Congenital amusia and executive functioning

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Introduction

Congenital amusia is a life-long musical disorder that cannot be explained by mental retardation, deafness or lack of exposure (Peretz, 2013). Amusic individuals tend to listen and enjoy musical activities less than the normal population does. As a consequence, amusics may show impairments in general cognitive functioning. Indeed, there is increasing evidence that musical experience enhances executive functions in general (e.g., Moreno et al., 2011; Zuk et al., 2014), not just musical abilities. Executive functions are cognitive capacities that allow for planned, controlled behavior.

The aim of this study is to examine whether the limited and abnormal musical experience of amusic adults leads to reduced executive functioning.

To this end, three groups of participants were tested: amusic adults, non-amusic individuals with little musical experience and choir participants. All of them were tested with the Simon arrows task (as used in Bialystok & DePape, 2009). Amusics were also tested with the Stroop task (Color-Word interference test, from the D-KEFS battery, Delis et al., 2001).

Method

Participants

13 amusic, 13 non-amusic, and 13 choir participants matched in age, education, as well as second language fluency were tested (see Table 1).

Table 1. Characteristics of groups.

	Amusics	Non-amusics	Choir participants
Gender	8F 5M	10F 3M	9F 4M
Age	66.3 (3)	64.3 (4.8)	65.9 (4.3)
Years of education, years	17.2 (2.6)	15.6 (2.8)	16.9 (3.1)
Years of musical training	2.1 (1.6)	2.8 (2.6)	30.9 (12.3)
Second language fluency[1]	2.4 (1.1)	2.5 (1)	2.8 (0.9)
MBEA scale, %	61 (11)	94.4 (5.2)	93.2 (4.7)

Note: [1]Second language fluency measured with a 5 point-scale (0=not at all; 4=very good); SD in parenthesis.

Simon arrows task

This task included four conditions (Direction control, Position control, Opposite, and Simon, see Figure 1) presented in a ABBA order.

Each trial starts with a fixation cross in the center of the screen for 250 ms followed by an arrow for 550 ms.

Participants were asked to respond as quickly and accurately as possible by pressing the appropriate left or right response key (see Figure 1), according to the instructions given with each condition.

Stroop task

The color naming and inhibition (naming the ink color) conditions of the Color-Word interference test (see Figure 2 for examples) were administered to 8 amusics, that were also tested with the Simon arrow task.

Figure 1. Control and experimental conditions.

Condition	Instruction, example and response key
Direction control	Where is the arrow pointing?
Position control	Where is the arrow?
Opposite	Which is the direction opposite to the arrow?
Simon (congruent)	Where is the arrow pointing?
Simon (incongruent)	Where the arrow is pointing?

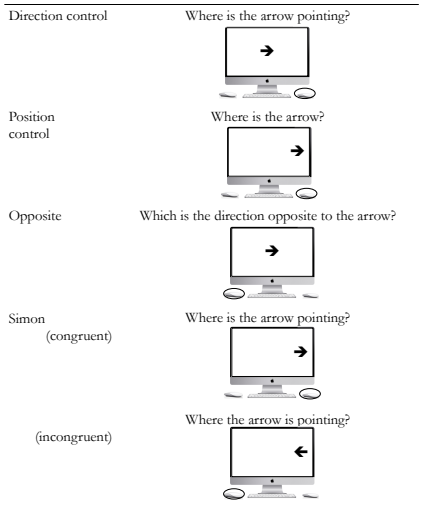
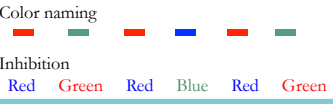


Figure 2. Color-Word interference conditions.



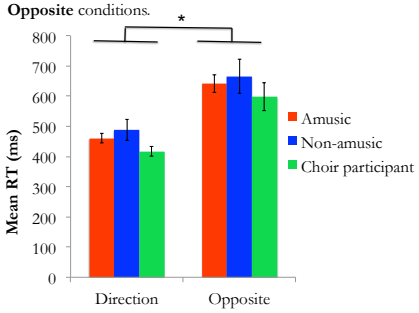
Results

Simon arrow task

Mean accuracy in the Simon arrow task ranged from 91 to 100%, and was equivalent across groups. RTs that were 3 SDs above the mean were excluded.

As expected, there was no effect of group or interaction (*ps* > .05). The effect of condition is significant (**p* < .05).

Figure 3. Mean RT and SE for the **Direction control** and **Opposite** conditions.



Both the effect of group and the interaction are not significant (*ps* > .05), and the effect of condition is significant (*p* < .05). Comparisons across conditions are significant (**p* < .05).

Figure 4. Mean RT and SE for the **Position control** condition, and **Simon** condition (presented separately for congruent and incongruent trials).

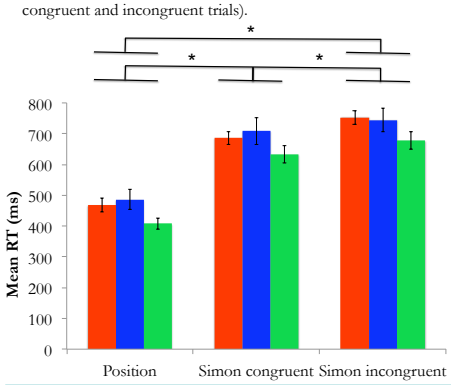
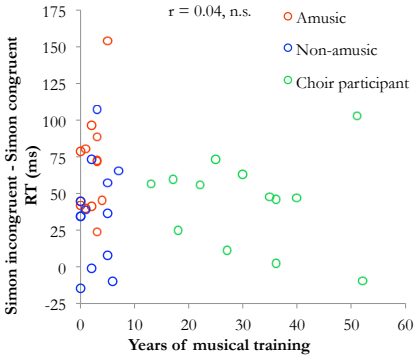


Figure 5. Individual differences in RTs between incongruent and congruent trials of the Simon condition as a function of years of musical training.



Stroop Task

Raw scores were converted to age-normed standardized scores and the inhibition condition were contrasted with the control condition. The mean score is 10 with a standard deviation of 3. Higher scores reflect better cognitive performance. As you can see in Table 2, all amusic individuals perform in the normal range on the Stroop task.

Table 2. Means and range of standardized scores on Color-Word interference test.

	Amusics
Color naming	11.4 (8-14)
Inhibition	12.1 (10-15)
Stroop effect	10.75 (7-16)

Conclusions

All participants were slower on the conflicting conditions (i.e., Opposite and Simon incongruent) than on the control conditions (i.e., Direction and Position). Results indicate that both the inhibition response and Simon effect were similar across groups. Moreover, there is no correlation between the conflicting conditions and musical training. Amusics also perform in the normal range on the Stroop task.

These new findings rule out a general executive impairment as a source of musical difficulties in congenital amusia.

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