Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/brainres

Brain Research

Research Report

Oscillatory brain responses to own names uttered by unfamiliar and familiar voices

Renata del Giudice[a], *Julia Lechinger*[a], *Malgorzata Wislowska*[a], *Dominik P.J. Heib*[a], *Kerstin Hoedlmoser*[a,b], *Manuel Schabus*[a,b,*]

[a]*University of Salzburg, Department of Psychology, Laboratory for Sleep, Cognition and Consciousness Research, Hellbrunnerstrasse 34, 5020 Salzburg, Austria*

[b]*Center for Cognitive Neuroscience Salzburg (CCNS), University of Salzburg, Hellbrunnerstrasse 34, 5020 Salzburg, Austria*

ARTICLE INFO

Article history:
Accepted 30 September 2014
Available online 13 October 2014

Keywords:
Oscillations
Disorders of consciousness
EEG
Subject's own name
Familiar voice

ABSTRACT

Among auditory stimuli, the own name is one of the most powerful and it is able to automatically capture attention and elicit a robust electrophysiological response. The subject's own name (SON) is preferentially processed in the right hemisphere, mainly because of its self-relevance and emotional content, together with other personally relevant information such as the voice of a familiar person. Whether emotional and self-relevant information are able to attract attention and can be, in future, introduced in clinical studies remains unclear. In the present study we used EEG and asked participants to count a target name (active condition) or to just listen to the SON or other unfamiliar names uttered by a familiar or unfamiliar voice (passive condition). Data reveals that the target name elicits a strong alpha event related desynchronization with respect to non-target names and triggers in addition a left lateralized theta synchronization as well as delta synchronization.

In the passive condition alpha desynchronization was observed for familiar voice and SON stimuli in the right hemisphere.

Altogether we speculate that participants engage additional attentional resources when counting a target name or when listening to personally relevant stimuli which is indexed by alpha desynchronization whereas left lateralized theta synchronization may be related to verbal working memory load. After validating the present protocol in healthy volunteers it is suggested to move one step further and apply the protocol to patients with disorders of consciousness in which the degree of residual cognitive processing and self-awareness is still insufficiently understood.

*Corresponding author at: Laboratory for Sleep, Cognition and Consciousness Research, Department of Psychology, University of Salzburg, Hellbrunnerstrasse 34, 5020 Salzburg, Austria. Fax: +43 8044 5126.

E-mail addresses: Renata.delGiudice@sbg.ac.at (R. del Giudice), Julia.Lechinger@sbg.ac.at (J. Lechinger), Malgorzata.Wislowska@sbg.ac.at (M. Wislowska), Dominik.Heib@sbg.ac.at (D.P.J. Heib), Kerstin.Hoedlmoser@sbg.ac.at (K. Hoedlmoser), manuel.schabus@sbg.ac.at (M. Schabus).

http://dx.doi.org/10.1016/j.brainres.2014.09.074
0006-8993/

1. Introduction

Many studies have investigated auditory processing of the subject's own name (SON). Also because of its countless repetitions during lifetime, the SON is intrinsically meaningful to individuals. In fact, among auditory stimuli, the own name is considered the most powerful stimulus which captures attention without any voluntary effort, as for example demonstrated in the classical "cocktail party" phenomenon (Holeckova et al., 2006; Mack et al., 2002; Moray, 1959), or by its residual processing during non-conscious states such as sleep (Perrin et al., 1999; Portas et al., 2000).

EEG studies have shown that the presentation of the SON evokes larger "P300" (Berlad and Pratt, 1995) or "P3" responses (Folmer and Yingling, 1997) than other first names, which is to be expected, as the P3 is the most significant event-related potential that is known to be related to the processing of relevant or "target" stimuli (Donchin and Cohen, 1967). In the frequency domain, only recently responses to SON have been studied. It has been reported that alpha (8–12 Hz) and theta (4–7 Hz) activity reflect attentional and/or memory processes (Fingelkurts et al., 2002; Klimesch, 1999, 2012). The evaluation of on-going oscillatory activity in response to SON stimuli can therefore shed light on involved cognitive functions. With respect to event-related response Tamura et al. (2012) found stronger theta event-related synchronization (ERS) to the SON which they interpreted as attentional engagement. Other recent studies found a decrease in alpha power in response to SON presentation which the authors likewise interpreted in terms of enhanced alertness or increased active processing due to release of inhibition (Höller et al., 2011; Ruby et al., 2013). Interestingly, also in patients suffering from a disorder of consciousness (DOC) or locked in syndrome (LIS) it is known that the salient SON can still evoke a significant brain response. Surprisingly not only minimally conscious state (MCS) but even supposedly unaware vegetative state/unresponsive wakefulness syndrome (VS/UWS) patients (Perrin et al., 2006) seem to be able to differentiate their own name from other names. A similar study by Fischer in line with these findings reports that some DOC patients, irrespective of their diagnosis, are able to process SON stimuli when they are presented as deviant stimuli in a stream of tones. The authors suggest that the processing of stimulus novelty might prove preservation of some cognitive function independent of conscious awareness (Fischer et al., 2010).

Because of its self-relevance and its emotional content, the SON is preferentially processed in the right hemisphere together with other personally relevant information (Adolphs et al., 1996; Perrin et al., 2005; Schwartz et al., 1975; Van Lancker and Klein, 1990). More interestingly, the activation of the right temporal-parietal junction in response to SON has been related to self-recognition processes (Holeckova et al., 2008). Interestingly, the processing of familiar voices or identifying the individual identity of voices likewise elicits right hemispheric dominant brain responses (Levy et al., 2001; Nakamura et al., 2001).

However, it has been discussed that the passive own name paradigm, in which subjects only passively listen to the presented stimuli might reflect mere automatic stimulus identification and does not allow for an inference about the level of preserved awareness (Bruno et al., 2011; Davis et al., 2007). Addressing this criticism, several EEG studies instructed participants and patients to focus their attention on an auditory target stimulus while ignoring other irrelevant stimuli (Schnakers et al., 2009a, 2008). Specifically, a greater P3 component for attended stimuli was observed in controls as well as in MCS patients (Schnakers et al., 2008). In a more recent study using time–frequency analysis, greater alpha event related desynchronization (ERD) was evident when participants were asked to count the SON, probably reflecting enhanced attentional engagement (Fellinger et al., 2011). In addition, stronger theta event related synchronization (ERS) reflecting working memory involvement was found when subjects were counting as compared to listening to the SON. This task related theta-synchronization was only evident for the SON, but not for unfamiliar name (UN) stimuli, indicating that top-down processes might be easier to engage when the stimulus is emotionally salient and already strongly bottom-up processed. In line with this view, it has been demonstrated earlier that familiar objects, because of their biographical and emotional relevance, are able to increase the number of responses as well as their goal-directedness in DOC patients (Di Stefano et al., 2012). Furthermore, meaningful stimuli with high emotional valence, such as infant cries or the voice of a family member, can induce more widespread "higher-order" cortical responses (Bekinschtein et al., 2004; Di et al., 2007; Jones et al., 1994; Laureys et al., 2004) and facilitate applying top-down attention to relevant input (de Jong et al., 1997; Fellinger et al., 2011; Holeckova et al., 2006). Given those findings, we believe that it is important to further elaborate on study protocols which focus on emotionally relevant stimuli on an individual level.

In the current study we used a modified version of the classical own name paradigm including an active "counting" as well as a familiar voice condition. The active condition, in which subjects were asked to (silently) count a specific unfamiliar name should give an important insight in the amount of top-down control and attentional resources engaged by target names and could, therefore, in future studies allow for identifying "awareness" in patients suffering from DOC, in whom behavioural assessment is often challenging and leads to high rates of misdiagnosis (Andrews et al., 1996; Schnakers et al., 2009b). The introduction of familiar voices aims at increasing the bottom-up stimulus strength by adding emotional valence, which should make it easier to attend to the presented stimuli and will provide us with important information regarding the processing of emotional and self-relevant information in the absence of an explicit cognitive demand.

We will focus on on-going oscillatory activity that is not necessarily exactly time-locked to the presentation of the stimulus, like event-related potentials. In fact, time–frequency analysis, quantifying evoked as well as induced brain activity, has been shown to be more sensitive than mere evoked responses which are more prone to temporal dispersion (Mouraux and Iannetti, 2008). Furthermore, concerning the intended clinical application in DOC patients in the future, it is important to consider that many DOC patients