BRAIN RESEARCH 1236 (2008) 159–165

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BRAIN RESEARCH

Research Report

The influence of gender and personality traits on individual difference in auditory mismatch: A magnetoencephalographic (MMNm) study

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ARTICLE INFO

Article history:
Accepted 26 July 2008
Available online 12 August 2008

Keywords:
Mismatch negativity/field
Gender
Personality trait
Persistence
Reward dependence
Cooperativeness

ABSTRACT

The mismatch negativity (MMN; and its magnetic counterpart, MMNm) is widely used to assess early-stage auditory cortical function in humans and its impairment in various neuropsychiatric disorders. To establish MMN as a useful clinical tool for objective monitoring of auditory cortical function in an individual, we investigated the effect of gender and personality traits on individual difference in MMNm in healthy subjects. Participants were 88 healthy adults (31 women and 57 men). The MMNm in response to the duration or frequency change of tones and those in response to across-phoneme change between vowels /a/ and /o/ were recorded using 204-channel whole-head magnetoencephalography. The temperament and character inventory (TCI) was used to assess individual personality traits. Women were associated with significantly delayed peak latency of phonetic MMNm for the right hemisphere compared with men. Men had greater strength of tonal duration MMNm for the left hemisphere than women. Additionally, the persistence score predicted the strength of phonetic MMNm for the left hemisphere in the combined sample and the tonal duration MMNm for the left hemisphere in men; reward dependence predicted the latency of the tonal duration MMNm for the left hemisphere in men; and cooperativeness predicted the strength of the tonal frequency MMNm for the right hemisphere in women. These results suggest that gender and personality traits have an effect on individual variability of the MMNm. Our observation may provide useful information to establish MMN/MMNm as a clinical tool for monitoring auditory cortical function on an individual basis.

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doi:10.1016/j.brainres.2008.07.120

1. Introduction

The auditory mismatch negativity (MMN) is an event-related potential (ERP) component elicited at approximately 100–200 ms by infrequent, physically deviant stimuli in a sequence of identical, repeated sounds (standard stimulus) (Näätänen et al., 1993). Näätänen et al. (1993) noted that MMN (or its magnetic counterpart (MMNm) measured by magnetoencephalography (MEG)) represents human sensory memory function as it is generated by an automatic (attention-independent) neural mismatch process with a memory trace that encodes the physical features of the standard stimulus. MMN is also referred to as an index of preattentive processing as well as an auditory automatic change detection process, since it can be detected even in the passive condition when subjects entirely ignore stimuli. Recent findings have also suggested that the transient auditory sensory-memory representation underlying the MMN is facilitated by a long-term memory representation of the corresponding stimulus. This means that some characteristics of the sensory-memory traces involved in the elicitation of this component are stored in a more durable representation and that these memory traces can be reactivated (Winkler and Cowan, 2005). MMN(m) is also elicited by contrast between phonetic stimuli (for review, see Näätänen et al., 2007).

Tonal and phonetic MMN(m) is widely used to investigate the pathophysiological mechanisms of neuropsychiatric disorders, such as schizophrenia (for tonal MMN, see Umbricht and Krljes, 2005 for review; phonetic MMN(m), Kasai et al., 2002b, 2003), depression (Lepistö et al., 2004) and autism (Ferri et al., 2003, Kasai et al., 2005), where groups with neuropsychiatric disorders indicate lower amplitude or delayed latency of MMN(m) than psychiatrically healthy groups. In contrast, Morgan and Grillon (1999) reported that the amplitude of the MMN was significantly greater in women with posttraumatic stress disorder (PTSD) compared to the non-PTSD women. To establish MMN(m) as a useful clinical tool for estimating individual ability of auditory cortical function, two issues have to be assessed: one is diagnostic values; and the other is the sources of inter-individual difference. For the former issue, for example, Javitt et al. (1995) reported that they were able to identify 29 of 30 patients with schizophrenia and 5 of 10 controls with an MMN amplitude cutoff of −5.0 μV. For the latter issue, we need to clarify the effect of gender and personality traits on the inter-individual difference in MMN(m), which are the main purpose of the current study. In particular, observed gender differences in the prevalence and course of various psychiatric disorders makes it highly likely that gender is a factor in inter-individual differences (for example, Kessler et al., 1993; Smeeth et al., 2004). Improving our knowledge about sex differences will enhance our ability to develop sex-specific evaluation and treatments for neuropsychiatric brain disorders (Cosgrove et al., 2007).

Previous studies have investigated gender difference in electric MMN (Barrett et al., 1998; Kasai et al., 2002a; Kudo et al., 2004; Nagy et al., 2003; Schirmer et al., 2005), but the results were not conclusive. Barrett and Fulfs (1998) found a significant gender effect for tonal intensity MMN. Although the results of Schirmer et al. (2005) were preliminary, they reported gender difference in emotional phonetic MMN. In contrast, Kasai et al. (2002a) reported no gender effect for either tonal duration MMN or phonetic MMN. Kudo et al. (2004) similarly showed no gender effect for tonal duration MMN. Additionally, Nagy et al. (2003) found no gender effect for tonal frequency MMN. To our knowledge, however, no studies have investigated gender effects on MMNm.

In the current study, we also sought to investigate the effect of personality on individual variability of MMNm. Cloninger et al. (1993) proposed a psychobiological model of temperament and character and developed a self-report questionnaire consisting of 240 items, called Temperament and Character Inventory (TCI), to evaluate personality traits. The use of self-report questionnaires such as TCI has been well-established as a means to assess individual differences in behavioral traits (Cloninger, 1987; Cloninger et al., 1993). TCI is based on the hypothesis that personality consists of two components; temperament and character. Temperament (consisting of four dimensions: novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (P)) is considered to be stable throughout life, and character (consisting of three dimensions: self-directedness (SD), cooperativeness (C), and self-transcendence (ST)) to be mature in adulthood (Cloninger et al., 1993). NS is defined as the tendency towards excitement in response to novel or rewarding stimuli; HA corresponds to the tendency toward an inhibitory response to signals of adverse stimuli; and RD

Table 1 – Mean peak ECD latencies for MMNm in female and male participants

Stimulus	Hemisphere	Male (n=44–53[a])		Female (n=25–27[a])		df[a]	t	P
		Mean	S.D.	Mean	S.D.			
Phonetic change	Left	143.4	28.4	144.7	35.1	76	−0.18	0.86
	Right	135.8	33.5	153.7	39.6	75	−2.08	0.041[b]
Tonal duration change	Left	166.0	22.1	159.9	18.5	76	1.22	0.23
	Right	151.3	27.4	152.1	27.1	78	−0.12	0.91
Tonal frequency change	Left	137.7	29.5	131.2	25.3	67	0.93	0.36
	Right	129.6	29.4	123.1	26.1	66	0.91	0.36

[a] Subjects N and degrees of freedom vary across stimuli since ECD was not successfully determined for some participants in some stimuli.
[b] Reached significance.