

Native language phonotactics impacts early word learning in (a)typical development: an eye-tracking study

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Background: Word learning requires associating sound sequences to meaning. It is well established that infants demonstrate a perceptual sensitivity to speech sounds that attunes to the native language during the first year of life [1]. How the knowledge about the sounds (speech perception abilities) interacts with the knowledge about the words (word learning) has been a matter of current research. It has been shown that early word learning is sensitive to native phonotactic patterns/regularities, with words having high frequency sounds being learned earlier (Gonzalez-Gomez et al. 2013; Bren et al. 2019). In addition, word learning is possible with non-native phonological sequences/phonemes [2, 3], but not with phonologically illegal sound sequences (Graf-Estes et al. 2011; MacKenzie et al., 2012). It has also been found that similar sounding word pairs are especially challenging for the early learner [4]. However, studies addressing legal and illegal phonotactics did not use similar sounding pairs, nor looked at atypical populations. This study examined whether and how phonotactic frequency and phonological grammar impact early word learning in typically developing children (TD), children at-risk for language impairment (AR) and children with Down Syndrome, using similar sounding pairs.

Method: 72 European Portuguese learning toddlers participated in the study. The TD group (N=31) included typically developing toddlers with low-risk for language impairment (mean age 20.4 mos); the AR group (N=29) comprised toddlers with high-risk factors (e.g., born premature, and familial risk) for language impairment (mean age 20.7 mos); the DS group included 12 toddlers (mean age 22 mos). Toddlers' eye gaze was assessed while they were learning new labels for unknown objects in three conditions: labels with high phonotactic probability sound sequences (HP), with low phonotactic probability sound sequences (LP), or with illegal sound patterns (IS). Frequency was computed from the frequency database FrePOP [5]. Similar C1VC2V label pairs were used, containing the same vowels across conditions. The labels were embedded in natural sentences (see 1). Control object-word pairs showing familiar objects were also presented. The task included a training phase, a test phase, and control trials. The experiment included 8 blocks, each composed of a learning phase (where a label-object pair was presented 6 times, and another object was presented unlabelled), a test phase (where the familiar label and an unfamiliar label were presented together with images of two objects), and the control (Fig. 1). Linear mixed model analysis was used to assess proportion of looking time to label-object pairs in the test phase and control trials.

Results and Discussion: Results showed that in control trials, both TD and AR increased their looking time to the target between the prenaming (0-2000ms) and postnaming (2500-5000ms) phase, indicating recognition of familiar words, unlike DS (Fig. 2). Difference between labelled and unlabelled object in the test phase was found only in TD, and only with high frequency patterns ($t = 3.44$, $p = .0008$) (Fig. 3). These results were related to the children's vocabulary development, measured by the EP CDI [6]. A link emerged between phonological knowledge and vocabulary knowledge: TD learning of high frequency pattern patterns was related to concurrent expressive vocabulary, whereas AR learning performance across all conditions was related to their expressive vocabulary at 24-30 months of age; toddlers with DS showed no learning and very low scores in expressive CDI until 24-30 mos. Our findings suggest that phonotactic frequency guides TD toddlers' early knowledge of the phonological grammar of words, with AR toddlers either showing phonological delay or a different developmental path, and DS toddlers exhibiting a substantial delay in overall word learning skills. Unlike TD toddlers, AR and DS toddlers showed low sensitivity to sound patterns in early word learning.

The study deepens our understanding of the role of native sound patterns (frequency and phonological grammar) in word learning, a critical task for language acquisition, with implications for clinical populations.

(1) Learning phase

Olá. Vamos dar um nome a este boneco. (Hi! Let's give a name to this toy)

Este é o ['maku]. (This is ['maku])

Olha para o ['maku]. (Look at ['maku])

Vamos brincar com o ['maku]. (Let's play with ['maku])

...

Eu tenho outro boneco. Também podes brincar com ele.

(I have another toy. You can also play with it)

Test phase

Olha! (Look!)

Trial 1: Onde está o ['maku]? (Where is ['maku]?)

Trial 2: Olha para o ['padu]! (Look at ['padu]!)

Examples – HP ['maku], ['tisu]; LP ['baçu], ['giRu]; IS ['nagu], ['ribu]

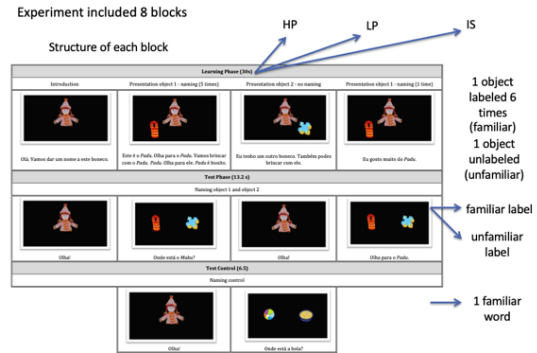


Figure 1: Structure of each block.

Control trials: Prenaming vs. Postnaming

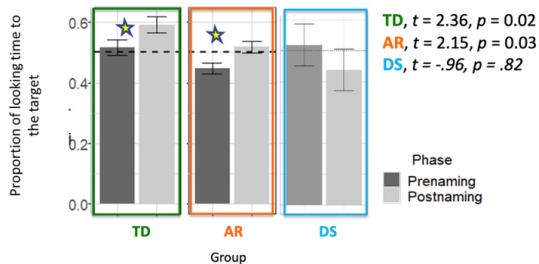


Figure 2: Control trials. Proportion of looking time to the target (prenaming vs. postnaming) conditions.

Test trials: Postnaming phase

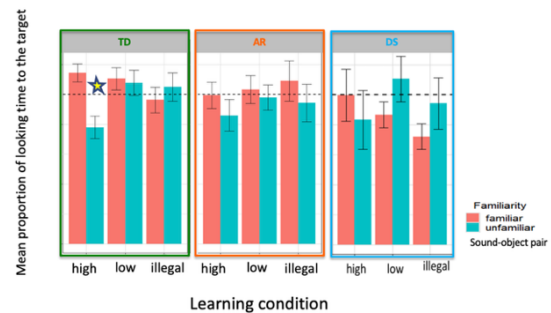


Figure 3: Mean proportion of looking to the target per learning.

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