Do Multilingualism and Bilingualism enhance Neural Speech Encoding at Subcortical Level?

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Introduction

Sensory subcortical processes appear to be dynamics and interact with cognitive processes such as memory, attention and multisensory integration areas, to modulate our perceptual system (1). This phenomenon is called *experienced-dependent- plasticity* and is observable when monolingual and bilingual brains are compared (3). Bilinguals, in contrast to monolinguals, have efferent neuronal pathways connecting the executive system of the frontal lobe to the central auditory system (2). This relation is bidirectionnal : efferent pathways optimize perception of certain sound features and auditory stimuli encoding in a behaviorally manner, whilst afferent pathways send stronger neuronal signals to the cortex which increase the efficacy of the executive function related to attentional control (1,2). Studies have demonstrated structural and functional changes in bilinguals, and have concluded that enriched linguistic environment leads to a more efficient central auditory processing (2,3). Multilinguism, a linguistic environment composed of more than three languages, is thought to present an even more efficient central auditory processing because it is richer than a bilingual environment. However, to the best of our knowledge, no previous studies have explored the effects of multilingualism on central auditory processing.

Objectives

The aim of the study is to use speech ABR to explore the way the central auditory systems of monolinguals and multilinguals react to auditory stimulation in favorable (quiet) and non-favorable (noise) listening conditions.

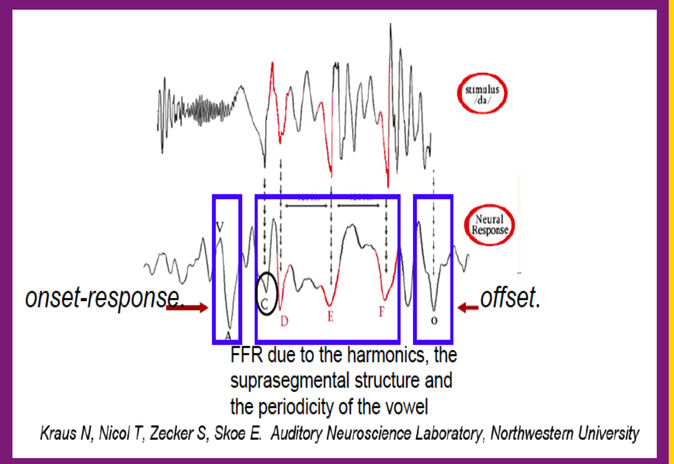
Methodology

Participants

Three groups of subjects, 18-25 years old
19 Monolinguals
22 Bilinguals
19 Multilinguals

Stimuli

Non-verbal (click)
Verbal (/da/)
- in quiet
- in white noise



Protocol

LEAP Questionnaire (6)
Hearing screening

Standard ABR montage recording protocol
Two trials of 2000 of speech ABR in quiet and in noise
Level of presentation in quiet: 80 dB SPL
Level of presentation of noise: 70 dB SPL
Right ear presentation
Passive listening condition

Figure I

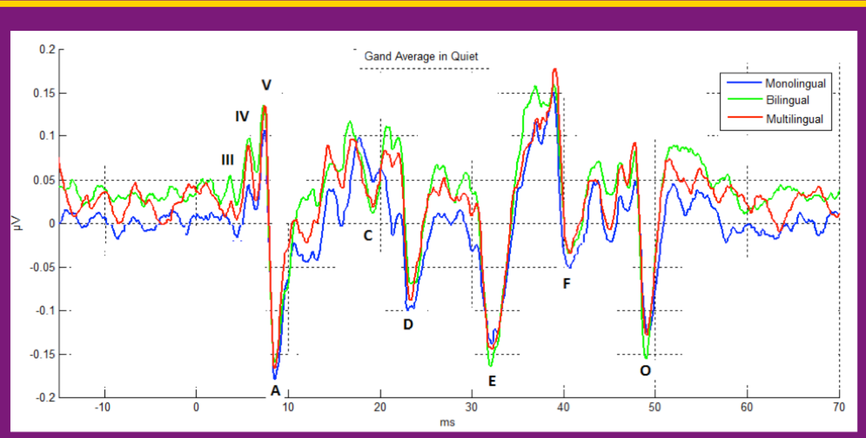


Figure II

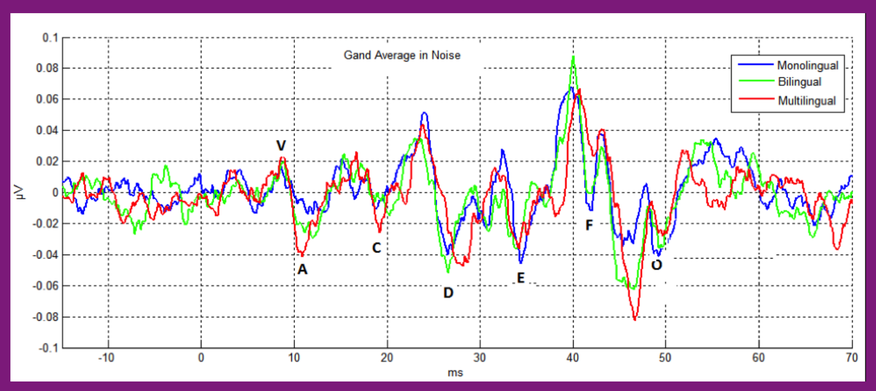
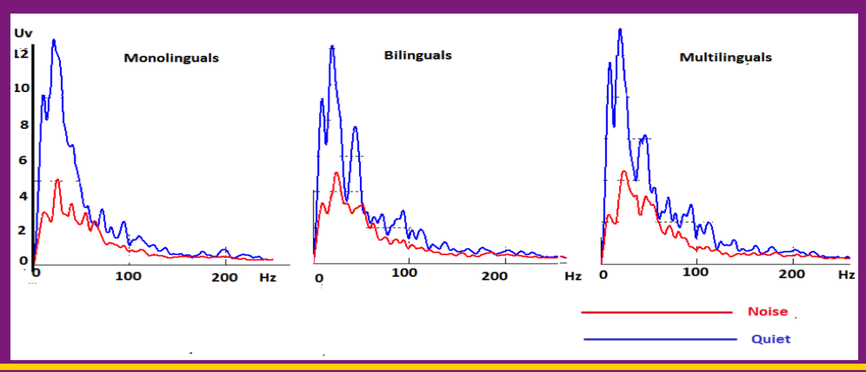


Figure III



•**Results:** **Neural Timing (Latency)** - Significant effects were observed for Waves V, A, and C latency values with respect to the two main factors (group and condition) and for the interaction between these factors . Language experience in multilinguals and bilinguals limits the degradative effects of noise on neural timing in response to the onset and formant transition of a speech syllable.

Neural magnitude (amplitude) – A significant effect was only observed for the main condition factor for the all of the waves . No significant effect was observed for the main group factor nor for the interaction between group and condition factor.

Steady state responses - ANOVA results showed a statistical significance for the main condition factor for the all of the waves only. However, these results revealed no significant effect for the main group factor nor for the interaction between group and condition factor.

Discussion: Although the morphology of the neural responses obtained in noise was generally degraded in the three groups, monolinguals demonstrated less robust subcortical encoding of sound as well as less resilient neural responses to speech in the presence of background noise. The results suggest that multilinguals, analogous to their bilingual counterparts, undergo changes to their neural structures that foster stronger connections between the cortical and subcortical processes leading to a more robust executive control of auditory processing.

Conclusion: Intensive musical training, bilingualism, and multilingualism are examples of a long life experience that could have an effect on the functional organization of the brain. The results from this study showed that enriched language experience leads to more efficient subcortical processing. Auditory brainstem response is a neurophysiological tool that offers a technique to observe the effects of both top-down and bottom-up activities and to evaluate auditory processing.

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