomination |
| 31-08-2015 | Markers of early language acquisition |
| **Descrição**<br>Description | |
| End of data collection for eye-movement and neurophysiological measures, on the basis of which early markers of language development and early markers of risk for ASD and SLI will be identified (as the final outcome of task 5, Janeiro 2018). | |
| **Data**<br>Date | **Designação da milestone**<br>Milestone denomination |
| 31-03-2016 | Towards early markers of language development |
| **Descrição**<br>Description | |
| Description of language development up to 30 months of age, for the NDG and the ARG children. This description, together with milestone 3, will allow the proposal of a set of early markers of risk for ASD and SLI to be used as an early diagnostic tool (scheduled for January 2018). | |

### 3.2.4.c Cronograma

3.2.4.c Timeline

*Ficheiro com a designação "timeline.pdf", no 9. Ficheiros Anexos, desta Visão Global (caso exista).*
*File with the name "timeline.pdf" at 9. Attachments (if exists).*

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### 3.3. Bibliographic References


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| [23] | 2011 | Severino, Cátia (2011). Fronteiras Prosódicas e Desambiguação no Português Europeu. MA Thesis (supervised by Sónia Frota & Marina Vigário), Universidade de Lisboa. |
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| [30] | 2011 | Bjerva, J.; Marklund, E.; Engdahl, J.; Lacerda, F. (2011) Anticipatory Looking in Infants and Adults. Proceedings of EyeTrackBehavior 2011, Stockholm University. |

### 3.4. Publicações Anteriores
3.4. Past Publications

| Referência<br>Reference | Ano<br>Year | Publicação<br>Publication |
|---|---|---|
| [A] | 2010 | **Cameirão, M. L. & Vicente, S. G. 2010. Age-of-acquisition norms for a set of 1749 portuguese words. Behavior Research Methods, 42(2), 474–480.** |
| [B] | 2012 | **Frota, S. 2012. Prosodic structure, constituents and their representations. In A. Cohn, C. Fougeron & M. Huffman (eds) The Oxford Handbook of Laboratory Phonology. Oxford. Oxford University Press, Chapter 11, 255-265. [ISBN 978–0–1–9–957503–9]** |
| [C] | 2012 | **Frota, S.; Butler, J.; Correia, S.; Severino, C. & Vigário, M. 2012. Pitch First, Stress Next? Prosodic Effects on Word Learning in a Intonation Language. Proceedings of the 36th annual Boston University Conference on Language Development edited by Alia K. Biller, Esther Y. Chung, and Amelia E. Kimball, 190-201. Somerville, MA: Cascadilla Press.** |
| [D] | 2008 | **Leal, A.; Dias, A. I.; Vieira, J. P.; Moreira, A.; Távora, L. & Calado, E. 2008. Analysis of the dynamics and origin of epileptic activity in patients with Tuberous Sclerosis evaluated for surgery of epilepsy. Clinical Neurophysiology 119(4), 853-861.** |
| [E] | 2006 | **Vigário, M.; Freitas, M. J. & Frota, S. 2006. Grammar and frequency effects in the acquisition of prosodic words in European Portuguese. Language and Speech (Special Issue Crosslinguistic Perspectives on the Development of Prosodic Words, guest-edited by K. Demuth) 49(2), 175-203.** |

## 6. Indicadores previstos
6. Expected indicators

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### Indicadores de realização previstos para o projeto
Expected output indicators

| Descrição<br>Description | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|
| **A - Publicações**<br>Publications | | | | | | |
| Livros<br>Books | 0 | 0 | 0 | 0 | 0 | **0** |
| Artigos em revistas internacionais<br>Papers in international journals | 0 | 0 | 0 | 1 | 4 | **5** |
| Artigos em revistas nacionais<br>Papers in national journals | 0 | 0 | 1 | 2 | 1 | **4** |
| **B - Comunicações**<br>Communications | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Comunicações em encontros científicos internacionais<br>Communications in international meetings | 0 | 0 | 3 | 4 | 4 | **11** |
| Comunicações em encontros científicos nacionais<br>Communications in national meetings | 0 | 0 | 2 | 3 | 2 | **7** |
| **C - Relatórios**<br>Reports | 0 | 0 | 1 | 1 | 1 | **3** |
| **D - Organização de seminários e conferências**<br>Organization of seminars and conferences | 0 | 0 | 0 | 0 | 1 | **1** |
| **E - Formação avançada**<br>Advanced training | | | | | | |
| Teses de Doutoramento<br>PhD theses | 0 | 0 | 0 | 0 | 3 | **3** |
| Teses de Mestrado<br>Master theses | 0 | 0 | 0 | 0 | 0 | **0** |
| Outras<br>Others | 0 | 0 | 0 | 0 | 0 | **0** |
| **F - Modelos**<br>Models | 0 | 0 | 0 | 0 | 0 | **0** |
| **G - Aplicações computacionais**<br>Software | 0 | 0 | 0 | 0 | 0 | **0** |
| **H - Instalações piloto**<br>Pilot plants | 0 | 0 | 0 | 0 | 0 | **0** |
| **I - Protótipos laboratoriais**<br>Prototypes | 0 | 0 | 0 | 0 | 0 | **0** |
| **J - Patentes**<br>Patents | 0 | 0 | 0 | 0 | 0 | **0** |
| **L - Outros**<br>Other | | | | | | |
| | 0 | 0 | 0 | 0 | 0 | **0** |
| | 0 | 0 | 0 | 0 | 0 | **0** |
| | 0 | 0 | 0 | 0 | 0 | **0** |

## Acções de divulgação da actividade científica
**Scientific activity spreading actions**

Actions to disseminate the project’s results will be promoted targeting all those interested in language development and language impairment, including researchers and professionals working on the assessment, prevention and intervention (e.g., speech therapists, psychologists, pediatricians, neurophysiologists, teachers). Such actions may include lectures, talks, and informal meetings. Spreading of the project’s activities and results will be ensured via the project´s website.

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