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# Consonants, vowels and levels of specification in the phonological representations of the first lexicon: a review

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**Título**: Consonantes, vocales y niveles de especificación en las representaciones fonológicas del léxico inicial: una revisión.
**Resumen**: Se presenta una revisión de las principales investigaciones sobre el formato de representación léxica en etapas iniciales del desarrollo lingüístico. Los resultados actuales, revelan un importante nivel de especificación fonológica en las representaciones del primer léxico, antes incluso de los dos años. Estos resultados se explican desde un marco teórico que plantea la existencia de múltiples niveles de codificación y sugiere diferencias en el acceso a la información representada en función de las demandas de la tarea o del nivel de vocabulario alcanzado. Un área de debate actual se sitúa en torno a la existencia de posibles diferencias en el grado de especificación de las vocales y consonantes representadas en el léxico. Este artículo analiza el estado actual de este debate teniendo en cuenta los resultados recientes obtenidos en investigaciones realizadas en distintas lenguas, con poblaciones de diferente entorno lingüístico (monolingüe y bilingüe) y metodologías experimentales que suponen distinto grado de exigencia cognitiva.
**Palabras clave** (4-8): Representación fonológica; desarrollo léxico; percepción del habla; reconocimiento de palabras; aprendizaje de palabras; especificación fonológica; vocales; consonantes.

**Abstract**: A review of the main studies on the format of lexical representation in the initial stages of language development is presented. Current investigations reveal a significant level of phonological specificity in the representation of words in the first lexicon, even before age two years. These results can be explained from a theoretical framework that posits the existence of multiple levels of encoding and suggests differences in accessing the represented information as a function of task demands or vocabulary size. The existence of possible differences in the degree of specification of vowels and consonants represented in the lexicon is an area of current debate. This article discusses the present state of this debate in the light of recent findings from research with different languages, in populations with different linguistic environments (monolingual and bilingual) and from experimental approaches that involve varying degrees of cognitive demands.
**Key words**: Phonological representation; lexical development; speech perception; word recognition; word learning; phonological specification; vowels; consonants.

## Introduction

In the initial stages of language acquisition lexical and phonological development are closely linked. The beginning of this relatedness takes place even before the first words production stage, when infants start building a receptive vocabulary. The ability to segment speech and extract possible word forms from the input starts approximately in the second half of the first year of life (Jusczyk, 1999). Perceptual reorganization that allows the construction of the main phonetic categories of the native language also takes place in the same period (Bosch and Sebastian-Gallés, 2003; Polka and Werker 1994, Werker and Tees, 1984). These are two basic skills that come together in the construction and representation of the first receptive lexicon that, in turn, precedes the onset of word production in the second year of life. The first words produced not only meet social purposes, but allow beginning to name objects and events of the external world. With lexical development children can be more effective in communicating with others in their environment and communicative functions in the context of verbal interactions with the adult are significantly improved.

Recognizing and understanding words efficiently means having stored in memory a representation of their sound form, sufficiently specified from the phonological point of view so these word forms can be differentiated from other stored lexical representations. Despite variability in the linguistic input children are exposed to (different speakers and intra-speaker variations in word production) in order to recognize words and understand their meaning they need to build and have access to a phonological representation more abstract than the perceived phonetic variability. It is accepted that this process occurs early in life and it is basic for receptive vocabulary development, although it is possible to discuss about the level of phonological specification (in terms of syllables, phonemes or subphonemic features) that is present in the first lexical representations of the child. This article presents a review of the main studies that have explored young children's early ability to recognize familiar words, differentiate them from other words, similar in form but involving minor segmental differences, or learn new words phonologically very close. Therefore, we are interested in analyzing the available evidence regarding the phonological specification of early lexical representations, identifying potential discrepancies in the data and describing the current state of the debate about the format of representation of the initial lexicon.

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## Perception, production and phonological representation of the first lexicon

In the last decades, the existing knowledge about the format of the lexical representations in child vocabulary has gradually evolved. Different behavioral methods have allowed researchers to explore experimentally, and with increasing accuracy, the stability and the level of specification of the phonological representations of the words that children acquire. Early studies on this topic (e.g. Barton, 1978; Eilers and

Oller, 1976; Garnica, 1973; Schvachkin, 1973) established a clear parallelism between perception and production of speech and proposed a slow and gradual development of perception and phonemic representations even beyond three years of age, following an acquisition sequence similar to that described in the articulatory domain. But those investigations were carried out when there was very limited knowledge of the speech perception abilities observed in infants during their first year of life. Through the development of research in the domain of infant speech perception, the perspective on the acquisition, processing and representation of speech in early childhood has varied substantially.

While it is true that from the point of view of production some limitations can be observed in children's ability to correctly produce certain consonants or consonant sequences in the early stages of speech development (Bosch, 2004; Ingram, 1989; Nittrouer, Studert-Kennedy and McGowan, 1989; Stoel-Gammon, 1985, 1998; Vihman, 1996), this evidence cannot be taken to suggest a strict parallelism between perception/phonological representation and production processes. There is no complete agreement on this issue, though. Some researchers, whose work falls within the Motor Theory of speech perception (Liberman and Mattingly, 1985), see a close dependence between perception and production, which means that accurate phonological representations would be achieved progressively over childhood. From this perspective, the articulatory gesture would be the unit of perception and production, with phonemes emerging late in development (Fowler, 1991). These models provide an alternative explanation to the phonological development from an articulatory perspective and propose a sequence in speech acquisition based on articulatory gestures and the organs involved, but these models have not addressed in depth the issues that this article intends to focus on, relative to the phonological representation of the early lexicon. Alternatively, the link between perception and production is seen in a more interactive way from other theoretical perspectives that take into account early speech perception abilities in young infants. A certain bi-directionality between perception and production is accepted, but with an emphasis on perceptual development. From this perspective, experience with the ambient language (the linguistic input) and sensory learning is what guides the development of speech motor patterns (Kuhl, Convoy, Coffey-Corina, Padden, Rivera-Gaxiola and Nelson, 2008).

Thus, phonetic learning in the first year of life, resulting from infants' sensitivity to the distributional properties of speech sounds in the ambient language and favored by additional cues present in infant-directed speech, leads to changes in speech perception that are manifested by enhanced sensitivity towards native sound categories and reduced sensitivity to non-native contrasts. At the end of this period, a first link between perception and production is established. This link can be observed in infants' vocalizations (babbling), which are tuned to and reproduce some of the specific sound properties of the ambient language (de Boysson-Bardies, 1993). In other words, initially, and as a result of linguistic experience, there are changes in the perceptual organization of speech that later will be manifested in production, still in the pre-lexical stage. This approach does not preclude that a late discrimination might be observed for some contrasts, as in the case of certain fricative sounds[2]. But in general, infants' early ability for speech sound discrimination and their perceptual tuning or reorganization processes relative to the native phonetic categories by the end of the first year of life, when the production of words is still extremely limited, testify to this relative advantage of perception over production (see Jusczyk, 1997, for an extensive review). Accepting this perceptual advantage does not necessarily rule out the bi-directional link that can be established between perception and production processes. Changes in the perception of native contrasts (phonetic learning) may influence the ability to detect word forms, and this ability, in turn, may improve contrast discrimination, according to the Native Language Magnet-expanded model (NLM-e) proposed by Kuhl et al., (2008).

It is possible, therefore, to argue that the knowledge derived from early phonetic learning can later be used in word learning processes. Many consonant and vowel segments could then be well-specified in the representations of the newly acquired words, revealing a continuity between the phonetic perception skills characteristic of the pre-lexical stage and the ability to phonologically represent the first words. However, it is also possible to accept a certain discontinuity and a gradation in the phonological specification of the early lexicon, especially if we take into consideration certain experimental results that have challenged this linearity in development and have led to a major controversy about the level of phonological specification present in the first vocabulary. More specifically, it has been suggested that the cognitive demands involved in word learning processes may temporarily limit the child's ability to use the knowledge about the phonetic categories acquired in the pre-lexical stage and to apply this knowledge when building phonological representations of newly learned words (Stager and Werker, 1997; Kuhl, 2009). Even within a continuity account, such data suggest a more gradual development (although limited to a short time period early in the second year of life) of the phonological specification of segments in the initial lexicon.

The first goal of this article is to review the results of the main research on the format of lexical representations in the second year of life done in recent years and discuss the controversy surrounding the continuity or discontinuity between phonetic discrimination skills in the pre-lexical stage and phonological specification of the first lexical representations. Additionally, a second goal of this article is to review the

[2] It has been observed that, probably due to their acoustic characteristics (lower amplitude), some fricatives may be difficult to discriminate at early stages of development and performance in perceptual tasks is usually lower in childhood than in adulthood (Kuhl, Stevens, Hayashi, Deguchi, Kiritani and Iverson, 2006; Nittrouer, 2001; Sundara, Polka and Genesee, 2006).

current debate on the different role that vowels and consonants can have in lexical representations. According to the hypothesis proposed by M. Nespor, consonants and vowels have different functions in language (Nespor, Peña and Mehler, 2003). Consonants would play an important role in lexical encoding, but vowels would not, the latter being more relevant to encode information at the morpho-syntactic level. This hypothesis is based on the fact that information about syntactic units in speech is marked by prosodic variations that occur in vowel segments (generally longer and more stable than consonant segments). Additionally, morphological information (nominal and verbal inflections) is mainly manifested by variations in vowel segments. Recent work, based on experiments with artificial grammars, has also shown the differential use of vowels and consonants according to the type of learning required: based on rules or statistics, respectively (Bonatti, Peña, Nespor and Mehler, 2005; Toro, Nespor, Mehler and Bonatti, 2008). It is thus possible to hypothesize that a certain under-specification of vowels as opposed to consonants might be found in early lexical representations. As we will see throughout this article, the experimental evidence is not completely unanimous on this issue, although there are some studies that support this asymmetry in favor of consonants.

## Studies on familiar word recognition

The implementation of highly controlled experimental tasks based on measures of visual fixation to images that correspond to words in the child lexicon, has allowed researchers to study more precisely the process of perception and phonological encoding in familiar word recognition. The intermodal preferential looking paradigm originally developed to study the time course of word recognition in children (Fernald, Pinto, Swingley, Weinberg and McRoberts, 1998), has been also successfully implemented to study phonological representations, from age 14 months[3]. In this paradigm correct and mispronounced words (involving different segments and in different position within the word) are presented to the infant. Visual fixation responses and orientation latency toward named images are recorded (Swingley, 2003, 2009; Swingley and Aslin, 2000, 2002).

Overall these studies reveal that from the early stages of lexical development, children are sensitive to slight changes in phonological word forms, showing shorter fixation times for mispronounced words, regardless of the size of their expressive vocabulary (Swingley, 2003, 2009, Swingley and Aslin, 2000, 2002) or the position that the segment has within the word (Swingley, 2003, 2009). These results have been taken as evidence that early lexical representations are phonologically well-specified. However, it must be taken into account that these studies have only explored a limited number of consonant mispronunciations, without further analysis of possible differences in sensitivity to mispronunciations depending on the type of segment (fricatives or stops) or number of distinctive features shared between the target consonant and its incorrect pronunciation (see Table 1).

Using a similar methodology (even though with some minor differences in the dependent variables), K. Plunkett and collaborators have addressed the same problem but also considering whether specification of phonological representations varies depending on the age of acquisition of the word (see Table 1). Results from 18- to 24-month-old children in a familiar word recognition task, using word-initial consonant changes, have revealed that even for newly acquired words phonological representation is accurate and is not affected by factors such as age, vocabulary size or the density of phonological neighbors of the tested words (Bailey and Plunkett, 2002). Even at a younger age, that is, with a lower vocabulary size and less language exposure, lexical representations are phonologically specified, as suggested by the results obtained at 14 months using the same type of methodology and comparing again familiar words with newly learned words (Ballem and Plunkett, 2005).

Research on the representation format is more precise in Bailey and Plunkett (2002) investigations, as compared with those by D. Swingley, since the former used consonant changes based on an incremental modification of different subphonemic features. The results showed similar responses regardless of the number of modified features in the incorrect pronunciations. The role of features in the phonological representations of the early lexicon was explored in more detail by White and Morgan (2008), whose research was based on the intermodal preferential looking paradigm, but using pictures of unfamiliar objects as distractors. They found that 19-month-old children had increasing difficulty in recognizing words with changes involving a higher number of altered dimensions (voicing, manner and place of articulation). These results, which reflect phonological representations similar to those observed in adults, strengthen the interpretation favoring accurate, well-specified phonological representations of words in the initial lexicon. However, a different study with Dutch infants showed that at age 20 months they were sensitive to changes in place of articulation in the initial consonant but not to changes in voicing (Van der Feest, 2007). This effect, which was no longer present at 24 months, led to an interpretation in terms of a gradual incorporation (in a very short period of time, between 20 and 24 months) of certain features in the phonological representation of consonantal segments at a lexical level, something that previous research had not explicitly suggested. Further work in Dutch, however, corroborates

[3] There are other studies, at 11 months of age, which analyze the listening preference to audio materials including lists of familiar, unfamiliar, correctly or incorrectly pronounced words (Hallé and de Boysson-Bardies, 1996; Swingley, 2005). However, as this methodology does not guarantee lexical recognition (no images or objects are presented), the results are not discussed here, nor included in this section. Interestingly, however, these studies suggest that at least consonants in the initial position of words may be phonologically specified at this early age.

**Table 1.** Familiar word recognition studies exploring phonological contrast encoding. Characteristics of the sample (age, language and number of participants), procedure used, phonological contrast and main conclusions of the study are provided.

| Authors, year | Sample | Procedure | Studied contrasts | Conclusions |
|---|---|---|---|---|
| **Swingley & Aslin, 2000** | 18 to 23 months<br>English; n = 56 | Preferential looking paradigm. | /æ-a/,/b-v/,/b-g/<br>/a-u/,/d-t/,/k-p/ | Sensitivity to all contrasts (initial position). |
| **Swingley & Aslin, 2002** | 14 months<br>English; n ~ 25<br>(in each experiment) | Preferential looking paradigm. | /æ/ → /a/-/o/<br>/b/ → /v/-/r/<br>/b/ → /g/-/ʒ/<br>/a/ → /u/-/i/<br>/d/ → /t/-/m/<br>/k/ → /p/-/j/ | Sensitivity to all contrasts (initial position). |
| **Swingley, 2003** | 19 months<br>Dutch<br>n ~ 30 (in each experiment) | Preferential looking paradigm. | Initial position:<br>/b/ → /d/-/g/<br>Medial position:<br>/b/ → /d/-/g/<br>/k/ → /d/-/g/ | Sensitivity to all contrasts (initial and medial position). |
| **Swingley, 2009** | 14 to 22 months<br>English; n = 96<br>Adults<br>English; n = 26 | Preferential looking paradigm. | Initial position<br>/b/ → /p/-/d/<br>/d/ → /b/-/g/<br>/k/ → /g/; /s/ → /z/<br>Final position:<br>/t/ → /d/; /p/ → /b/<br>/g/ → /b/<br>/k/ → /p/-/t/-/g/ | Sensitivity to all contrasts (initial and final position). |
| **Bailey & Plunkett, 2002** | 18 and 24 months<br>English<br>n = 24 (in each age group) | Preferential looking paradigm. | Consonants in initial position, one or two contrasting dimensions (place, manner of articulation and voicing). | Sensitivity to all contrasts. |
| **Ballem & Plunkett, 2005** | 14 months<br>English<br>n = 29 | Preferential looking paradigm. | /t/ → /p/-/d/<br>/v/ → /f/-/z/<br>/b/ → /g/-/p/<br>/k/ → /g/-/t/ | Sensitivity to all contrasts (both in familiar and in recently acquired words). |
| **White & Morgan, 2008** | 19 months<br>English<br>n ~ 30 (in each experiment) | Preferential looking paradigm. | Stops and fricatives, initial position. Modifications in one, two or three dimensions (place, manner of articulation and voicing). | Gradual sensitivity (greater when more dimensions are modified). |
| **Van der Feest, 2007** | 20 and 24 months<br>Dutch<br>n = 48 (in each age range) | Preferential looking paradigm. | /b/→ /p/-/d/<br>/p/→ /b/-/t/<br>/d/→ /t/-/b/<br>/d/→ /t/-/g/<br>/t/ → /d/-/p/ | Gradual sensitivity (greater for place of articulation than for voicing). No sensitivity to voicing at age 20 months. |
| **Altvater-Mackensen, Van der Feest & Fikkert, 2013** | 18 and 25 months<br>Dutch<br>n = 16 (in each age range and condition) | Preferential looking paradigm. | Modifications in place and manner of articulation of the initial consonant (stops vs fricatives / coronals vs labials):<br>/b/→ /d/-/v/<br>/v/→ /z/-/b/<br>/d/→ /b/-/z/<br>/z/→ /v/-/d/ | Asymmetrical sensitivity at 18 months of age (they detect changes from labial to coronal and from fricative to stop, but not in the opposite direction). |
| **Ramon-Casas, Swingley, Sebastián-Gallés & Bosch, 2009** | 18 to 24 months<br>Catalan-Spanish<br>n = 24 (in each experiment) | Preferential looking paradigm. | Vowels:<br>/e/→ /ɛ/-/a/-/i/<br>/ɛ/→ /e/-/a/-/i/ | Only sensitivity to language specific contrasts. |
| **Mani & Plunkett, 2007** | 15, 17 and 24 months<br>English<br>n ~ 30 (in each experiment and age range). | Preferential looking paradigm. | Vowels: /o-æ/-/e-o/<br>/i-æ/, /u-i/, /a-i/<br>Consonants: /b-d/<br>/b-g/, /b-p/, /k-g/, /k-t/ | Sensitivity both to consonants and vowels. |
| **Mani, Coleman &Plunkett, 2008** | 18 months<br>English<br>n = 59 | Preferential looking paradigm. | Height, backness or roundness modifications in /ɔ/-/ʌ/-/I/-/ɛ/-/ɑ/ | Sensitivity to height and backness but not to roundness. |
| **Mani & Plunkett, 2010** | 12 months<br>English<br>n ~ 30 (in each experiment) | Preferential looking paradigm. | Vowels: /a-u/,/a-ɔ/<br>/a-ɑ/, /u-ɛ/, /o-ɑ/<br>/o-ʌ/, /u-ɔ/, /a-ʌ/, /i-ɛ/<br>Consonants: /b-m/<br>/b-d/, /k-g/, /k-t/<br>/d-t/, /d-g/, /f-v/<br>/h-tʰ/, /m-b/ | Sensitivity to all contrasts except to voicing in consonants. |

this pattern of results, extending it to place and manner features and revealing asymmetrical effects (Altvater-Mackenses, Van der Feest and Fikkert, 2013). Some feature under-specification might then be present in the initial phonological representations of words and some changes might take place during the second year of life, as suggested by the late inclusion of the voicing feature in the representation, following the initial specification of place and manner of articulation features in the consonantal segments of the early words (but see evidence of asymmetrical representations in Altvater-Mackensen et al., 2013). It cannot be ruled out that differences in the methodology used, specific characteristics of the target language and the age of the participants could justify, in part, the discrepancy between the results obtained in Dutch and previous ones obtained from British and American English participants. However, a lag in incorporating the voicing dimension on lexical phonological representations has also been described in the literature. Mani and Plunkett (2010) also observed less sensitivity to changes in voicing, compared to changes affecting the other two dimensions that characterize consonantal segments (place and manner of articulation) in a study with 12-month-old participants. A later incorporation of a particular feature (voicing in this case) in the phonological representation of consonants introduces an interesting nuance to the processes of phonological encoding and specification of the early lexicon that deserves further exploration. Meanwhile, the predominant view suggests that the format of representation of the early lexicon is at least sufficiently accurate to allow differentiation between correct and incorrect words, with minimal changes in the pronunciation of the consonants.

The phonological specification of vowels in the initial lexicon has also been explored in children from 12 months onwards, using the same methodological approach (Mani and Plukett, 2007; Mani, Coleman and Plunkett, 2008; Mani and Plukett, 2010; Ramon-Casas, Swingley, Sebastián-Gallés and Bosch, 2009). The findings of these studies suggest that children are sensitive to changes in the quality of the vowels represented in their first words and respond differently when mispronunciations are created via a vowel change that is contrastive in the native language (Ramon-Casas et al., 2009). However, there is also evidence that some dimensions may not be initially represented, such as roundness (Mani et al., 2008).

Overall, data just reviewed suggest that in the second year of life, with a relatively small receptive vocabulary, children seem to be using the information they have acquired in the pre-lexical stage, about sounds and phonetic categories that characterize the language in their environment, to represent the words they acquire. In terms of phonological specification a large number of subphonemic features are initially represented. However, between 12 and 24 months of age, some specific features, such as the voicing dimension in consonantal segments, seem to be gradually incorporated, according to the above mentioned Dutch and English data. It is possible, as suggested by Swingley (2009), that phonological representations of words in early child vocabulary are not yet adult-like, but they certainly have sufficient phonological specification to allow rapid recognition and avoid confusion between lexical items that are close in the phonological space. Further research is still needed to help us better understand which specific features, what kind of segments (plosives versus fricatives, vowels versus consonants, as discussed below), and which positions within the syllable and the word must be taken into account when discussing phonological specification in the initial lexical representations, and how it can be affected by factors such as frequency in the input or, as we will see, by factors relative to cognitive and attentional demands of the experimental task.

## Phonological representation in learning new words

A number of studies have dealt with issues relative to phonological representation while exploring word learning abilities in toddlers. These studies were initially focused on the analysis of toddlers' capacity to use their already acquired knowledge about native phonetic categorization in word learning tasks, from 12 months of age onwards. Most of these studies were based on the paradigm of habituation, using visual fixation as the dependent variable. Other research, however, has been focused on slightly older participants, around the age of two years, using a task inspired by the pioneering study of Shvachkin (1973), that is, using real unfamiliar objects which are associated to novel lexical labels (involving a minimal pair) that the child must learn. Children´s responses (i.e. pointing to or reaching a specific object), depend on phonological similarity judgments and they can reveal details about the phonological representation of these novel noun labels. In this section, studies based on the paradigm of habituation will be first described.

In word learning paradigms, based on a habituation procedure, two new pseudo-words are presented and associated to two new objects. These new words can be phonologically different or involve a minimal pair, that is, two words differing by a single segment (e.g./ bin/ and /din/). In the initial phase (habituation phase), the novel objects are presented repeatedly in alternation with their corresponding "lexical" labels until the child reaches a pre-set criterion of decrease in attention time. After that, in the test phase, children are exposed to two kinds of trials, a same and a switch trial. In the so called switch trial, the label-object learned association is altered. If the word-object pair change is detected, a longer attention time is expected in this kind of trial (response to novelty). When learning involves a minimal pair, it can be inferred that the differential feature has been encoded in the representation of these novel words. Different contrasts can be tested with this paradigm, differing by one or more subphonemic features. Compared to the familiar word recognition tasks described in the previous section, word learning paradigms usually involve greater difficulty for the young

learner. The child must implement a lexical learning mechanism, highly demanding from a cognitive and attentional point of view, which can hinder the correct perception and encoding of the segments in the word. Early studies using this paradigm (see Table 2) revealed that 14-month-olds were not able to correctly perform the task involving a minimal pair (Pater, Stager and Werker, 2004; Starger and Werker, 1997), but they succeeded at 17 months (Werker, Fennell, Corcoran, and Stager, 2002). Follow-up studies indicated that success at 14 months could be attained when the procedure was slightly modified and cognitive demands were reduced by pre-exposure to the novel objects in the habituation phase without naming them yet (Fennell, 2004), by inserting the words into sentences and including a training phase (Fennell & Waxman, 2010), or by adding familiar objects to the test phase (Yoshida, Fennell, Swingley, and Werker, 2009). These results seem to suggest that if task demands are reduced, 14-month-old infants are able to correctly encode a place of articulation contrast in new words for the pair of voiced stops, /b/ and /d/, just as they could respond to a mispronunciation in a familiar word recognition task (see Table 2).

By means of this methodology, phonological representation of vowel segments has also been explored. Results have shown some difficulties in toddlers below 18 months of age (Curtin, Fennell and Escudero, 2009; Mani and Plunkett, 2008). More specifically, vowels need to differ in more than one dimension to observe a differential response in the child's attentional behavior (Mani and Plunkett, 2008). Changes in height dimension are detected earlier than changes in backness or roundness, from 15 months of age (Curtin et al., 2009).

A different investigation analyzed the representation of vowel sounds in the lexicon, contrasting not only height but also duration (a dimension that is contrastive in Dutch, but not in English). Results showed that at 18 months, these dimensions are represented only if they are relevant in the native language (Dietrich, Swingley, and Werker, 2007). This cross-linguistic study demonstrated differences in the vowel dimensions represented in newly learned words from young learners exposed to different languages (English and Dutch), but at the same time showing early sensitivity to vowel contrasts based on the specific dimensions under analysis.

There are other studies that have used a rather different word learning paradigm in which pairs of novel words are associated with triads of new real objects and children are required to select an object based on its phonological form (name-based categorization task). After a presentation phase that shows two objects associated with a couple of different CVC words (usually minimal pairs pronounced six times each), the test phase begins and a third object, named by the experimenter with one of the previously used labels, is shown. The child must select the object that goes with it (i.e. that has the same label). In the first study of an experimental series (see Table 2) it was found that 20-month-old children could properly accomplish the task based on consonantal information, distinguishing between consonants that differed in place and manner of articulation regardless of their position within the word (Nazzi, 2005). A second study suggested that place of articulation was more reliably represented than voicing (Havy and Nazzi, 2009), a similar result to that obtained by Van der Feest (2007) with a different methodology.

However, the most striking result of these investigations was that, unlike consonants, vowels did not seem to be well-specified in the format of representation of the first lexicon (Havy and Nazzi, 2009; Nazzi, 2005). This result, somewhat paradoxical, and in conflict with previous data from English-learning children (Mani and Plunkett, 2007, 2010), was replicated in subsequent studies, using the same paradigm. It was not until 30 months of age that children seemed to properly use information about vowels in this task (Nazzi, Floccia, Moquet and Butler, 2009). The possible existence of an asymmetry favoring consonants in the format of lexical representations and the controversy surrounding these results mostly obtained with French-learning participants deserve further analysis that we develop in the next section.

## Differences between vowels and consonants in lexical representations

Phonetic categorization studies with pre-lexical infants have shown that perceptual reorganization processes occur earlier for vowels than for consonants (Kuhl, Williams, Lacerda, and Stevens, 1992; Polka and Werker 1994, Werker and Tees, 1984). Can we also find differences between vowels and consonants in word recognition tasks? Does the representation of vowels in the first lexicon follow a different time-course compared with consonants? It is known that vowels have acoustic properties that make them more salient, stable and longer than most of the consonants. So, it could be argued that presenting words with changes in vowel segments would generate a greater reaction in children. However, this is not the pattern of results obtained in some of the studies just reviewed. Instead, the opposite effect has been found. Furthermore, there is a hypothesis that suggests an advantage of consonants at the lexical representation level (Nespor, Peña and Mehler, 2003). In this context, how can all the data obtained in recent years, which reflect differences in phonological representation and specification of vowel segments at the lexical level, be properly integrated?

**Table 2.** Word learning studies exploring phonological representations. Characteristics of the sample (age, language and number of participants), procedure used, phonological contrast and main conclusions of the study are provided.

| Authors, year | Sample | Procedure | Studied contrasts | Conclusions |
|---|---|---|---|---|
| **Starger & Werker, 1997** | 14 months. English. n = 16 | Switch paradigm. | /b-d/ | No sensitivity. |
| **Werker, Fennell, Corcoran & Stager, 2002** | 14, 17 and 20 months. English n = 16 (in each experiment) | Switch paradigm. | /b-d/ | Sensitivity only in infants older than 17 months. Vocabulary size and sensitivity correlation at 14 months. |
| **Pater, Stager & Werker, 2004** | 14 months. English n = 16 (in each experiment) | Switch paradigm. | /b-d/, /b-$p^h$/, /d-$p^h$/ | No sensitivity. |
| **Fennell, 2004** | 14 months. English n = 29 | Switch paradigm. | /d-g/ | Sensitivity when objects are familiar. |
| **Fennell & Waxman, 2010** | 14 months. English n = 44 | Switch paradigm (plus modification). | /b-d/ | Sensitivity when words are presented in a sentence and in a referential context. |
| **Yoshida, Fennell, Swigley & Werker, 2009** | 14 months. English n = 36 | Switch paradigm (plus modification). | /b-d/ | Sensitivity when words are included in the test phase. |
| **Curtin, Fennell & Escudero, 2009** | 15 months English n ~ 20 (in each experiment) | Switch paradigm. | Vowels: /i-I/, /i-u/, /I-u/ | Only sensitivity to /i-I/ contrast (height dimension). |
| **Mani & Plunkett, 2008** | 14 and 18 months English n ~ 30 (in each age range) | Switch paradigm. | Vowels: /æ-u/, /o-i/ | Only sensitivity if more than one dimension is modified. |
| **Dietrich, Swingley & Werker, 2007** | 18 months English Dutch n = 36 | Switch paradigm. | Vowel length: /a-a:- æ/ Vowel quality: /a-ɛ/ | Only sensitivity to contrasts of their own language. |
| **Nazzi, 2005** | 20 months French n = 24 (in each experiment) | Name-based categorization task. | Consonants (initial and final position): /d-g/, /p-t/, /k-t/, /b-g/ Vowels: one dimension: /u-ɔ/, /i-y/, /e-Ø/ more than one dimension: /u-oe/, /i-a/, /e-u/ final position: /a-i/,/e-u/,/o-i/ | No sensitivity for vocalic contrasts. |
| **Havy & Nazzi, 2009** | 16 months French n = 24 (in each experiment) | Name-based categorization task. | Consonants: Place of articulation (/p-t/, /d-g/, /b-d/, /t-k/); Voicing (/p-b/-/k-g/, /t-d/, /p-b/); Vowels: one dimension (backness): /y-u/, /oe-o/; more than one dimension (height/backness): /ɛ-a/, /y-oe/, /u-o/, /i-e/ | No sensitivity for vocalic contrasts. |
| **Nazzi, Floccia, Moquet & Butler, 2009** | 30 months French English n = 16 (in each experiment) | Name-based categorization task. | Consonants: Place of articulation (initial/final): /d-g/, /p-t/, /k-t/, /d-b/ Vowels, one dimension: roundness (/i-y/, /e-Ø/, /i-u/, /ɛ-oe/); height (/u-ɔ/). Vowels, two dimensions: backness + roundness (/ʌ-ɑ/, /a-ɔ/), backness + height (/æ-I/, /ɛ-I/) | No sensitivity for vocalic contrasts. |
| **Havy, Bertoncini & Nazzi, 2011** | 3, 4 and 5 years French n ~ 18 (in each experiment and age range) | Name-based categorization task. | Consonants and vowels at initial and final Word position (CVC), involving all dimensions. | Consonantal bias between 3 and 5 years, but not at 4. Higher sensitivity in girls. |

Mani and Plunkett (2007) observed no asymmetry favoring consonants in the phonological representation of familiar words, using an intermodal preferential looking paradigm at 15, 18 and 24 months of age. They explored children's reaction in front of changes in consonant and vowel mispronunciations regarding place of articulation and voicing for consonants, and height and backness for vowels. Although asymmetries were not observed, at 15 months of age sensitivity to changes was more pronounced for consonants than for vowels and reaction to vowel changes was different depending on the contrast. A subsequent study explored more deeply 18-month-olds sensitivity to vowel changes, using mispronounced words that involved changes in three different dimensions (height, backness and roundness). The results showed that children were able to detect mispronunciations involving backness and height dimensions, but not roundness (Mani et al., 2008)[1]. In further work, Mani and Plunkett (2010) studied the phonological representation in familiar words at a younger age (12 months) with the same procedure. They observed that changes in the three vocalic dimensions hindered infant recognition of familiar words, whereas for consonants, infants were only sensitive to changes in place and manner of articulation, but not to voicing. The authors concluded that initially, by 12 months of age, vowels are relevant and even "over-specified" in the lexical representations but a few months later changes can occur in their representations as a consequence of specific properties of the ambient language. The authors argued that the fact that roundness was correctly specified at 12 months, but not at 18 months, could be explained by the existing correlation between rounded and back vowels in English. Backness becomes a more salient dimension over time, hindering the sensitivity to roundness at older ages. According to Mani and Plunkett (2010) changes in the representation of vowels can occur, from a first stage when acoustic-phonetic detail is encoded, to a second stage in which a more abstract phonological representation is reached and the young learner becomes then more tolerant or flexible to variability. This developmental pattern would occur for both consonants and vowels, but may occur earlier for certain consonant segments and somewhat later for vowels, perhaps due to the greater range of variability in the latter. Dealing with variability inherent to vowels probably requires more experience with multiple exemplars (longer exposure to the input) in order to successfully establish and stabilize the vowel contrast at a phonological level. More research is needed to test this hypothesis, both from a longitudinal and a cross-linguistic perspective.

Meanwhile, a rather different position on this issue comes from research developed by T. Nazzi and colleagues on the role of vowels in phonological representations of words. Their results, mostly from French-learning participants, support the view that vowels are underspecified at a lexical level. As already described, in the name-based categorization task, children aged 16 to 20 months could successfully learn minimal pairs of words differing in a consonant, but not in a vowel (Havy and Nazzi, 2009; Nazzi, 2005). By age 30 months children could eventually succeed in the task when it involved a vowel contrast, but even then their sensitivity appeared to be lower than the one observed for consonants (Nazzi et al., 2009). These results are, thus, consistent with the consonant advantage hypothesis in lexical representations (Nespor et al., 2003).

The importance of this debate is reflected in the most recent work by the French group. The bias favoring the representation of consonants has been explored in pre-school children, in order to offer a more complete developmental perspective (Havy, Bertoncini and Nazzi, 2011). In their study, 3- to 5-year-old French children were presented with two pseudo-words (which differed only in a consonant or in a vowel segment) associated to two novel objects. Then, they were asked to choose a third object whose lexical label was more similar to one of the two newly learned words, but still differing in a vowel or in a consonant segment. So, in this case, to give an answer children should discard some information, either vocalic or consonantal. At age 3, children preferred to attend to consonantal information and discard the vocalic change. In contrast, in older children this effect had disappeared. That is, the consonantal bias was observed only at 3 years, but not at 5. In a second experiment, they found a consonantal bias at 3 years, a change at 4 years favoring vowels, and again an absence of consonantal bias at 5 years (Havy et al., 2011). The authors concluded that there is a bias favoring consonants in lexical representations, but this bias follows a U-shaped developmental pattern, being present in early stages of lexical development, disappearing around 4 years (when attention to vowels increases as they are relevant for syntactic and morphological acquisition) and reappearing in adulthood.

So far we have briefly summarized two independent and not totally convergent research lines, developed by K. Plunkett and colleagues in UK and T. Nazzi and colleagues in France. Both research lines analyze vowel representations in the lexicon from different perspectives and offer a different interpretation for their results. K. Plunkett argues that the observed changes in vowel representations are the consequence of the variability that characterizes vowels, while T. Nazzy suggests that changes are the result of a universal bias favoring consonants in the lexical representations. Note that the ages of the participants in these studies were quite different, mainly due to the methodological approach adopted in each case, related to the specific aims of the study. The word learning task, with triads of objects and minimal pair pseudo-words used with older children, poses cognitive demands that may have favored the emergence of a consonantal bias which was not evident in studies with younger infants (under 18 months) tested with the intermodal prefer-

[1] Difficulties in representing certain dimensions that characterize vowels have also been observed in word learning tasks with a habituation paradigm (Curtin et al., 2009, Mani and Plunkett, 2008), although in these cases the limitations in the representation of vowels can be a result of the higher cognitive demands in this kind of task.

ential looking paradigm in a familiar word recognition task. The latter might then be more neutral regarding the bias as it allows exploring, at younger ages, the characteristics of the emergent phonological representations of the words in the lexicon and the presence of changes before a more stable, fully-specified representation is reached.

## What is the contribution of research on bilingual children to the study of phonological representations?

The studies just reviewed focused almost exclusively on data from infants growing up in monolingual environments. But how about children growing up in a bilingual context? How does the bilingual input affect phonological representations of words? Is there experimental evidence available on this topic?

It is possible to argue that for bilinguals it is important to phonologically specify both vowels and consonants, in order to differentiate between words corresponding to each of their two language systems. Each phonological system has a specific set of contrasts that the bilingual has to acquire. The acquisition of language-specific sound properties starts early in development and can already be identified in the bilingual's expressive vocabulary from the first stages of word production. If languages are differentiated in production as revealed by an early presence of translation equivalents (Genesee, Nicoladis and Paradis, 1995), then, the format of representation of words in the bilingual lexicon can be phonologically well-specified, similarly to what has been described in studies with monolingual participants. Furthermore, the proximity or distance of the bilingual's two languages in terms of the number of cognate words in the lexicon, may enhance the early representation of certain types of segments and reveal the presence of possible biases in phonological representation. In bilinguals exposed to two close languages, such as, for instance, Catalan and Spanish, which have a high number of cognate words often just differing in their vowel segments (as in the word for "pear", that is [peɾa] in Spanish and [pɛɾə] in Catalan), the phonological specification of vowels would be much useful to distinguish lexical forms in each language and would perhaps minimize the consonantal bias described in the French monolinguals studies. It is, therefore, a potentially interesting research area regarding the debate about the consonantal bias in phonological representations reviewed in the previous section.

**Table 3.** Phonological representation studies in bilingual children. Characteristics of the sample (age, language and number of participants), procedure used, phonological contrast and main conclusions of the study are provided.

| Authors, year | Sample | Procedure | Studied contrasts | Conclusions |
|---|---|---|---|---|
| **Ramon-Casas, Swingley, Sebastián-Gallés & Bosch, 2009** | 18 to 24 months<br>Catalan-Spanish bilinguals<br>n = 24 (in each experiment) | Word recognition. Preferential looking paradigm. | Vowels:<br>/e/→ /ɛ/-/a/-/i/<br>/ɛ/→ /e/-/a/-/i/ | Sensitivity only to common contrasts in both languages (/e-a-i/). |
| **Ramon-Casas & Bosch, 2010** | 18 to 25 months<br>Catalan-Spanish bilinguals<br>n = 24 | Word recognition. Preferential looking paradigm. | Vowels: /e-ɛ/ | Sensitivity to a specific contrast of one of their languages in non-cognate words. |
| **Fennell, Byers-Heinlein & Werker, 2007** | 14-17-20 months<br>English -Chinese or English - French bilinguals<br>n ~ 16 (in each experiment) | Word learning. Switch paradigm. | Consonants: /b-d/ | No sensitivity to the contrast before 20 months. |
| **Mattock, Polka, Rvachew & Krehm, 2010** | 17 months<br>English - French bilinguals<br>n = 16 (in each experiment) | Word learning. Switch paradigm. | Consonants: /b-g/ | Sensitivity to the contrast only if in the habituation phase words are presented in both languages (English and French). |

Unfortunately, there are not many studies on bilingual children exploring the levels of specification in their phonological representations of the lexicon (see Table 3). In word learning research using the habituation paradigm, only two studies with English-Chinese and English-French bilinguals, acquiring languages that contain very few cognate words, have been reported (Fennell, Byers-Heinlein and Werker, 2007; Mattock, Polka, Rvachew and Krehm, 2010). These studies focused on the encoding of consonantal contrasts. Results showed that bilingual children were able to learn two labels forming a minimal pair by 20 months of age, while monolingual children were able to perform the same task already at 17 months (Fennell et al., 2007). In contrast, Mattock et al. (2010) showed that 17-month-old bilingual children already were sensitive to the studied contrast, but only when participants were exposed to both languages in the habituation phase of the experiment. In other words, the experimental situation had to be clearly set in a bilingual context for participants to succeed in the word learning task. Therefore, the slight delay reported by Fennell et al. (2007) could partly be the consequence of an inadequate specification of the language context in the testing situation.

In our laboratory, Catalan and Spanish monolinguals as well as Catalan-Spanish bilinguals around two years of age were tested on familiar word recognition using the intermodal preferential looking paradigm (Ramon-Casas et al., 2009). Differences between bilinguals and monolinguals were observed depending on the vowel contrast used to create word mispronunciations. Bilinguals did not react to a mispronunciation based on a vowel contrast present in just

one of their two languages (the Catalan /e/-/ɛ/ contrast not present in Spanish) but they were able to adequately represent vowel contrasts common to both languages (/a/-/e/-/i/). No data from mispronunciation of consonants were obtained in that research, but at least for vowels it could be concluded that bilingual children at 18-24 months had adequately established a phonological representation of vowels that were common to their two languages. In a follow-up study, the specific Catalan (/e/-/ɛ/) contrast that was not represented in the bilingual lexicon at 18-24 months in cognate words was shown to be adequately represented when non-cognate words were used in the experiment (Ramon-Casas and Bosch, 2010).

These results suggest that for bilingual populations a broader perspective has to be adopted in order to adequately explain the data. Beyond the nature of the contrast that is being tested, other factors relative to lexical and phonological properties of the two languages of the bilingual have to be taken into account. The number of factors that may play a role in the phonological encoding and the level of specification of vowel and consonant segments is thus greater in bilinguals than in monolinguals. This is a difficult research area with still very limited data. Further research is definitely needed to gain a better understanding of the specificity of the phonological representation of words in the bilingual lexicon.

## Discussion

In this review of research addressing the phonological representation of words in the early lexicon we have seen that a great number of studies favor the existence of well-specified representations already in the early stages of lexical development (Bailey and Plunkett, 2002; Ballem and Plunkett, 2005; Fennell 2004; Fennell & Waxman, 2010; Mani and Plunkett, 2007; Mani et al., 2008; Swingley, 2003, Swingley, 2009, Swingley and Aslin, 2000; Swingley and Aslin, 2002; Yoshida et al., 2009). Overall, experimental evidence indicates that words in the early lexicon may have a format of representation phonologically well-specified, suggesting that toddlers can benefit from knowledge about phonetic categorization they have acquired through exposure to the native language along the first year of life. However, research reviewed also indicates that there is room for a range of variability as some under-specification of phonological features has been attested (Altvater-Mackensen et al., 2013). Some changes in the format of representation have been described as the child gets older, sometimes adding to the representations a particular dimension (for example voicing in the case of stop consonants as in Mani and Plunkett, 2010), but also losing one when the dimension initially represented becomes redundant and has no contrastive value any more (for example roundness for English vowels as in Mani et al., 2008).

The methods used to assess lexical and phonological representations also play a role in favoring or limiting the possibility of showing the level of specification in the format of the phonological representation. Most studies that used the intermodal preferential looking paradigm in word recognition tasks (cognitively less demanding than word learning tasks) have revealed that phonological representations of the early lexicon, even in 12-month-olds, are not totally underspecified, as previous studies had suggested, and the level of specification in the format of representation is rather independent of the size of receptive vocabulary (Bailey and Plunkett, 2002; Ballem and Plunkett, 2005; Mani and Plunkett, 2007, 2008; Swingley, 2003, 2009; Swingley and Aslin, 2000, 2002).

However, the role of receptive vocabulary size as a determinant factor of the level of specification reached in the phonological representation of the early words remains a controversial issue despite the above mentioned results. In some research, especially focusing on early stages of lexical acquisition (between 12 and 17 months), a positive correlation between vocabulary size and the ability to encode phonological information has been observed. Specifically, 12-month-olds with greater receptive vocabulary size were found to be more sensitive to changes in certain vowel dimensions (Mani and Plunkett, 2010). Moreover, and in a word learning task, 14-month-old toddlers (but not at 17 or 24 months of age), were more sensitive to a consonantal change when they had a greater number of words in their receptive and expressive vocabularies (Werker et al., 2002). As we can see, despite a first series of results in which phonological specification and vocabulary size almost appeared as independent factors, different types of data currently available suggest that this may not be entirely true and the possibility of an interaction, at early stages of lexical development, between increases in vocabulary size and gains in phonological specification, cannot be totally ruled out. These gains would involve the incorporation of some dimensions initially under-represented.

Accepting gradual changes in the specification of some subphonemic features in the early lexicon cannot be considered as a way back to the theories that were prevalent in the 90s, according to which first lexical representations were considered to be holistic and phonological specification would occur gradually, as a consequence of the subsequent incorporation of phonological neighbors that would force a higher segmental specification in acquired words. Authors such as Charles- Luce and Luce (1990), Fowler (1991) and Metsala and Walley (1998), with the Lexical Restructuring Model, represent this line of thought which assumes holistic initial lexical representations, highly under-specified, in which vowels and consonants become gradually better specified. Gains in cognitive skills and the incorporation of new words to the lexicon were considered necessary to improve in phonological accuracy. This perspective does not consider the development in speech perception that takes place in the first year of life, nor, apparently, does it accept the link between the skills acquired in the pre-lexical stage (relative to knowledge about the sound pattern of the native language and possible word forms) and the initial lexical development.

A different position, more in line with studies of speech perception in infants and lexical recognition and word learning in the second year of life, is presented in the model developed by P.K. Kuhl (NLM-e, in Kuhl et al., 2008). According to this model, it is accepted that there may be a gradual transformation or improvement of phonological representations in the second year of life. Not all dimensions would be represented initially and their incorporation would reflect a bi-directionality between phonetic learning (knowledge about the sound patterns in the native language) and word learning: phonetic learning would facilitate the detection of word patterns and learning new words, phonologically similar, would facilitate an improvement in the specification of the represented features (Kuhl et al., 2008). This model also emphasizes the interaction between the processes of speech perception and production, suggesting that the progressive experience with the ambient language and the development of perceptual skills directly affect the development of the productive skills and these, in turn, may affect the modification and specification of certain phonological representations. Although this model can integrate some of the results we have reported on the changes observed in the phonological specification of some suphonemic features (such as voicing in stop consonants) it is, however, too general in its approach, and its predictions are mainly focused on the changes in the initial phonetic sensitivities that take place during the first year of life.

The model that addresses in a more extensive way the relationship between pre-lexical learning and early lexical development, and how different factors that play a role in the specification of lexical representations will be integrated, is the PRIMIR model (*Processing Rich Information from Multidimensional Interactive Representations*), proposed by Werker and Curtin (2005). This model was initially developed to integrate data from phonetic discrimination studies in the pre-lexical stage and data from phonological representations in learned words. Specifically, they wanted to explain the controversial results at 14 months, when infants failed to differentiate consonantal changes relative to place of articulation (/b/-/d/) in a word learning task, while they could discriminate that contrast at an acoustic-phonetic level. The model proposes the existence of different levels of representation, describes mechanisms that can modify the existing representations and includes a series of dynamic filters that allow preferential access to certain levels of representation depending on the age, lexical stage or task characteristics. The model has been recently expanded to include aspects of perception and lexical representation in bilingual children (Curtin, Byers-Heinlein and Werker, 2011). The authors also hypothesize about a gradual building of phonological representations, from the initial storing of possible word-forms which contain highly detailed acoustic-phonetic information, to phonemic representation that would gradually emerge during the second year of life, with phonemes placed at an abstract level of representation. The different levels or planes of analysis, once formed, would all be accessible, although different kinds of tasks would favor the access to some planes rather than others. For example, in research carried out using familiar words that are already part of the child´s lexicon, the access to the phonemic level would be facilitated. However, in more complex tasks such as novel word learning, and especially in the name-based categorization task (e.g. Nazzi, 2005), the access to the phonemic level would be more difficult and perhaps for this reason results from these tasks clearly differ from results obtained with the standard paradigms of word recognition. PRIMIR model suggests that information is represented in detail, but access to it might depend on the evaluation task. Furthermore, it is accepted that first phonological representations may not yet be adult-like, and that vocabulary growth, or even learning to read, can contribute to establishing increasingly robust phonological representations. This proposal accepts that a gradual specification in the phonological representations of the lexicon can take place early in development, but it also takes into account and integrates into the model the knowledge the infant has acquired during the first year of life regarding the specific sound properties of the input language. The model does not suggest great discontinuities in development, but the possibility of representing the information at different levels or planes and having selective access to each plane as a function of context or task demands. According to this, most of the results we have described in this review could be well integrated into the model, coming from different age groups, different languages or different methodologies.

A final point to discuss is related to the presence of a bias in the representation, especially for consonants, according to the hypothesis of the differential role between consonants and vowels at the lexical level (Nespor et al., 2003). In the present review we confirm that the results supporting a consonantal bias are limited to those studies that have used the name-based categorization task (Havy and Nazzi, 2009; Nazzi, 2005; Nazzi et al., 2009). Moreover, even within this line of research, changes in the direction of this bias have been described in the period between 3 and 5 years (Havy et al., 2011). Certainly, this is an important point of controversy that is still present in recent research. The existence of a bias in lexical representation favoring consonants goes far beyond the issue about a more or less accurate specification of vowels in the lexicon. Clearly, a significant number of research results indicate that vowels are phonologically specified in the lexicon (Dietrich, Swingley, and Werker, 2007; Mani and Plunkett, 2007, 2010; Ramon-Casas et al., 2009; Swingley and Aslin, 2000). But, it is also true that certain acoustic dimensions may have an earlier representation than others (Curtin, Fennell and Escudero, 2009; Mani and Plunkett, 2008; Mani, Coleman and Plunkett, 2008), in the same way as the voicing dimension for consonants is possibly less well specified in the early lexicon (Mani and Plunkett, 2010; Van der Feest, 2007). However, the observation of a consonantal bias in certain tasks, but not in others, points to a different level of analysis, as it suggests differences in the use

of segmental information depending on task requirements and the type of computations that need to be implemented. Exploring this phenomenon in early stages of development and describing its time-course from infancy to adulthood, when the consonantal bias at the lexical level has already been attested in many different tasks (Carreiras and Price, 2008; Carreiras, Gillon-Dowens, Vergara and Perea, 2009; Cutler, Sebastián-Gallés, Soler-Vilageliu and van Ooijen, 2000; Lee, Rayner and Pollatsek, 2002; New, Araujo and Nazzi, 2008; Toro et al., 2008), constitutes a relevant area of research that would takes us beyond the characterization of phonological representations in the lexicon, into a domain involving a different type of phenomena that characterize the processing of linguistic information.

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