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# Hypersensitivity to acoustic change in children with autism: Electrophysiological evidence of left frontal cortex dysfunctioning

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**Abstract**

Exaggerated reactions to even small changes in the environment and abnormal behaviors in response to auditory stimuli are frequently observed in children with autism (CWA). Brain mechanisms involved in the automatic detection of auditory frequency change were studied using scalp potential and scalp current density (SCD) mapping of mismatch negativity (MMN) in 15 CWA matched with 15 healthy children. Compared with the response in controls, MMN recorded at the Fz site in CWA showed significantly shorter latency and was followed by a P3a wave. Mapping of potentials indicated significant intergroup differences. Moreover, SCD mapping demonstrated the dynamics of the different MMN generators: Although temporal component was evidenced bilaterally in both groups, it occurred earlier on the left hemisphere in CWA, preceded by an abnormal early left frontal component. The electrophysiological pattern reported here emphasized a left frontal cortex dysfunctioning that might also be implicated in cognitive and behavioral impairment characteristic, of this complex neurodevelopmental disorder.

**Descriptors:** Autism, Auditory evoked potential (AEP), Mismatch negativity (MMN), Scalp potential mapping (SP), Scalp current density mapping (SCD), Children

Autism is a severe pervasive developmental disorder defined by disturbances in social interaction, verbal and nonverbal communication deficiencies, stereotyped behavior and limited activities and interests. This last aspect of autistic syndrome which remains present at all ages is also characterized by a strong resistance to or distress over changes in the surroundings, initially emphasized by Kanner (1943) in his original description of autism as an imperious need for sameness. In this developmental disorder, intolerance of change is strongly expressed at the sensory level in all modalities. It has been observed in the tactile domain, with, for example, problems with adapting to new types of clothing fabric (Grandin, 1992); in the auditory domain with markedly exaggerated reactions to auditory stimuli of both mild and low intensity (Grandin & Scariano, 1986) and an individual who was frightened by the change in the bell in the subway he took every day; and in the visual domain with, for example, a child who became angry when his cubes were not placed with colored faces on the top (Kanner, 1943).

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Investigations using psychophysiological and electrophysiological methods have provided evidence to confirm this dimension of autistic disorder. Studies based on cardiovascular system responses (heart rate, blood pressure, etc.) and reaction times have shown a hypersensitivity of children with autism to variations that occur in their surroundings (James & Barry, 1980; Kootz, Marinelli, & Cohen, 1982). In contrast, studies involving late auditory evoked potentials mostly conclude that the cortical response usually evoked by an unexpected novel auditory stimulus inserted in a sequence of expected sounds in normal children (A/Pcz/300) was smaller in children with autism (Courchesne, Kilman, Galambos, & Lincoln, 1984; Lincoln, Courchesne, Harms, & Allen, 1993). The mechanisms underlying this fundamental feature of autistic disorder are therefore far from being understood.

In the present study, we focus on auditory processes and we hypothesize that behavioral hypersensitivity to change in autism might be related to particular brain processes involved in the automatic detection of any change occurring in the physical features of the stimulation. In the auditory modality, the brain process involved in stimulus-change detection can be assessed through an electrophysiological probe called mismatch negativity (MMN; Näätänen, 1992). This response is assumed to be generated by a comparison process between infrequent (deviant) auditory input and a neuronal sensory memory trace formed by the repetitive standard sound. MMN studies in adults have shown that it includes

multiple components involving several brain areas. The major component of MMN is generated bilaterally in the supratemporal plane of the auditory cortex (review in Alho, 1995). Giard, Perrin, Pernier, and Bouchet (1990) have also identified a frontal component of MMN in adults that might be related to initiation of involuntary switching of attention to stimulus changes (Giard et al., 1990; Näätänen, 1992). The method they used to evidence these different components was combined topographical analysis of scalp potentials (SP) and scalp current density (SCD) that offered the opportunity to identify noninvasively the different cortical brain regions whose simultaneous activation results in the scalp response recorded. A recent study also based on SP and SCD analysis showed that MMN in 5- to 10-year-old children also includes temporal and frontal components (Gomot, Giard, Roux, Barthélémy, & Bruneau, 2000).

MMN reports in children with autism are scarce. The only two studies available were performed using few electrodes and they found no difference in MMN between autistic and control children (Kemner, Verbaten, Cuperus, Camfferman, & Van Engeland, 1995), or reported longer latency and smaller amplitude in children with autism than in controls (Seri, Cerquiglini, Pisani, & Curatolo, 1999). These discrepancies in MMN results in children with autism remain to be clarified.

Because the aim of our study was to provide better understanding of the brain processes involved in acoustic change detection in autism, MMN was studied using SP and SCD topographic methods in order to dissociate the brain regions involved and to evidence the dynamics of their activation. In particular, this might make possible investigation of the functioning of temporal and frontal regions previously shown to be affected in children with autism (Bruneau, Roux, Adrien, & Barthélémy, 1999; Zilbovicius et al., 1995, 2000).

## Methods

### *Subjects*

Fifteen children with primary autistic disorder (AUT) and 15 gender- and chronological age-matched normally developing children (control group: CONT) participated in the experiment. Children were aged 5–9 years (mean ± *SEM*: AUT, 6 years 10 months ± 4; CONT, 6 years 9 months ± 5). Each group included 12 boys and 3 girls. The clinical participants were recruited among patients attending a child psychiatry day-care unit of a University Hospital. Infantile autism was diagnosed according to DSM-IV criteria (American Psychiatric Association, 1994) by two independent experts (a child psychiatrist and a clinical psychologist). Developmental quotients of children with autism were evaluated by using mental age-appropriate tests: the Brunet-Lézine-R developmental test for infants (Brunet-Lézine, 1976) that allows examination of psychomotor development from 1 to 30 months, and EDEI-R for children (a revised form of a French scale evaluating intellectual skills) that assesses cognitive abilities from 30 months to 9 years (Perron-Borelli, 1978). These two developmental scales provide overall developmental quotients (DQ) and verbal (VDQ) and nonverbal (nVDQ) quotients that were 57 ± 7; 50 ± 7 and 63 ± 7 (mean ± *SEM*), respectively. All participants were right-handed and had normal hearing as assessed by brain stem auditory evoked responses (BAER) recorded before study of late auditory evoked potentials. Children with metabolic or chromosomal disease, a history of substantial neurological disorders or seizures, or an abnormal EEG with either slow waves or epileptiform discharges were excluded. All children were free of psychotropic medication for at least 1 month before the electrophysiological study. The Ethics Committee (CCPPRB) of the University Hospital of Tours approved the protocol. Signed informed consent was obtained from parents, and assent from the children was obtained when possible.

### *Stimuli and Procedure*

Auditory stimulus sequences consisted of 1000 Hz standard tones and 1100 Hz deviant tones (probability of occurrence: $p = .15$) delivered in random order, with the constraint that each deviant tone was preceded by at least three standard tones. All tones had an intensity of 70 dB SPL and duration of 50 ms (5 ms rise/fall). Stimuli were presented monaurally through headphones with a constant (onset to onset) interstimulus interval of 700 ms. A block of 1,000 stimuli was delivered to each ear; the order of the stimulated ear was counterbalanced across participants. During the recording session that lasted 25 min, the participants watched a silent movie on a TV screen.

### *EEG Recording and Data Analysis*

The electroencephalogram (EEG) was recorded from 28 Ag/AgCl electrodes referenced to the nose (the ground electrode was placed on the Fpz location). Seventeen of the electrodes were placed according to the international 10-20 system (Fz, Cz, Pz, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6). The remaining positions were midway between two positions of the 10-20 system: FC1 (between Cz and F3), CP1 (between Cz and P3), FC5 (between T3 and F3), and CP5 (between T3 and P3), and their homologous locations on the right hemiscalp; electrodes were also placed at FFz (between Fz and Fpz) and M1 and M2 (left and right mastoid sites). The impedance value of each electrode was less than 10 kΩ. Horizontal and vertical electro-oculograms (EOG) were recorded differentially from two electrodes located on the outer canthi of the right and left eye (horizontal bipolar) and two electrodes above and below the right eye (vertical bipolar).

The EEG and EOG were amplified with an analog bandpass filter (0.5–70 Hz; slope 6 dB/octave) and digitized at a sampling rate of 256 Hz. Epochs with either movements or eye blinks exceeding ±100 $\mu$V were discarded. Automatic correction of the deviations due to ocular activity was then applied (Anderer, Semlitsch, & Saletu, 1989). EEG epochs were averaged separately for the standard and deviant tones over a 500-ms analysis period, including a 100-ms prestimulus baseline, and were digitally filtered (0–30 Hz). The ERPs to deviant tones included at least 120 responses for each participant. MMN was measured in the difference waveforms obtained by subtracting the responses to the standard tones from responses to the deviant stimuli.

Because no N1 wave was recorded in response to standard tones in children, peak amplitude and latency of the most prominent negative deflection occurring over fronto-central sites (N250 wave) were measured in each participant in a 150–250-ms latency range.

MMN peak amplitude and latency were then measured in each participant by locating the most negative deflection within a ± 30-ms latency window around the peak of the grand average waveform of each group (i.e., CONT, 200 ms; AUT, 170 ms).

Because MMN peak latency measured at Fz and mastoid sites did not significantly vary according to the ear stimulated in either group, responses to right and left ear were pooled. This improved the signal-to-noise ratio and therefore made it possible to extract reliable information from SCD mapping.

SCD amplitudes of MMN were estimated for each participant as the mean value over a ±30-ms time window around the peak latency in the grand average SCD waveform for each group. In 5 children with autism it was difficult to distinguish SCD responses from noise, thus leading to uncertainty of the assessment; they were, therefore, not considered in the SCD results. SCD map analysis was then performed in 10 children with autism (aged 6 years 9 months ± 4; DQ 64 ± 8; nVDQ 67 ± 8; VDQ 59 ± 9) compared with 10 chronological age- and gender-matched controls (7 years ± 5 months). The statistical significance of SCD was tested by comparing the amplitude to zero for each subject using Student's *t* test for paired data.

Amplitudes and latencies were analyzed using repeated-measures analysis of variance (ANOVA) with group (CONT, AUT) as the between-subjects factor and electrode as the within-subjects factor. SP and SCD topographic differences were tested in the interactions between these two factors on normalized data (McCarthy & Wood, 1985). Measurements for each subject were normalized with respect to the minimum value of the measurement at each site and then were divided by the result of the max − min subtraction.

Scalp potential topographic maps were generated using a two-dimensional spherical spline interpolation (Perrin, Pernier, Bertrand, & Echallier, 1989), and a radial projection from Cz (top views), which respects the length of the meridian arcs. SCD maps were estimated by computing the second derivative of the interpolated potential distribution (Perrin, Bertrand, & Pernier, 1987; Perrin et al., 1989).

## Results

### *Potentials Analysis*

The grand average waveforms in response to standard and deviant stimuli for each group at selected electrodes are illustrated in Figure 1. The obligatory responses in children consist of fronto-central negativity peaking at around 240 ms and called N250. This response was clearly identified at fronto-central electrodes in all children and did not vary significantly in amplitude or latency according to group (response to standard at Fz mean ± SEM: CONT, −6.6 ± 0.5 μV, 239 ± 5 ms; AUT, −6.2 ± 0.6 μV, 242 ± 6 ms).

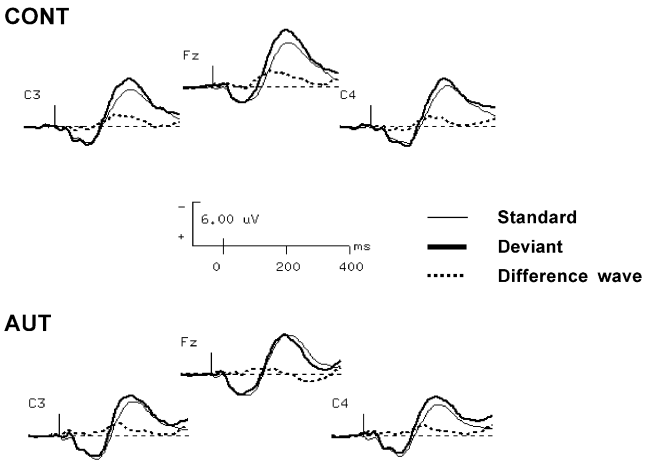


**Figure 1.** Grand average responses recorded at Fz, C3, and C4 electrodes for the standard tones (thin line), deviant tones (thick line), and difference waveform (dotted line) in each group (top: CONT, bottom: AUT). Note that the difference between standard and deviant responses is less marked in AUT than in CONT at the Fz site, whereas it is similar in both groups at C3 and C4 electrodes.

Figure 2A shows the grand mean difference waveform for each group at selected electrodes. In both groups, MMN was evident at the fronto-central sites around 170–200 ms after stimulus onset, with its positive counterpart at mastoid electrodes (M1 and M2), indicating (with reference at nose) involvement of generators located in the supratemporal cortex.

In AUT subjects, the fronto-cental MMN was followed by a positive potential peaking at around 300 ms. MMN peak latency at Fz was significantly shorter in AUT (172 ± 9 ms) than in CONT (201 ± 9 ms), $F(1,28) = 5.19$, $p < .04$. Similar latency shortening was found on the positive peak at the mastoid sites (measured at M1, CONT, 200 ± 6 ms, AUT, 175 ± 10 ms; $F(1,28) = 4.92$, $p < .03$ and at M2, CONT, 202 ± 7 ms, AUT, 177 ± 7 ms; $F(1,28) = 6.34$, $p < .02$). MMN peak amplitude at Fz was larger in CONT (−3.7 ± 0.4 μV; mean ± *SEM*) than in AUT (−2.8 ± 0.5 μV), but the difference was not significant. However, the following topographical results indicate that it has to be analyzed in relation to the whole scalp activity.

Figure 2B (top) presents the scalp potential distribution of MMN at the mean peak latency for each group. In CONT, the map displayed a large negativity over fronto-central areas, associated with bilateral positivity at temporo-mastoid sites. In AUT, while the temporo-mastoid positivity distributions were quite similar to those recorded in CONT, the negative potential field showed a bilateral distribution over central areas with maxima at C3 and C4. Thus, the maximum negative activity in the MMN latency range was recorded at Fz in controls and at C3 and C4 in children with autism and statistical analysis was therefore performed for these sites.

The topographic difference was statistically confirmed by a significant Group × Electrode (Fz, C3, C4) interaction on normalized data, $F(2,56) = 3.58$, $p < .03$. Planned comparison indicated larger amplitudes at C3 and C4 than at Fz in AUT ($p < .01$). No group effect (or interaction) was found in the amplitudes of positive fields (measured at M1 and M2), in spite of the smaller MMN amplitude on both sides in AUT than in CONT.

It must be emphasized that similar abnormal patterns of potential distribution were found when the AUT group was divided into two subgroups according to the severity of mental retardation (DQ > 50, $N = 7$ and DQ < 50, $N = 8$). There also were no intergroup differences on MMN amplitude or latency measured at Fz according to the level of mental retardation in children with autism (Figure 3).

### *Scalp Current Density Analysis*

For both groups, the SCD maps of MMN at their respective peak latency presented a current sink-source pattern in inferotemporal areas, inverted in polarity over the approximate location of the sylvian fissure (Figure 2B, bottom). In addition, frontally distributed current sinks of weak amplitude were observed around FC1 and FC2 in both groups. Table 1 gives the mean amplitude and significance of these currents for each group. No significant differences were observed in temporal sink/source or frontal negative currents between the two groups. Furthermore, SCD distribution in AUT subjects presented supplementary marked sources. The first was recorded midway between F3 and FFz and the second at around Cz. These positive current patterns were significant in AUT but not in CONT subjects.

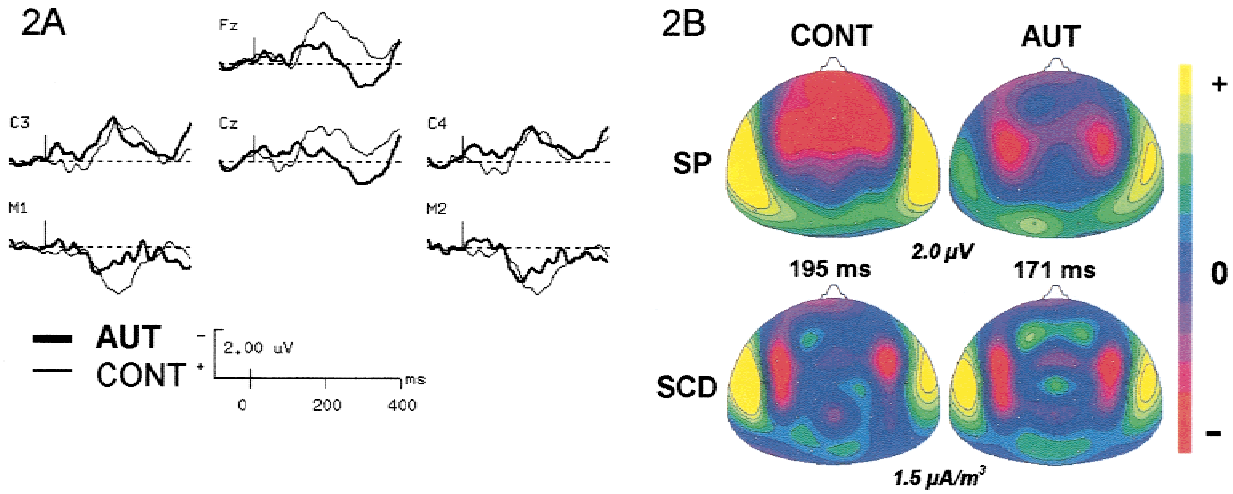


**Figure 2.** (a) Grand average MMN waveform for each group at frontal (Fz), central (C3, Cz, C4), and mastoid (M1, M2) sites. (b) (top) Scalp potential distribution of the grand average MMN at peak latency at Fz for each group (left, CONT; right, AUT); (bottom) Scalp current density distribution of the grand average MMN at peak latency at FT4 for each group.

Figure 4 shows the temporal evolution of MMN over the 100–260-ms latency window. It can be seen that (1) the temporal sink/source activity began earlier in AUT than in CONT, and (2) the left frontal source in AUT clearly preceded the temporal component, whereas the central source emerged at around the same latencies, both sources lasting until 260 ms poststimulus.

## Discussion

The main findings of our study were the earlier MMN peak latency in children with autism than in normal controls and the different MMN topography between the two groups, indicating different brain mechanisms involved in auditory stimulus-change detection.

First of all, analysis of the responses to standard tones revealed that obligatory sensory cortical processes were normal and could not explain the unusual reactions to acoustic change in children with autism. Indeed, as previously shown in BAER studies, autism could not have been considered to be associated with brain stem abnormalities (review Klin, 1993). Moreover, several N1 wave studies in response to auditory stimuli have been carried out in children with autism (Courchesne, Lincoln, Kilman, & Galambos, 1985; Kemner et al., 1995; Lincoln, Courchesne, Harms, & Allen, 1995; Nakamura, Toshima, & Takemura, 1986; Oades, Walker, Geffen, & Stern, 1988) but the findings are not concordant. One explanation is that the N1 component, which is so reliable in adults, does not clearly emerge before age 8–10 years (Bruneau, Roux, Guerin, & Barthélémy, 1997; Csépe, 1995; Martin, Barajas, Fernandez, & Torres 1988; Tonnquist-Uhlèn, Borg, & Spens 1995). The most prominent deflection of AEPs in school-age children is a large negativity peaking at fronto-central sites at about 250 ms after stimulation and called N250 (Ceponiene, Cheour, & Näätänen, 1998; Csépe, 1995; Korpilahti & Lang 1994; Ponton, Eggermont, Kwong, & Don, 2000; Sharma, Kraus, McGee, & Nicol, 1997). Our results show that N250 displays normal characteristics in

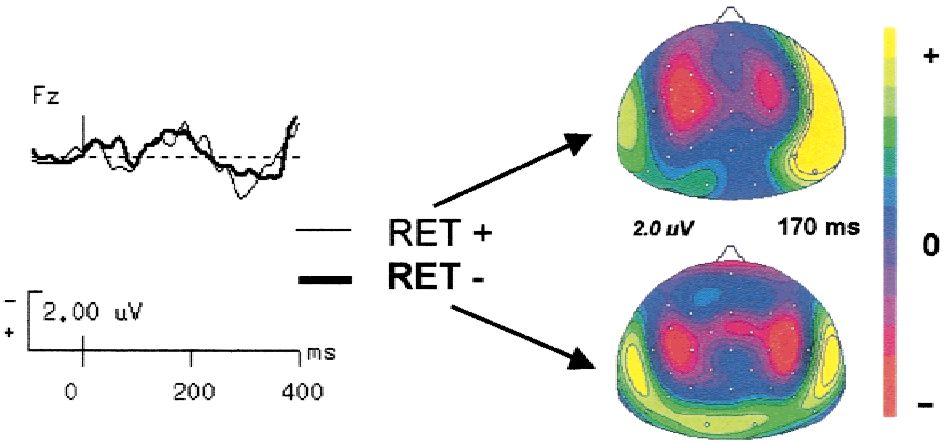


**Figure 3.** (left) Grand average MMN waveform in children with autism for each subgroup of mental retardation at the frontal (Fz) site, and (right) scalp potential distribution of the grand average MMN at peak latency at Fz for each group (top: RET +, DQ < 50; bottom: RET−, DQ > 50).

**Table 1.** *Mean Amplitude of Current Densities (Mean Value over a ± 30 ms Time Window around the Peak) in Each Group (Mean ± SEM $\mu A/m^3$)*

| | Recording site | Control | Autistic |
|---|---|---|---|
| Temporal sink | FT3 | −1.78 ± 0.4*** | −1.93 ± 0.4*** |
| | FT4 | −1.93 ± 0.4*** | −2.23 ± 0.6*** |
| Temporal source | T3 | 0.74 ± 0.5 n.s. | 0.37 ± 0.3 n.s. |
| | T4 | 0.42 ± 0.2* | 0.51 ± 0.1*** |
| Fronto-central sink | Mean FC1, FC2 | −0.35 ± 0.2* | −0.50 ± 0.2* |
| Frontal source | Midway between F3 and FFz | 1.05 ± 0.5* | 2.09 ± 0.6*** |
| Central source | Cz | 0.09 ± 0.2 n.s. | 0.64 ± 0.3** |

*$p < .10$, **$p < .05$, ***$p < .01$ (significant differences from 0 (paired samples)).

children with autism, thus suggesting no particular features in the functioning of the supratemporal region where this response is generated (Bruneau & Gomot, 1998).

Although our findings raised questions about the reliability of MMN amplitude measurement at Fz in children with autism, it is at this frontal site that MMN is usually recorded, thus allowing comparison with previous studies. Our findings do not agree with the results of Kemner et al. (1995), reporting normal latency and amplitude of MMN in children with autism. However several differences must be emphasized: Kemner et al. performed their study on high functioning children with autism and used speech stimuli. This type of stimulus usually evokes larger MMN than tones (Csépe, 1995) and might be processed by children with autism in a different way than tone stimuli. Above all, the unusual stimulation conditions used by Kemner et al. for MMN recording (long ISI, varying between 4 and 6 s) may have induced wide variability that did not reveal significant MMN intergroup differences. In another study, Seri et al. (1999) showed significantly smaller amplitude and longer latency in children suffering from tuberous sclerosis complex associated with autistic behaviors. However, MRI investigation in these children indicated that all had lesions involving one or both temporal lobes. This could contribute to the differences found in MMN characteristics, as the main brain areas involved in the generation of this response are situated in the temporal auditory cortex.

Our most striking finding was a shortening of latency of MMN in children with autism. Basic research on MMN has shown that shorter MMN latencies are recorded for greater intensity (Schröger & Winkler, 1995) and frequency deviations (Näätänen, Simpson, & Loveless, 1982; Tiitinen, May, Reinikainen, & Näätänen, 1994). One explanation might be that children with autism possibly detect acoustic changes in their surroundings more rapidly than normally developing children because of a higher cerebral reactivity to the deviancy. Information on the neural networks involved is provided by topographical findings, indicating different cerebral activity evoked by acoustic stimulus change in children with autism. While both autistic and control children displayed temporal and frontal MMN components similar to those previously detailed in normally developing children (Gomot et al., 2000), additional current sources were evident at midline in children with autism. These positive currents may explain the smaller MMN potential amplitude at the midline and the bilateral distribution of the negative potential field over central areas, thus indicating different rather than reduced deviance-related cortical activity in these children.

Above all, as seen in Figure 4, which shows the temporal evolution of MMN between 100 and 260 ms, the positive current generated in the left cortex region occurs very early after deviant stimulus onset and may induce the early triggering of genuine left temporal MMN in children with autism. This pathological mechanism raises questions about an eventual dissociation between left and right temporal components of MMN.

This early deviance-related positive activity found in the left prefrontal cortex in children with autism on SCD mapping might correspond to an early MMN-like response activated before the

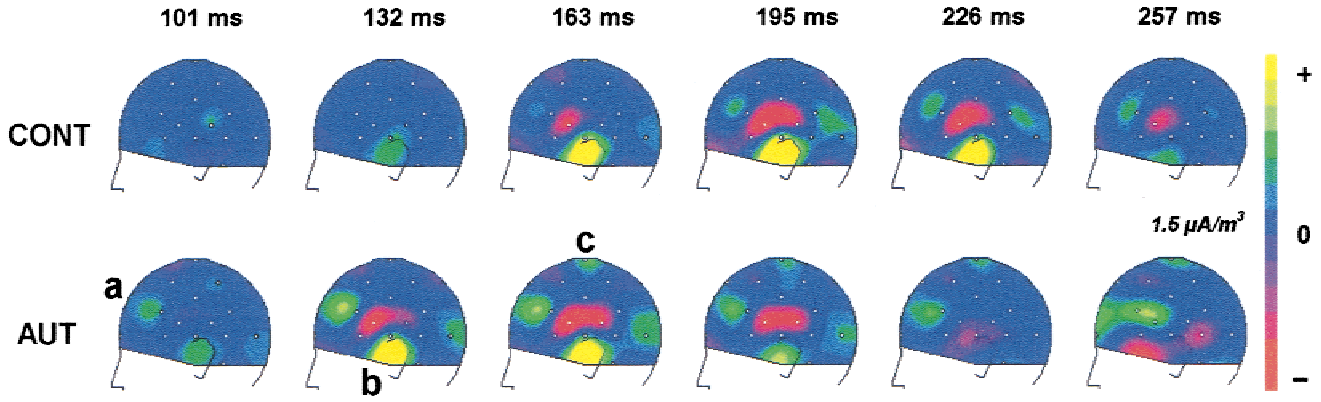


**Figure 4.** MMN SCD maps (left hemiscalp) between 100 and 260 ms post stimulus in each group (top: CONT, bottom: AUT). (a) left frontal source, (b) temporal sink/source pattern, and (c) central source.

supratemporal MMN component. It may be evoked earlier by nonprimary thalamo-cortical projections (Martinez-Moreno, Llamas, Avendano, Renes, & Reinoso-Suarez, 1987). Such activation by the thalamic contribution to MMN generation through the thalamo-cortical pathway was previously discussed by Yago, Escera, Alho, and Giard (2001) in healthy adults. Indeed, intracranial recordings in guinea pigs have shown activity in the nonprimary subdivision of the auditory thalamus for frequency deviations (Kraus, McGee, Littman, Nicol, & King, 1994). The absence of MMN in patients with anteromedial thalamic lesions also supports an auditory change detection mechanism at the thalamic level (Mäkelä, Salmelin, Kotila, & Hari, 1998). Such findings suggest the existence of a parallel pathway that could be overactivated in children with autism and would explain the shortening of MMN latency observed in these children. This abnormal processing in thalamo-frontal loops might be related to neurotransmission dysregulation. Indeed, synthesis of serotonin has recently been shown to be impaired in the left frontal cortex and thalamus in autistic boys (Chugani et al., 1997). The atypical activity of the left frontal region observed is essential and will be discussed below in the physiopathological framework of autism.

Interestingly, MMN in children with autism was followed by a P3a-like wave. It has been shown in healthy adults that this response, which is usually maximum over frontal sites, may follow the MMN to changes in an unattended auditory stimulus sequence (Alho et al., 1998). Although several brain areas, including the dorsolateral prefrontal cortex, the temporo-parietal junction, the posterior hippocampal region (Knight, 1984, 1996; Knight, Scabini, Woods, & Clayworth, 1989), and the auditory cortex (Alho et al., 1998), have been proposed to participate in P3a generation, SCD analysis of P3a shows current source patterns at fronto-central sites (Schröger, Giard, & Wolff, 2000). The results presented in Figure 4 strongly suggest that these P3a currents are already present during the MMN time range in children with autism. P3a is assumed to be associated with involuntary switching of attention toward stimulus changes occurring outside the current focus of attention (Escera, Alho, Winkler, & Näätänen, 1998; Schröger, 1996). Such involuntary orienting of attention is possibly enhanced in children with autism, whereas automatic discrimination remains at the preattentive level in normal controls in the same conditions of stimulation. It may thus be supposed that any change, even nonsignificant, occurring in the environment of the autistic child may lead to attention switching and, as a consequence, to distractibility and distress.

Although allowing better understanding of the possible meaning of stimulus-change reaction in autism, this pattern (MMN/P3a) remains nonspecific and has been previously described in the normal population. The most striking and specific finding of this study is atypical activity of the left frontal region in children with autism. This supports the hypothesis of frontal lobe dysfunction in autism suggested 20 years ago on the basis of clinical resemblance between frontal lesion symptoms and autistic behaviors (Damasio & Maurer, 1978). Subsequently, an executive function deficit underlain by a frontal dysfunction has been proposed in autism (Hugues, Russell, & Robbins, 1994; Ozonoff & Jensen, 1999). Indeed, children with autism display difficulties when attempting formal tasks involving planification (Ozonoff, Pennington, & Rogers, 1991), flexibility (Prior & Hoffman, 1990; Rumsey & Hamburger, 1988), and working memory (Benetto, Pennington, & Rogers, 1996), all functions concerning attention shifting.

Abnormal frontal lobe metabolism has then been reported in children with autism (George, Costa, Kouris, Ring, & Ell, 1992; Zilbovicius et al., 1995), and reduced or absent attention-related electrical responses have also been recorded over frontal sites in autism (Ciesielski, Courchesne, & Elmasian, 1990; Courchesne et al., 1984; Dawson, Klinger, Panagiotides, Lewy, & Costelloe, 1995). However these electrophysiological findings do not clearly demonstrate frontal cortex origin of the ERP abnormalities observed, as potentials recorded on the scalp result from several overlapping components that could be generated near or far from the recording sites. The application of SCD to surface potential data basically serves as a spatial high-pass filter to enhance underlying local brain activities while minimizing distant contributions (Pernier, Perrin, & Bertrand, 1988; Perrin et al., 1989). In the present study, this method evidenced abnormal functioning of a neural network, including the left frontal cortex, involved in the automatic detection of acoustic stimulus change in children with autism.

Taken together, these findings strongly suggest particular processing of auditory stimulus change in children with autism that might be related to their behavioral need to preserve sameness. This study emphasizes the importance of spatiotemporal analysis of brain electrical activity to provide better understanding of the neurophysiopathological mechanisms of auditory processing in children with autism.

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