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Influence of musical expertise and musical training on pitch processing in music and language

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Abstract. *Purpose:* We review a series of experiments aimed at studying pitch processing in music and speech. These studies were conducted with musician and non musician adults and children. We found that musical expertise improved pitch processing not only in music but also in speech. Demonstrating transfer of training between music and language has interesting applications for second language learning. We also addressed the issue of whether the positive effects of musical expertise are linked with specific predispositions for music or with extensive musical practice. Results of longitudinal studies argue for the later. Finally, we also examined pitch processing in dyslexic children and found that they had difficulties discriminating strong pitch changes that are easily discriminate by normal readers. These results argue for a strong link between basic auditory perception abilities and reading abilities.
Methods: We used conjointly the behavioral method (Reaction Times and error rates) and the electrophysiological method (recording of the changes in brain electrical activity time-locked to stimulus presentation, Event-Related brain Potentials or ERPs).
Results: A set of common processes may be responsible for pitch processing in music and in speech and these processes are shaped by musical practice.
Conclusion: These data add evidence in favor of brain plasticity and open interesting perspectives for the remediation of dyslexia using musical training.

1. Preliminary remarks

In this chapter, we will first review a series of experiments that were designed to investigate the influence of musical expertise on pitch processing. These experiments were conducted with adults and with children. Results showed that musical expertise improved pitch perception not only in music but also in language. We will then present the results of longitudinal studies with children that aimed at determining whether the influence of musical expertise is linked to specific predispositions for music or is rather the consequence of musical training. Clear evidence was found in favour of musical training. Finally, we will report results of an experiment on pitch processing in dyslexic children showing that phonological dyslexics encounter difficulties in a pitch discrimination task and we will argue that such pitch processing deficits may at least in part account for their reading difficulties.

2. Theoretical framework

Clearly, as one may expect, many results in the neuroscience of music literature, using a variety of brain imaging methods, have demonstrated that musical expertise influences music perception (e.g., Altenmüller, 1986; Besson et al., 1994; 1995; Brown et al., 2004; Elbert et al., 1995; Koelsch et al., 2000: 2002; 2003; 2005; Lütkenhöner et al., 2006; Mazziota et al, 1992; Onishi et al., 2001; Pantev et al., 1998, 2001; 2003; Platel et al., 1997; Schmithorst & Holland, 2003; Schneider et al., 2002; Schulz et al., 2003; Sergent et al., 1992;

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Seung et al., 2005; Shahin et al., 2003; 2004; Tervaniemi & Hughdahl, 2003; Trainor et al., 1999; Vuust et al., 2005; Zatorre et al., 1998) and performance (Bangert et al., 2006; Jäncke et al., 2000; Karni et al., 1995; Koeneke et al., 2004; Kristeva et al., 2003; Seitz et al., 1994) .

Magnetic Resonance Imaging (MRI) also revealed that such functional differences between musicians and non musicians have anatomical bases although the evidence for a direct link between brain structures and functions is still sparse (Schneider et al., 2002; 2005). Different brain structures, such as the corpus callosum (Schlaug et al., 1995a; Schmithorst et al., 2002), the Heschl gyrus gray matter volume (e.g., Gaser & Schlaug, 2003; Schneider et al., 2002), the planum temporale (Keenan et al., 2001; Luders et al., 2004; Schlaug et al., 1995b), the inferior frontal gyrus (Gaser & Schlaug, 2003; Luders et al., 2004), the primary motor cortex (Amunts et al., 1997) and the cerebellum (Hutchinsons et al., 2003), are larger in musicians than in non musicians. Thus, musical expertise influences the anatomo-functional organization of different brain regions. Interestingly, the different brain structures that are found to be more developed in musicians than non musicians are not necessarily specific to music processing. Functional MRI has highlighted, for instance, that similar networks of brain structures are activated by music and language processing (Brown et al., 2004; Levitin & Menon, 2003; Koelsch et al., 2002, 2004; Maess et al., 2001; Meyer et al., 2002; Vigneau et al., 2006; Zatorre et al., 2002).

Based on this general framework, we reasoned that if musical expertise influences the anatomo-functional organization of the brain and if similar networks of brain structures are involved in some aspects of music and language processing, musical expertise may also influence some aspects of language processing. But is there any behavioural evidence for transfer effects from music to other perceptive, cognitive or motor abilities and, in particular to language abilities? Results of transfer of training experiments have revealed somewhat mixed results with positive transfer effects on mathematics (Gardiner et al., 1996; Graziano et al., 1999, but see Vaughn, 2000; Costa-Giomi, 2004), symbolic and spatio-temporal reasoning (Hetland, 2000; Rauscher, 1997, but see Hassler et al., 1997), visuo-spatial abilities (Brochard et al., 2004; Gromko et Poorman, 1998), verbal memory (Chan et al., 1998; Ho et al., 2003), self estim (Costa-Giomi, 2004), general intelligence (Schellenberg, 2004; 2006). Two main reasons can account for this lack of reliability in the findings of transfer effects. First, several factors such as between groups differences, motivation, cognitive stimulation, were often not controlled in these experiments (Schellenberg, 2001). Second, and may be most importantly, very few studies were aimed at testing specific hypothesis regarding the causality of potential transfer effects (Chan et al., 1998; Ho et al., 2003; Thompson et al. 2004). In the series of experiments presented below we tested the specific hypothesis that musical expertise, by increasing pitch discrimination, will improve pitch processing in language.

3. Pitch processing in music and speech

Pitch is the perceptual attribute that corresponds to frequency and can be defined as “That attribute of auditory sensation in terms of which sounds may be ordered on a musical scale” (American National Standards Institute: www.ansi.org). For harmonic or quasi-harmonic sounds, pitch is related to the fundamental frequency (F0) in the spectral domain and to the periodicity of envelope changes in the temporal domain. The intriguing question of how the percept of pitch is generated from the complex spectrum of a sound has recently found some answers. Results of elegant studies in both animals (Bendor & Wang, 2005; Penagos et al., 2004) and humans (Griffiths et al., 1998, 2001; Patterson et al., 2002; Schneider et al., 2005) have shown that the antero-lateral region of Heschl gyrus is activated by the presentation of sounds with the fundamental (F0) absent (Bendor & Wang, 2006).

This region would therefore be responsible for the construction of the pitch percept. Pitch is a musically relevant parameter as it allows to define the melodic aspects of a musical sequence (i.e., the succession of ups and downs in pitch). As a basic acoustic parameter of sounds, pitch is also linguistically relevant, specifically in tone languages (Vance, 1976). Moreover, together with other acoustic parameters (duration, intensity and timbre), pitch contributes to the expression of the emotional function (i.e., express joy, sadness, anger . . . ; Schirmer et al., 2001; Kotz et al., 2003) and linguistic function (i.e., segmentation, modality, focus, . . . through pauses, intonation, accents; Astesano et al., 2004; Böcker et al., 1999; Eckstein & Friederici, 2005; Friedrich et al., 2004; Magne et al., 2005; Meyer et al., 2000; Steinhauer et al., 1999) of prosody in speech. Pitch manipulations are therefore both musically and linguistically relevant.

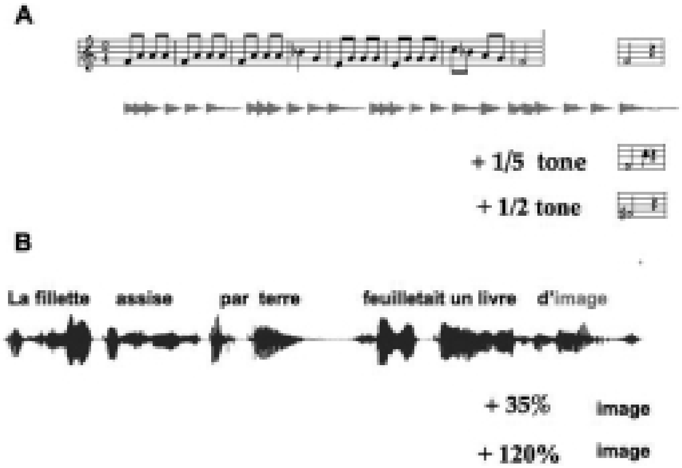

Fig. 1. Example of stimuli used in the music (A) and speech (B) pitch discrimination tasks (*The girl sitting on the floor was reading a picture book*). The pitch of the final note/word was congruent or parametrically manipulated so as to be weakly (1/5 of a tone or 35% increase) or strongly incongruous (1/2 of a tone or 120% increase). (Adapted from Schön, Magne & Besson, 2004 and Magne, Schön & Besson, 2006)

4. The effect of musical expertise

4.1. General description of the experiments

In the experiments described below we used the Event-Related brain Potentials (ERPs) method that allows to examine the temporal dynamics of the changes in brain electrical activity elicited by an event of interest and that can easily be used both with adults and with children. We always used the same musical materials (120 musical phrases; half from the children repertoire, e.g., "Les Crocodiles", *Crocodiles,* and half composed for the experiment following the same musical rules, see Fig. 1) and the same linguistic materials (120 utterances from children's book, e.g., "La fillette assise par terre feuilletait un livre d'images", *The girl sitting on the floor was reading a picture book*"). Half of the musical and linguistic phrases ended with the expected congruous note/word and the other half with a parametric manipulation of pitch so that the final note was increased by 1/5 or $^1/_2$ of a tone and the F0 contour of the final words was increased by 35% or 120% (weak and strong incongruities, respectively). Musicians and non musicians participants were asked to listen attentively to the musical and linguistic phrases, that were presented in separated blocks of trials, and to decide whether the final note/word was normal or strange. ERP recordings were time-locked to the final note/word of the phrases. We hypothesized that musicians and non musicians should detect congruous and strongly incongruous notes equally well because both are easy to detect. By contrast, musicians should detect weak incongruities better than non musicians because 1/5 of a tone is a subtle pitch change, only noticeable by a musical ear. Moreover, we hypothesize that a musical ear may also be of use to detect small pitch changes in speech. Thus, musicians should detect 35% increase in F0 better than non musicians but no differences should be found for both congruous and strong incongruities in speech.

4.2. Pitch processing in adults

A total of eighteen adults (9 musicians and 9 non musicians) were tested in the first Experiment (Schön, Magne & Besson, 2004). In line with our hypothesis, results in adults showed that the percentage of errors to weak pitch violations was lower for musicians than for non musicians not only in music but also in speech. No significant differences between groups were found for the congruous and strong incongruity endings (see Fig. 2). Moreover, ERP data in adults showed that strong incongruities elicited early negative components (100–300 ms latency bands) in both groups and in both music and language but with a different scalp distribution: right fronto-temporal in music and temporal bilateral in language with a clearer bilateral distribution in musicians than in non musicians. Most importantly, while strong incongruities also elicited positive components in both groups, weak incongruities in both music and language did elicit larger positivity than congruous endings only in the music group (see Fig. 3). These results therefore show that musical expertise improved pitch discrimination and this was reflected by

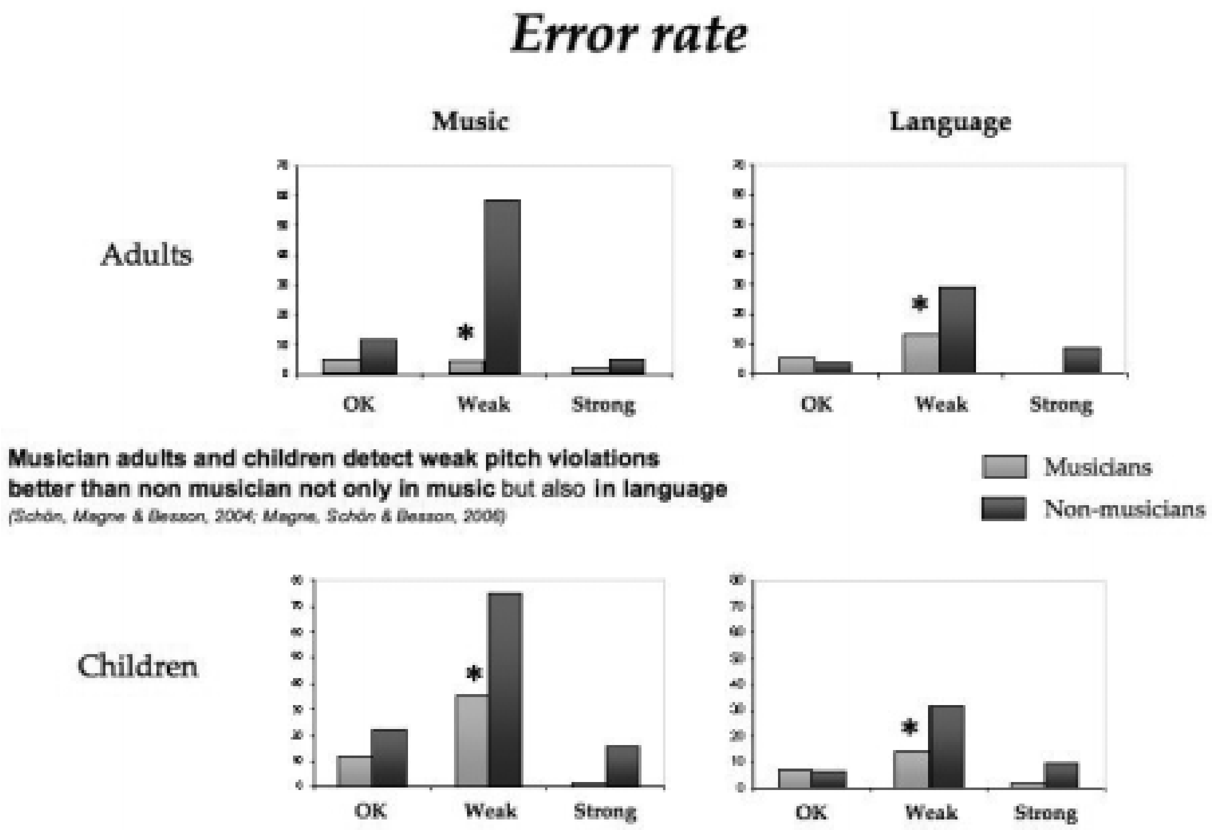

Fig. 2. Error rate for each condition (congruent, weak incongruity and strong incongruity) in the language and music tasks in musician and non musician adults and children.

an increased positivity to weak incongruity in musicians but not in non musicians. Most interestingly, similar effects were found in music and speech which demonstrates clear positive transfer effects from music to speech processing. Consequently, having a musical ear seems to improve perception of pitch changes in language (Gandour et al., 1998; Wong et al., 2007).

4.3. Pitch processing in a foreign language

In a follow-up study, we used similar pitch manipulations in Portuguese and we presented these Portuguese utterances to French adults musicians and non musicians who did not understand Portuguese (Marques et al., 2007). Results showed that musicians were able to detect small pitch changes in Portuguese better than non musicians and that the onset latency of the positivity was 300 ms earlier in musicians than in non musicians. Very recently, Wong et al. (2007) have shown greater similarity of the contour of the brainstem response to pitch contour of Mandarin tones in musicians than in non musicians, even if none of the participants understood Mandarin. Taken together, these results therefore concur in showing that musical expertise influence pitch perception not only in music but also in language and that this influence occurs very early in the auditory pathway. They also point to the positive influence of long-term music exposure for second language learning (e.g., Sleve & Miyake, 2006), a line of research that we will pursue in further experiments.

4.4. Pitch processing in children

A total of twenty 8-year-old children (10 musicians and 10 non musicians) were tested in this experiment (Magne, Schön & Besson, 2006). Results similar to adults were found in children: the percentage of errors to weak pitch violations was lower for musicians than for non musicians children not only in music but also in speech. No significant differences between groups were found for the congruous and strong incongruity endings (see Fig. 2). As illustrated on Fig. 4, ERP data in children revealed that while a negative-positive complex (N200-P600) was elicited by strong incon-

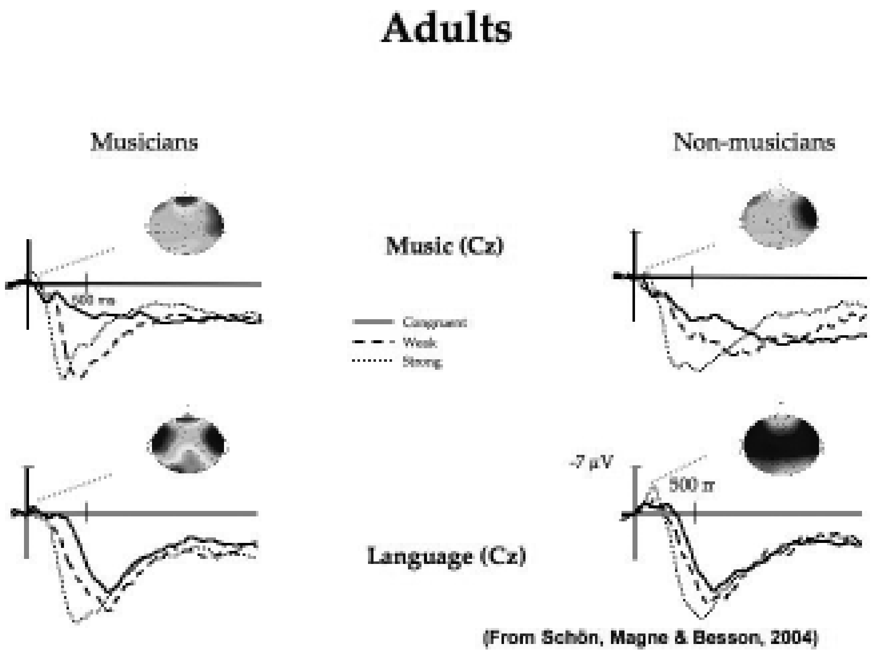

Fig. 3. Averaged electrophysiological data recorded from musician and non-musician adults in the music and language tasks. Recordings are time-locked to the onset of the final note/word in the strong and weak incongruity conditions and in the congruous condition. Results are illustrated for one representative central electrode (Cz). In this figure, as in the following ones, the amplitude (in microvolt) is plotted on the ordinate (negative up) and the time (in millisecond) is on the abscissa. (Adapted from Schön, Magne & Besson, 2004)

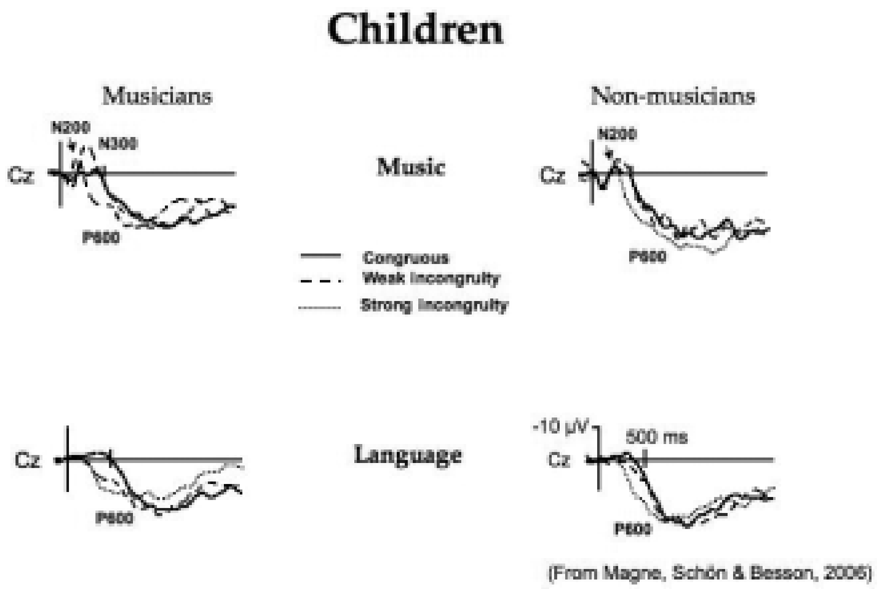

Fig. 4. Averaged electrophysiological data recorded from musician and non-musician children in the music and language tasks. Recordings are time-locked to the onset of the final note/word in the strong and weak incongruity conditions and in the congruous condition. Results are illustrated for one representative central electrode (Cz). (Adapted from Schön, Magne & Besson, 2006)

gruities in music in both groups, a negative component (N300) developed in response to weak incongruity only in musicians. In speech, a positive component, peaking around 600 ms was elicited by strong incongruities in both groups. By contrast, no significant differences between weak incongruities and congruous words were found in non musicians, but weak incongruities elicited significantly larger positive components than congruous endings as early as 200 ms in musicians. Taken together these results show first, that the increased auditory acuity in musicians than in non musicians, as reflected by the lower error rate to weak incongruity in music, has an electrophysiological correlate in the occurrence of the N300 component only in musicians. Second, these results also demonstrated that transfer of training effects between music and speech, as revealed by the lower error rate of musicians than non musicians to weak incongruities in speech, are reflected by an increased early positivity (starting at 200 ms but peaking at 600 ms and therefore called P600), again only in musicians. In conclusion, two ERP components, the N300 and the P600 were sensitive to musical expertise and clearly differ between musician and non musician children.

5. The influence of musical training

A long-standing and still unresolved issue in music research is whether differences between musicians and non musicians reflect specific predispositions for music or are rather linked with the effects of intensive musical training (e.g., Fujioka et al., 2006, Wong et al., 2007). To address this issue, we conducted two longitudinal studies with 8-year-old children and we controlled for a number of factors that are known to be of particular importance in longitudinal studies. Thus, all children were non musicians (with non musician parents), from similar socio-economic background (middle class) with parents having a similar level of education. Moreover, we tested an equal number of girls and boys and all were right-handed and had normal hearing. Perhaps most importantly, children were pseudo-randomly assigned to either a music training group or to a painting training group. Thus, based on results at the neuropsychological assessments and at the tests that were specifically designed to address our hypothesis (see below), we assigned the child to one group or to the other, while ensuring that there were no difference between groups before training.

5.1. Longitudinal studies

Two longitudinal experiments were conducted, one in Marseille (France; Moreno & Besson, 2006) and the other in Aveiro (Portugal; Moreno et al., in preparation). These two experiments mainly differed in the duration of the training period (8 weeks in the first experiment and 6 months in the second experiment). Also, neuropsychological assessments were obtained for all children in the Aveiro but not in the Marseille experiment. Both experiments comprised three phases.

Phase 1: Children were tested individually in one session (Marseille) or two sessions (Aveiro) that lasted around 2 hours each. These results served as the basis for the pseudo-random assignment of children to the music or painting groups and as a baseline to evaluate the impact of the training programs.

In the neuropsychological assessment session (*Aveiro*), children were tested using the Wechsler Intelligence Scale for Children (WISC-III (Thompson, Schellenberg & Husain, 2004); Portuguese Adaptation), the Digit Span subtest as well as reading tests.

In the pitch discrimination session, children in the Marseille experiment were presented with the same musical and linguistic materials as used by Magne et al. (2006) and children in the Aveiro experiment listened to the same melodies but to the linguistic materials used in the Marques et al.' study (2007).

Phase 2: Children were pseudo-randomly assigned to two training groups and they participated in music or painting training for either 8 weeks (twice a week for 50 mn in Marseille) or for 24 weeks (twice a week for 75 minutes in Aveiro).

5.2. Training methods

In Marseille, musical training was based upon a new technology called the "musical garden" (Conceptor: C. Napoléoni). In short, a large carpet comprises patches from different colours that are connected to a computer. When the child walks on the patches, different sounds are generated depending upon the software in use. Here, we used synthesized sounds from the piano. Children were trained to hear differences in pitches and were familiarized to the notion of musical intervals. In Aveiro, musical training was based on a combination of Kodály, Orff and Wuytack methodologies (www.kodaly.org.au). Children learned about basic musical components, such as rhythm, melody, harmony, and timbre, and were taught musical forms and general musical aspects, such as expression and movement that largely contribute to music appreciation and performance. In both Marseille and Aveiro, painting training emphasized the development of visuo-spatial performance. Children learned about basic painting components: visual (light and colour), spatial (lines and perspectives) and materials (texture and paint types).

Phase 3: Children were again tested for neuropsychological assessments (Aveiro) and pitch discrimination (both Marseille and Aveiro) in two separate sessions by using the same procedure and stimuli as in Phase 1.

5.3. *The effect of 8 weeks of musical training*

The basic hypothesis tested in these experiments is that if improved pitch processing in both music and language, as described above, is linked to musical training rather than to specific predispositions for music, children in the music group should perform better than children in the painting group. Results for the weak incongruity are particularly interesting in this respect because this is the most difficult to detect. Thus, while we expected no differences between groups after training for both the congruous endings and strong incongruities, children in the music group should detect weak incongruities better than children in the painting group. Moreover, if these effects are linked with musical training, we should also be able to generate the ERP effects previously found in 8-year-old children for the weak incongruity (i.e., the N300 and the P600 effects). No between group differences in pitch discrimination performance were found, however, after 8 weeks of training, but in the ERPs, strong incongruities elicited smaller P600 after than before training in the music group only (see Fig. 5). While this may reflect automation of pitch processing with musical training, thereby requiring fewer resources and smaller neuronal networks to detect the strong incongruity (Batty & Taylor, 2002; Jäncke et al., 2000; Koeneke et al., 2004; Tatsuno & Sakai, 2005), this effect was not predicted on the basis of our previous data.

5.4. *The effect of 6 months of musical training*

More interesting are the results after 6 months of training. In this case, musically-trained children detected weak incongruities in both music and language better after than before training, but no such differences were found with painting-trained children. No training effects were found in either groups for the congruous endings and strong incongruities. Most importantly, these behavioural effects were associated with clear ERP effects (see Fig. 6). Thus, the amplitude of the N300 to weak musical incongruities was clearly increased after musical training but not after painting training. Very recently, Fujioka and collaborators (2006) reported the results of a longitudinal study with 4- to 6-year-old

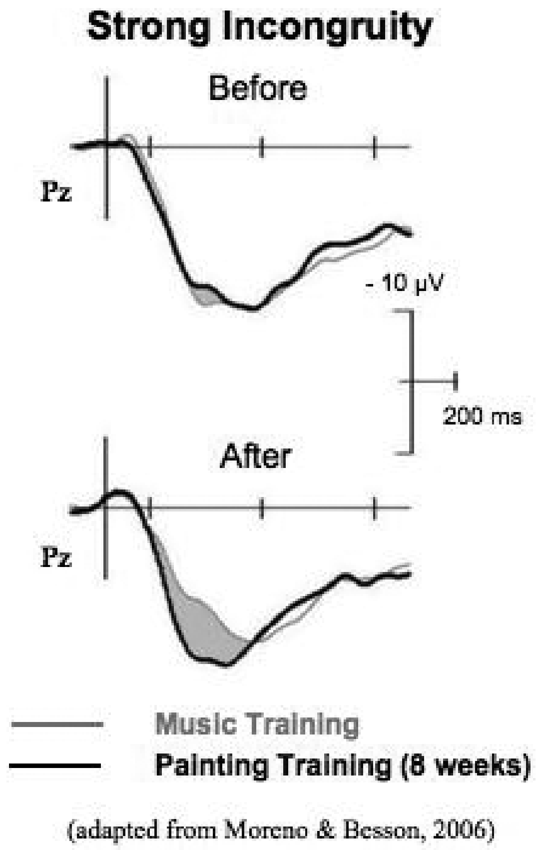

Fig. 5. Averaged electrophysiological data time-locked to the strong incongruity in the language task. Recordings before and after training are overlapped for children with 8 weeks of musical (grey line) or painting training (black line) at a representative electrode (Pz).

children tested four times over a year using the Magnetoencephalography (MEG) method. They found that a magnetic component, the N250m elicited by violin tones was larger in musically trained children than in control children. While electric N300 found in our study and the magnetic N250m reported by Fujioka et al. (2006) show some similarities, they however, also present several differences indicating that they may not be functionally equivalent. Perhaps most importantly, the amplitude of the N250m decreases over the 4 MEG recording sessions a finding that the authors interpret in terms of decreased attention. The functional significance of the N250m/N300 needs to be further explored by doing a within experiment comparison of the effects of musical training on the ERPs/AEFs elicited by pitch manipulations on single tones and on tones occurring within more complex musical materials.

Finally, the effects of training were not significant for congruous and strong incongruities in either group. By

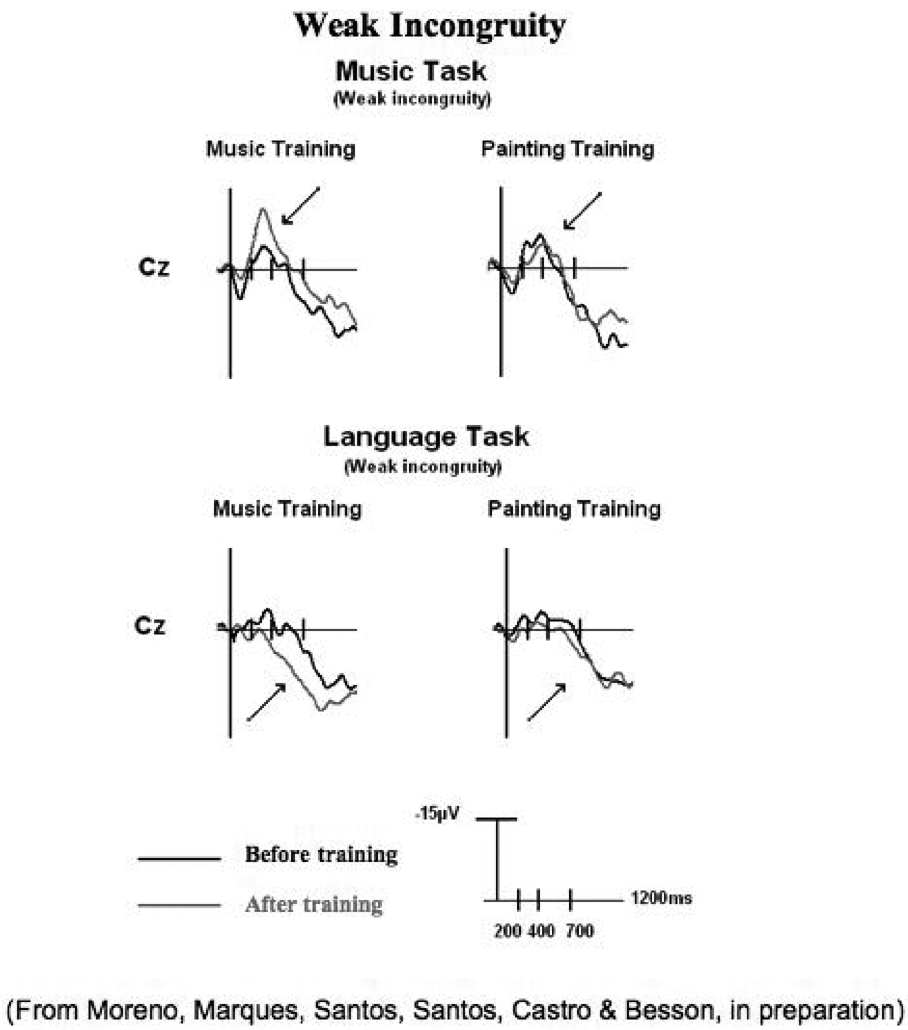

Fig. 6. Averaged electrophysiological data time-locked to the weak incongruity in the music and language task. Recordings before training (blue line) and after training (red line) are overlapped for a representative electrode (Central, Cz) in both the music and painting training groups.

contrast, the amplitude of the P600 to weak incongruity (that started around 150 ms post-word onset) was also clearly increased after musical training but not after painting training. Finally, as previously reported by Moreno & Besson (2006), P600 to strong incongruity was reduced in amplitude after music training but no such effect was found in the painting training group.

5.5. Summary

Taken together, these results show that 6 month of musical training allowed children to detect small pitch changes in both speech and music. Moreover, we were able to generate the effects previously reported in 8 year-old musician children. Indeed, the weak incongruity in music was associated with increased N300 in musically trained but not in painting trained children. Similarly, the weak incongruity in language was associated with increased P600 in musically trained children but not in painting children. It should be noted that differences in cognitive stimulation and motivation between the two groups can be ruled out because children participated in equally stimulating extra-curricular activities, music and painting. Comparing two groups of children also allowed us to tease apart the effects that were specifically linked to musical training from those that might be due to normal development or maturation (children were on average 6 months older after training) or due to practice with the tasks at hand (short gap -6 months- between test and retest). Consequently, it seems reasonable to conclude that the effects previously found with musician children reflect the influence of musical training rather than specific predispositions for music. This conclusion is in line with results of Schlaug and collaborators showing no differences (as revealed by both MRI and fMRI) between children starting musical training and children not planning to take music lessons (Norton et al., 2005). These results and ours do not imply, however, that there are no naturally occurring variations in pitch perception abilities, or that these variations have no genetic basis. Drayna et al. (2001) for instance, have demonstrated that pitch perception is more similar in monozygotic than dizygotic twins, thereby highlighting heritable differences in auditory functions.

5.6. Neuropsychological assessments

Finally, results at the neuropsychological assessments also revealed larger, but non significant, increase in full-scale IQ in the music group than in the painting group. By contrast, Schellenberg (2004) found small but significant general IQ increase in 6 year-old children after one year of musical training. Thus, both the age of the children and the duration of training can account for the differences between the two studies. In line with previous findings in adults (Chan et al., 1998) and in children (Ho et al, 2003; Fujiooka et al., 2006), our results showed improved verbal memory after musical but not painting training. Moreover, we also found that musical training improved reading abilities, a result in line with previous ones by Foxton et al. (2003) showing correlations between discrimination of global pitch contour of sound sequences and reading abilities in non musician adults. This result is also in line with results of a large scale-study showing that music perception ability is predictive of reading skills (Anvari et al., 2002) and with results showing impaired pitch processing in dyslexic children as shown by Overy et al. (2003) and by Santos et al. (2007), as described below.

6. Pitch processing in dyslexic children

Still using the same French linguistic materials as described above, we tested 10 dyslexic children and 10 control normal readers (Santos et al., 2007) in a longitudinal study. The reading level of dyslexic children was 18 months below chronological age and they were diagnosed as phonological dyslexics. All children were first tested in the speech pitch discrimination task. Surprisingly, results showed that the error rate to the strong incongruity was significantly higher for the dyslexic children (45%) than for the control children (4%). Dyslexic children were then trained for 8 weeks using a combination of phonological training (known to be of direct benefit for these children; daily 10 minutes phonological exercises) and audio-visual training (using the *Play-On* software developed by Magnan et al., 2004; 20 minutes twice a week). Control children were involved in painting training for 8 weeks (twice a week for 50 minutes). Finally, all children were tested again using the same speech pitch discrimination task. No significant differences were found between the two groups of children. Therefore, the combination of phonological and audio-visual training clearly improved the detection of strong pitch incongruities in speech in dyslexics. Interestingly, this behavioural improvement was reflected in the pattern of brain waves. While strong incongruities elicited large positive components (P600) in control children before training, no such component was found in dyslexics (see Fig. 7). After training, however, not significantly different P600s were elicited by strong incongruities in both groups.

Several authors have argued that early abilities to perceive speech flay the foundation for reading skills (Hetland, 2000). In line with this hypothesis, previous results have shown that children with reading impairments encounter difficulties in performing basic auditory analysis such as rapid spectro-temporal processing (Fujioka, Ross, Kakigi, Pantev & Trainor, 2006; Foxton et al., 2003). Here, we have demonstrated that dyslexic children also have difficulties in pitch processing, an important aspect of speech. Thus, both deficits in spectro-temporal and pitch processing may have consequences for the development of reading skills. Phonological processing was proven to be a powerful remediation method. In future experiments, we will test directly the hypothesis that musical training has beneficial effects on reading skills by improving auditory skills, and may consequently have particular importance in the remediation of dyslexia (Ho, Cheung & Chan, 2003; Jäncke, Shah & Peters, 2000; Fujioka, Ross, Kakigi & Pantev Trainor, 2006; Foxton et al., 2003; Foxton & Brown, 2004; Kilgour, Jackobson & Cuddy, 2000).

7. Conclusion

By increasing our understanding of how brain networks are shaped by experience, the present results

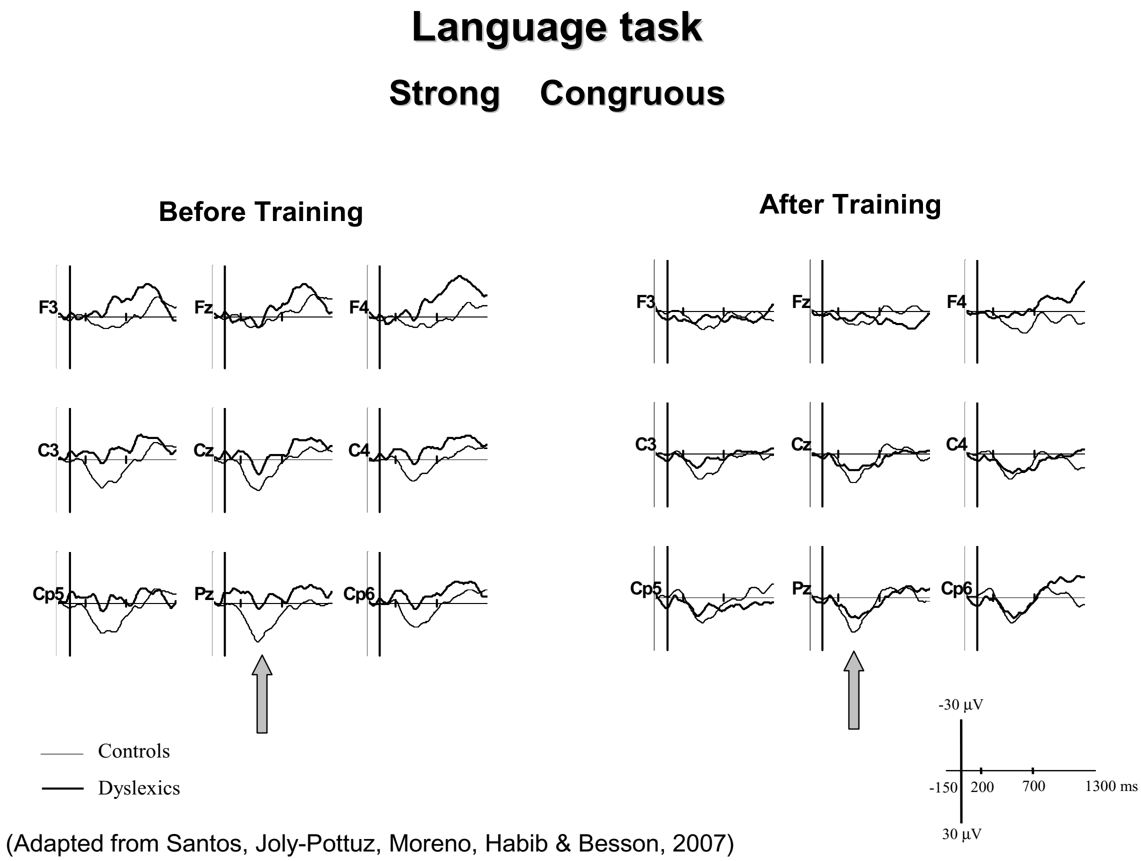

Fig. 7. Difference waves (Strong incongruity – Congruous) in the language task before and after phonological and audio-visual training. Recordings for dyslexics (thick line) and controls (dotted line) are overlapped for representative central and lateral electrodes.

should benefit research-based education programs and should help develop new methods to improve the abilities of children with abnormal development (Posner & Rothbart, 2006; Tallal & Gaab, 2006; Goswami, 2006). They also open new research perspectives. Further comparing pitch processing in music and speech using different stimuli and brain imaging methods to better understand why weak incongruities did elicit N300 components in music and early positivity in speech (differences in the acoustical properties of linguistic and musical sounds, overlap between different components, task difficulty?), determining whether the effects reported here are long-lasting, testing for the influence of musical training on other aspects of speech perception, such as rhythm or timbre, and determining whether the influence of music generalizes to other domains such as second language learning (Tallal & Gaab, 2006) or mathematics, are exciting research topics for the years to come.

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