Title: The neural correlates of linguistic rhythm
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Relevance

Rhythm is common in both music and language. Since the brain processes both these auditory stimuli, the neural correlates of rhythm have implications for both of these high cognitive functions, language and music. The current study investigated the processing of linguistic rhythm in auditory stories, in the absence of a rhythmic or phonological task.

Introduction

Rhythm in language is composed by combining the lexical patterns of the words with the metrical pattern of the language. German, the language used in the current study, follows a stress-timed rhythmic pattern, with isochronous intervals between strong beats (stressed syllables); this metrical rhythm interacts with the lexical stress of the words, thereby creating well-formed rhythmic regularities. Previous studies on the neural correlates of linguistic rhythm for German [1-3] used functional magnetic resonance imaging (fMRI) during sentence comprehension and reported activation in the inferior frontal gyrus (IFG), supplementary motor area (SMA), superior temporal gyrus (STG), Insula and Anterior Cingulate Cortex (ACC). The novelty of the current study is the investigation of *naturally* occurring – and thus not strictly periodic – strong beats of language within two-minute long auditory stories, in combination with a task targeting the story content and not its auditory properties.

Methods and Materials

Compound words were embedded into stories, which were specifically created for this study. The stories are available in a figshare repository [4]. We used 20 German compounds following the structure A(BC): A was either a monosyllabic or bisyllabic (and stressed on the first syllable) noun and BC was a bisyllabic noun, stressed on its first syllable. Depending on whether A was monosyllabic or bisyllabic, the stress of BC was shifted or not shifted from syllable B to syllable C. Thus in our stimuli the initial lexical stress needed to be shifted given the rhythmical context, thereby creating a 2x2 design of lexical stress with rhythmical well-formedness. We modelled the whole-brain blood-oxygen-level dependent (BOLD) signal responding to the compounds.

Results

For the interaction of lexical stress and rhythmical well-formedness, we found one suprathreshold cluster localised between the cerebellum and the brain stem. For the main effect of lexical stress, we found higher BOLD responses to the retained lexical stress pattern in the bilateral SMA, bilateral postcentral gyrus (PoCG), bilateral middle fontal gyrus, bilateral inferior and right superior parietal lobule, and right precuneus.

Discussion

The bilateral activation in the PoCG and SMA show that linguistic rhythm, as composed by lexical stress and rhythmical well-formedness, is processed as part of a sensorimotor network of speech comprehension [5]. Importantly, and in connection to auditory rhythm perception, beat processing in language can be interpreted as part of domain-independent timing perception [6].

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[4[Kandylaki, KD figshare (2016). https://doi.org/10.6084/m9.figshare.3122515.v1

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[6] Kotz SA and Schwartze M Front Integr Neurosci (2011) 5:86.