# Music can reduce cognitive dissonance

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Abstract

The fundamental cognitive functions of music in the brain have not been known and evolutionary reasons for musical abilities seem mysterious. A recent hypothesis[1)] suggested that a fundamental function of music has been to help mitigating cognitive dissonances. A cognitive dissonance is “a discomfort caused by holding conflicting cognitions” simultaneously[2,3)]; it usually leads to devaluation of conflicting knowledge. Since every concept implies some degree of contradictions to other knowledge, unmitigated cognitive dissonances could prevent evolution of cognition. Thus music might be fundamental for the evolution of cognition. Here we provide experimental confirmation of this hypothesis using a classical paradigm known to induce a cognitive dissonance and devaluation of a dissonant object; in presence of music devaluation has not occurred.

Debates on the origin and function of music have a long history. Aristotle[4] listed the power of music among the unsolved problems. Kant[5], who so brilliantly explained the epistemology of the beautiful and the sublime, could not explain music. According to Darwin[6], the human musical faculty “must be ranked amongst the most mysterious with which (man) is endowed” because music is a human cultural universal that appears to serve no obvious adaptive purpose. While some scientists argue that music itself plays no adaptive role in human evolution, others suggest that music clearly has an evolutionary role, and point to music’s universality[7]. In 2008, Nature[8] published a series of essays on music. The authors agreed that music is a cross-cultural universal, still “none... has yet been able to answer the fundamental question: why does music have such power over us?” “We might start by accepting that it is fruitless to try to define ‘music” [9].

Recently, we have presented a hypothesis about the fundamental cognitive function of music[1]. It suggested that the evolution of language led to relatively fast cultural evolution of multiple mutually contradictory concepts (any different concept must be contradictory to some extent; otherwise one concept would be sufficient). This created cognitive dissonance and consequently led to devaluing knowledge[10]. If cognitive dissonance could not be mitigated, our progenitors would devalue knowledge, and human language, knowledge, and culture would not evolve. It was hypothesized that the fundamental function of music in cognition was to serve precisely this function. The purpose of the study reported here was to experimentally explore this possibility.

A cognitive dissonance is a discomfort caused by holding conflicting cognitions[2]. Ancient Greeks new that people tend to resolve the dissonances by devaluing a conflicting cognition. In the Aesop’s fable The Fox and the Grapes a fox sees high-hanging grapes. A desire to eat grapes and inability to reach them are in conflict. The fox overcomes this cognitive dissonance by deciding that the grapes are sour and not worth eating. Since the 1950s cognitive dissonances became a wide and well studied area of psychology. It is known that tolerating cognitive dissonances is difficult, and people often make irrational decisions to avoid them[11]. In 2002 this research was awarded Nobel Prize in economics, emphasizing the importance of this field of research. Our findings that music can reduce cognitive dissonances are tentatively supported by known brain mechanisms. Previous research demonstrated involvement of the anterior cingulate gyrus in creating cognitive dissonances[12]. At the same time, it is known that listening music decreases activity of the ventral medial prefrontal cortex as well as the limbic system, making listening more pleasurable, so that activation of the anterior cingulate gyrus is decreased[13)].

In the present study, cognitive dissonance was experimentally created in 4-year-old children using a well-established method (the induced-compliance paradigm). The general procedure adopted in the present experiment was essentially identical with that of the previous research[14)]. With each child an experimenter first played an “evaluation game” to elicit a toy ranking. In the next session, while a child was playing with toys, an experimenter said “I have to leave now for a few minutes to do an errand. But why don’t you stay here and play with these toys while I am gone? I will be right back. You can play with this one [pointing], this one, and this one. But I don’t want you to play with [mentioning the name of the second-ranked toy].” According to the previous research this was expected to create a cognitive dissonance, and eventually result in devaluing the second-ranked toy. Exactly this result was observed, when the experimenter returned and played “ranking game” again: the toy previously ranked as the second was devalued to near bottom rank.

An experiment with another group of children was only different in one respect. The participants were exposed to music (one of Mozart’s sonatas) while playing alone. If music indeed helped mitigating cognitive dissonance as previously hypothesized in[1)], we would expect that devaluing of the second-ranked toy would be not as strong as without music, or possibly no devaluation would occur at all. This is exactly what was observed. The group of children exposed to music did not devalue the “forbidden” toy. We concluded that indeed music helped mitigating the cognitive dissonance and no devaluation was needed.

Other aspects of the experiment were designed to confirm that our results are consistent with those previously reported by other researchers and are typical for cognitive dissonance and the following devaluation (without music). They are reported in the following sections. They are not essential for the main reported result that music helps mitigating cognitive dissonances.

The results of changes of the participant’s ranking of the attractiveness of a “forbidden” toy are summarized in Table 1. With exposure to music, 15 of the 25 participants increased their rating of the toy, 7 did not alter their rating, and 3 decreased it. Whereas without exposure to music 5 participants increased their rating, 14 did not alter and 6 decreased it. The difference between the two conditions was statistically significant ($\chi^2(1) = 6.00$, P = 0.049).

In addition, a third group of 25 participants experienced strongly worded suggestion not to play with the toy ("I don't want you to play with [mentioning the name of the second-ranked toy]. If you played with it, I would be very disappointed. I would have to take all of my toys and go home and never come back again. You can play with all the others while I am gone, but if you played with [mentioning the name of the second-ranked toy], I would think you were just a baby."). This third experimental condition, according to the previous research, expected to produce no cognitive dissonance, and correspondingly it was conducted without exposure to music; no devaluation is expected. In this case 16 participants increased their rating, only one participant decreased it, and 8 did not alter it. This was significantly different from the change of ranking (devaluation due to cognitive dissonance) reported previously for participants who experienced a mild suggestion without exposure to music ($\chi^2(1) = 9.33$, P = 0.009). But it was not significantly different from the change of ranking recorded for participants reported previously with exposure to music ($\chi^2(1) = 1.03$, P = 0.597). These results confirmed expectations based on the previous research[1)] that strongly worded suggestion produces no cognitive dissonance and no devaluation.

Subsequently, all the participants were tested to evaluate the changes in attractiveness of a toy when it was simply withdrawn. Again, the purpose was to confirm agreement with the previous research that this produces no cognitive dissonance and no devaluation. The results of the testing are summarized in Table 2. They confirmed the expectations. Among the 25 children who had previously experienced a mild suggestion with exposure to music, 16 increased their rating of the toy, 3 decreased it, and the remaining 6 did not alter it. Similarly, 16 increased their rating, 4 decreased it, and 5 did not alter it in the group that had previously experienced the mild suggestion without exposure to music. The difference was not statistically significant ($\chi^2(1) = 0.09$, P = 0.956). Among the 25 participants who had previously experienced a strongly worded suggestion without exposure to music, 15 increased their rating of the toy, 2 decreased it, and the remaining 8 did not alter it. This change was not significantly different from that of the participants who had experienced the mild suggestion with exposure to music ($\chi^2(1) = 0.72$, P = 0.696) or without exposure to music ($\chi^2(1) = 0.32$, P = 0.853). To summarize, all these additional experiments undertaken for comparison with expectations based on the past research went as expected.

The data presented in Table 2 reveal that the attractiveness of a toy for the children tended to be enhanced if it was merely withdrawn temporarily from them. This tendency was observed in all three of the groups to which the present participants were randomly assigned, and is consistent with previously reported findings[14)]. When forbidden to play with the toy with no exposure to music, moreover, the 25 children in the group that had experienced a mild suggestion were more likely to devalue that toy than the 25 children of the group that had experienced a strong suggestion. These findings are in accordance with the following notion proposed by the classical theory of cognitive dissonance: when a child experienced a strong prohibition, his cognition that he did not play with an attractive toy was consonant with his cognition that he was strongly prohibited to play with the toy. On the other hand, when a child refrained from playing with a toy in the absence of a strong prohibition he experienced a cognitive dissonance. His cognition that he did not play with the toy can be interpreted to be dissonant with his cognition that it was attractive. To reduce this dissonance, he devalued the toy. These results, on the basis of the methodology that reproduced cognitive dissonance effects observed in the previous research, indicate that a child experienced a cognitive dissonance.

Under the same circumstances, however, the 25 children in the group who were exposed to Mozart’s sonata were less likely to devalue the toy. As an alternative explanation for that, one may hypothesize that Mozart’s sonata had made the children more relaxed and thus care less, therefore, not seeing any conflict and no need for updating the toy’s value. However, it should be noted that psychophysiological effects of this sonata upon its listeners have been extensively investigated as “the Mozart effect”; it enhances cognitive performance of the listeners and increases the listeners’ brain activation[15)]. Ten-minute listening of the sonata is found to enhance the performance of spatial reasoning skills in both adults and young children. Electroencephalographic measurements in young children during exposure to the music revealed enhanced synchrony of the firing pattern of the right frontal and the left temporoparietal regions as well as increased power of beta spectrum in extremely extensive brain regions. Such accumulating evidence leads to a hypothesis that the children exposed to music might have been more aroused than usual, rather than been calmed down. The activity of the limbic system could have been calmed down, which nevertheless could predispose the children to pleasure as noted before[13]. Rather, the present findings should be explained to indicate that the sonata exerted strongly positive influences upon the performances of the children not only at relatively lower levels of their cognition (such as spatial reasoning), but also at their much higher levels, so that it could be served as a basis on which the children are enabled to reconcile the cognitive dissonance, as hypothesized by the theory of the cognitive function of music[1].

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## Author contributions

NM and LP conceived of the study, and participated in its design and coordination and drafted the manuscript. NM conducted the experiments and participated in the data analysis and interpretation. All authors read and approved the final manuscript.

Additional Information

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Table 1

Change in attractiveness of the second-ranked toy when it was forbidden to play with it

| Experimental condition | Rating | | |
|---|---|---|---|
| | Increase | Same | Decrease |
| Mild suggestion with music | 15 | 7 | 3 |
| Mild suggestion without music | 5 | 14 | 6 |
| Severe suggestion without music | 16 | 8 | 1 |

Table 2

Change in attractiveness of the second-ranked toy when it was merely withdrawn

| Previous experience | Rating | | |
|---|---|---|---|
| | Increase | Same | Decrease |
| Mild suggestion with music | 16 | 6 | 3 |
| Mild suggestion without music | 16 | 5 | 4 |
| Severe suggestion without music | 14 | 7 | 4 |

FIGURE CAPTION