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ORIGINAL PAPER

The level of primitive reflex integration in children who play a musical instrument

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ABSTRACT

Introduction: Primitive reflex integration (PRI) is a natural process, which indicates maturity progress in the central nervous system (CNS) in toddlers. Somehow, we observe that some children even in school-age have persistent primitive reflexes.
Aim of the study: To establish if there is a difference in the PRI in musically vs. generally educated children.
Material and methods: The data were collected from 45 healthy children aged six to seven years. A group of child musicians (22 students) was examined and compared to a group of non-musicians (23 students). Each child in the examined groups was assessed individually by primitive reflex tests. Asymmetrical tonic neck reflex (ATNR), symmetrical tonic neck reflex (STNR), and tonic labyrinthine reflex (TLR) were evaluated.
Results: Based on the results of the studied children, children musically educated had a significantly better level of PRI than the control group ($p < 0.03$). There was no one with grade 3 and 4 disintegration in the group of child musicians, and nearly 20% of them showed full PRI, as opposed to non-musicians among whom there was no one with full PRI. The most frequently occurring reflex was the ATNR L (83% of non-musician children and 55% of musician children), and the least frequently performed was TLR FLX – 8% of non-musician children.
Conclusions: Musical training can be a stimulus influencing PRI. Musical training may influence the maturation of the CNS measured by PRI. Musical training may be part of the reflex integration therapy in children.

KEY WORDS:

children, music, primitive reflexes.

INTRODUCTION

Primitive reflex integration (PRI) is a natural process, which shows maturity progress in the central nervous system (CNS) of toddlers. It has been observed that some children, even those of school age, have primitive reflexes that persist. The primitive reflexes, if persistent, can influence a child's development. Primitive reflexes coexist with poor psychomotor levels and trunk rotation in healthy children [1–3], and additionally, as some authors have indicated, these reflexes can be observed in a trace form even in adults [4, 5]. The persistence of primitive reflexes can be the reason for emotional and behavioural immaturity as well as learning disorders [6]. Therefore, influencing the modulation of the primitive reflexes' level can be the aim of various professional practitioners as well as the parents themselves. It is very important to begin with a very basic multidisciplinary treatment of a child's problems, which seems to be the proper way to integrate primitive reflexes.

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In this research we studied three of them: asymmetrical tonic neck reflex (ATNR), symmetrical tonic neck reflex (STNR), and tonic labyrinthine reflex (TLR).

We analysed the difference in PRI between children who play a musical instrument and children who do not play a musical instrument. The impact of music on the acoustic changes and speech processing in the child is a common and well-researched field. However, we could not find any studies related to music and PRI. Therefore, we decided to undertake this study.

The aim of the study was to establish the level of PRI in musically trained children in comparison with their non-musically trained peers.

MATERIAL AND METHODS

PARTICIPANTS

The study was approved by the Medical University Ethical Committee. All the parents of the subjects were kept informed of the purpose and process of examination and subsequently gave their written consent prior to the study.

The data were collected from 45 healthy children between the ages of six and seven years from a school in Wroclaw, Poland. The condition for exclusion was a statement of special educational needs.

The group of musically trained children (22 students) were examined and compared to the group of non-musically trained children (23 students). The groups were not statistically different ($p < 0.05$) in terms of age, sex, weight, height, and BMI, as shown in Table 1. Also, there was no correlation found between age, sex, BMI, and PR integration level (respectively, 0.062, –0.127, –0.009).

One group consisted of children who had played a musical instrument for a year in a professional capacity, and the other group was made up of children from a general class, i.e. with no additional musical training. The music pupils had been playing instruments and taking music lessons such as: instrumental lessons twice a week for an hour, vocal lessons once a week for two hours, and musical theory. All the instruments that the music participants were playing are shown in Table 2.

The most frequent instrument was the piano, which was practiced by 27% of the examined children, the subsequent two most popular instruments were the guitar and violin (18% each). The piano and violin were being studied simultaneously by 5% of the group.

Every child from the examined groups was assessed individually by primitive reflex tests (ATNR, STNR, and TLR) [4, 7].

TABLE 1. Subjects characteristics

Characteristic	Musicians	Non-musicians	*p*-value
Girls, *n*	12	10	
Boys, *n*	10	13	
Mean age, SD	7.6 ±0.4	7.5 ±0.5	0.49
Mean height, SD (m)	1.27 ±0.04	1.28 ±0.07	0.33
Mean weight, SD (kg)	25.8 ±3.25	27.8 ±5.15	0.15
Mean BMI, SD	16 ±1.5	17 ±1.9	0.23

TABLE 2. Instruments played by musically trained children

Children	Flute	Piano	Trombone	Piano and violin	Violin	Saxophone	Guitar	Accordion	Drums
n	3	6	1	1	4	1	4	1	1
Percent	14	27	5	5	18	5	18	5	5

MEASUREMENT OF PRIMITIVE REFLEXES

In the primitive reflex examination we followed the methods described by Gieysztor *et al.* [8]. The classification was made according to a five-point rating scale suggested by Goddard-Blythe [4, 7, 9]:

- 0 – no reflex occurs,
- 1 – reflex present in 25%,
- 2 – reflex present in 50%,
- 3 – reflex present in 75%,
- 4 – reflex survived 100%.

All the points from the reflex tests ATNR left (L) and ATNR right (R), STNR FLX and STNR EXT, TLR FLX and TLR EXT were summed up, and the results showed the level of reflex integration from 0 to 4. The better the integration, the lower the score the child could have achieved.

STATISTICAL ANALYSIS

The statistical analysis was carried out using Statistica version 12. Descriptive statistics were computed for all variables. Results are presented as mean and standard deviation (±SD) or percentages. The normality of distribution was assessed using the Shapiro-Wilk test. The occurrence of primitive reflexes due to gender and musically trained or non-musically trained status were performed using the $\chi 2$ test with the Yates correction. Spearman's correlation was applied for dependency between variables. All parameters were considered to be significantly different statistically if $p < 0.05$.

RESULTS

The children who took music lessons had a significantly better level of PRI than the non-musically trained

children ($p < 0.03$). Table 3 represents the percentage of PRI level.

In the group of the musicians there were none with grade 3 or 4 disintegration, and nearly 20% of them showed full PRI. About 80% of the musically trained children showed a trace of retained primitive reflexes.

In the non-musically trained group, there were no pupils with level 0, which means that there must have been at least one of the six disintegrated reflexes in each child. The study shows that the degree of retained primitive reflexes in musicians is between "none" and "medium", which indicates a trace level of the occurrence. Conversely, 4% of children from the non-musically trained group demonstrated a high level of unintegrated primitive reflexes (3 points). Both groups showed the tendency of maturity of the nervous system. Furthermore, the musically trained group showed full integration at 18%, as opposed to the non-musically trained group. There were no children in the non-musically trained group whose reflexes were totally integrated. The comparison is shown in Table 3.

Moreover, we analysed the primitive reflexes one by one. This analysis is indicated in Table 4.

The most frequently occurring reflex was the ATNR L (83% of the non-musically trained children and 55% of the musically trained children), and the least frequently occurring was TLR FLX – 8% of the non-musically trained children. We observed that TLR FLX was the best integrated reflex. It was not only fully integrated in 100% of the musically trained children, but also in 91% of the non-musically trained children. Reflexes such as: STNR FLX and EXT, TLR FLX and EXT, and ATNR R did not demonstrate maximum intensity in any of the children. The percentage results are shown in the figures. We found that ATNR L performed at the top of the scale (4 points), appearing in 4% of the non-musically trained children and 9% in the musically trained children. Successively, the largest amount on a three-point scale was the reflex ATNR R (17%), STNR EXT (13%), and TLR EXT in 4% of children. STNR FLX and TLR FLX were the mildest, in 61–91% of the examined groups (Fig. 1).

TABLE 3. Percentage of children represents level of primitive reflexes integration (0 – fully integrated, 4 – totally disintegrated)

Level	Musicians	Non-musicians
0	18	0
1	73	83
2	9	13
3	0	4
4	0	0

Analysis of the persistence of PRI in the musically trained group shows that the best integrated reflex in this group was TLR FLX and EXT. TLR FLX was fully integrated in 100% of the group, and TLR EXT was fully integrated in 77% and mildly disintegrated (1 point) in 23% of the musically trained group. ATNR L was the most disintegrated amongst the examined reflexes. There were 9% of children who achieved as high as 4 points during the examination. The "All results" column in Figure 2 reflects this. Figure 3 shows the level of primitive reflex persistence in the groups of musicians and non-musicians, $p < 0.03$.

DISCUSSION

Our findings indicate that the PRI can be influenced by musical training – not only music perception and productivity in music technique, but also very complex processing mechanisms, such as the integration of primitive reflexes. In our research, each of the non-musicians

TABLE 4. Each examined reflex in percentage of occurring in musician and non-musician children

Level	Musicians	Non-musicians	Musicians	Non-musicians	Musicians	Non-musicians
	ATNR L		STNR FLX		TLR FLX	
0	45	17	73	91	100	91
1	36	43	14	0	0	4
2	5	17	9	9	0	4
3	5	17	5	0	0	0
4	9	4	0	0	0	0
	ATNR R		STNR EXT		TLR EXT	
0	45	30	45	35	77	61
1	36	39	36	39	23	35
2	9	13	18	13	0	0
3	9	17	0	13	0	4
4	0	0	0	0	0	0

ATNR – asymmetrical tonic neck reflex, L – left, R – right, STNR – symmetrical tonic neck reflex, FLX – flexion, EXT – extension, TLR – tonic labyrinthine reflex

demonstrated at least one primitive reflex, and 8% of them at level 3. Compared to the musicians, 82% retained at least one primitive reflex in its mild intensity, and none of them achieved level 3 and 4. The above leads us to the conclusion that musical training may have an impact on neurological development. It is noteworthy that TLR FLX was fully integrated in the musically trained group. We might justify this result by the fact that the children have to sit in a still position for a long time while playing an instrument and concentrating on reading notes, which we observed during musical training. This complex task can stimulate CNS for more specific brain function and has an impact on TLR. Musically trained children have to co-ordinate their hands, legs, and reading skills while playing an instrument. This process highly engages the brain, thus influencing CNS maturity.

We know that persistent primitive reflexes can influence a child's cognitivism and motoric function as well as psychomotor development, as found in the Goddard-Blythe and Hyland [7], Goddard-Blythe [9], Madejewska *et. al* [3] and Gieysztor *et al.* [8] studies. Reflex integration training is the tool used in improving children's abilities in the developmental process. As a result of this study, we found that the next tool for increasing the degree of PRI might be music training. In the case of a lack of CNS integration, the joint efforts of movement rehabilitation proposed by Goddard-Blythe and music training may reinforce the treatment.

As many authors have proven, changes in the brain and synaptic plasticity under the influence of music training is obvious [10–18]. However, we can also prove their existence by clinical signs of the differentiation in neural maturity. The clinical tests are easy to use and might be applied whenever needed. Therefore, they could be used in a periodic examination to verify children's neurodevelopment. To reinforce the significance of our results, it seems reasonable to conduct a longitudinal study in this field.

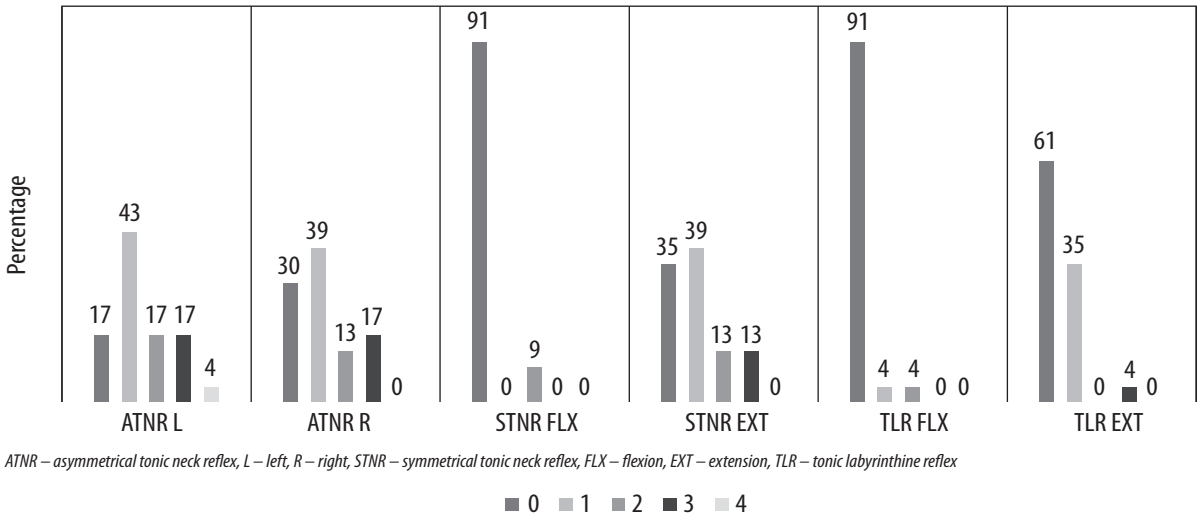

FIGURE 1. Persistent primitive reflexes on a 5-point scale (0 – fully integrated, 4 – totally disintegrated) in non-musically trained children

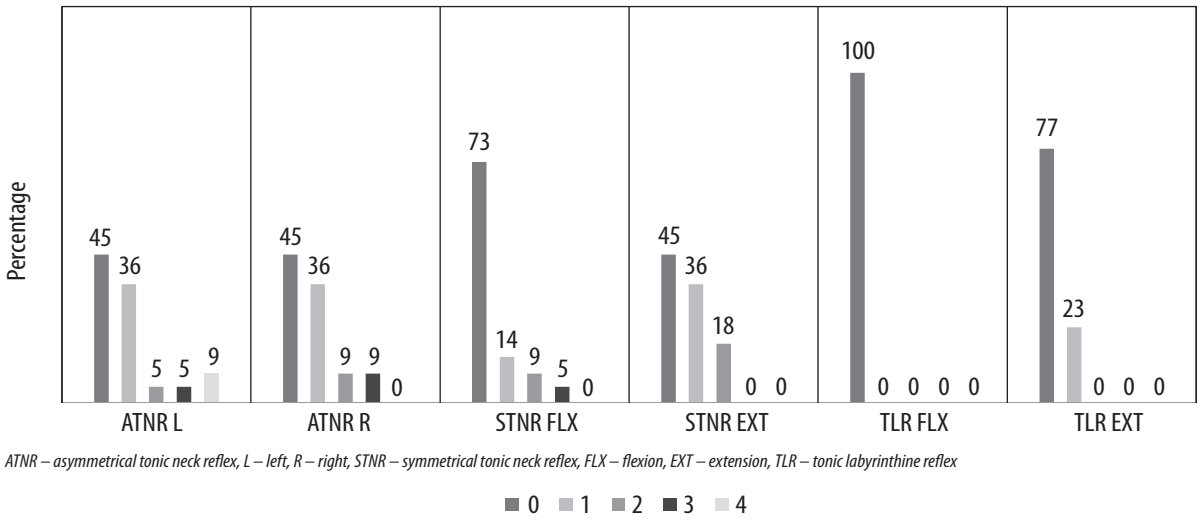

FIGURE 2. Persistent primitive reflexes on a 5-point scale (0 – fully integrated, 4 – totally disintegrated) in musically trained children

The improvement in other areas of life impacted by music have been studied by other authors. Yang *et al.* [19] studied the cognitive benefits of music training. They found better language achievement in musically trained pupils by conducting a language learning skills test, but they found no influence on intellectual benefits. Elmer *et al.* [20] found an impact of music training on speech processing. Rauscher *et al.* in their longitudinal research also indexed improvement in spatial-temporal reasoning as a result of music training [21]. Other authors found improvement in many other fields [22, 23]. As Carmichael described, musicians have an ability called cross-model perception, which is seen in the integration of visual, auditory, physical, and movement senses in instrument players [24]. The high engagement of the musician's senses, which reorganise the brain's paths and have an impact on areas such as listening, brain development, perception, and the ability to move the limbs separately, have been demonstrated in many papers [11–13, 25, 26].

Also, Habibi *et al.* [27] conducted cognitive, social, and neural tests based on children attending music or sport classes. However, surprisingly, they found that music had no impact on their abilities.

Many developmental treatments can have an impact on children's development. One of them is music. If any disturbances or disintegration is observed, both the parents and therapists might involve music in everyday life for better neuro-stimulation. This training is not only effective for children at high disorder risk but can also be helpful for maximum stimulation of CNS maturity in any child.

The weakness of the study we indicate as being the low number of participants; a wider group should be examined in the future. We can also point out that future research should contain an experimental part, and the first examination should be repeated as a follow-up after half a year or a year of music training and then compared with the control group (to be examined in the same cycle).

CONCLUSIONS

Based on the above findings, we can conclude that performing music by children can enhance their PRI. Moreover, music lessons may be implemented as a tool in reflex inhibition therapy for better therapeutic effects.

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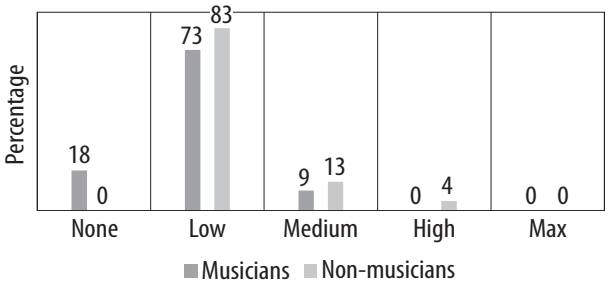

FIGURE 3. The level of primitive reflex persistence in the groups of musicians and non-musicians, $p < 0.03$

DISCLOSURE

The authors declare no conflict of interest.

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