

# Congenital Amusia Interferes with the Ability to Synchronize with Music

SIMONE DALLA BELLA<sup>a,b</sup> AND ISABELLE PERETZ<sup>a</sup>

<sup>a</sup>*Department of Psychology, University of Montreal, Montreal, Quebec, Canada*

<sup>b</sup>*Department of Psychology, Ohio State University, Columbus, Ohio 43210, USA*

**ABSTRACT:** Eight adults with a music-specific learning disability (i.e., tone deafness, but we prefer the term “congenital amusia”) were asked to tap along with music (e.g., Ravel’s *Bolero*) and with nonmusical isochronous sequences (i.e., noise bursts). The amusic persons’ tapping performance was poorly synchronized with music compared to that of nine matched control participants. By contrast, synchronization with the noise bursts was normal, suggesting that amusic persons’ timing difficulty is limited to music.

**KEYWORDS:** congenital amusia; synchronization

## INTRODUCTION

The ability to synchronize with music (e.g., tapping the foot along with music) is a basic skill that is shared by musicians and nonmusicians.<sup>1–3</sup> This ability develops spontaneously and precociously.<sup>4</sup> Yet, a few individuals may never acquire this ability. They suffer from congenital amusia, a learning disability that is specific to the musical domain.<sup>5,6</sup> This disorder has been diagnosed in adults who show above average intellectual, memory, and language abilities. As shown in a previous study,<sup>6</sup> these amusic individuals exhibit a deficit when performing basic musical tasks, such as discriminating music on the basis of pitch information and recognizing well-known tunes. The underlying cause for the disorder is ascribed to a defect in fine-grained pitch perception.<sup>5,6</sup> The objective of the present study is to examine whether persons with congenital amusia are also impaired in timing tasks, as suggested by Ayotte and collaborators.<sup>6</sup>

## METHOD

Eight persons with congenital amusia (age range 51–62 years) who participated in a previous study<sup>6</sup> and a group of nine matched control participants (age range 50–67 years) performed two tapping tasks. Participants were asked to tap with their dominant hand in two different conditions: (1) in time along with a musical piece

Address for correspondence: Simone Dalla Bella, Department of Psychology, Ohio State University, 1885 Neil Ave., Columbus, OH 43210, USA. Fax: 614-292-5601.  
dalla-bella.2@osu.edu

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**TABLE 1. Performance obtained by amusic subjects and matched controls in the music condition**

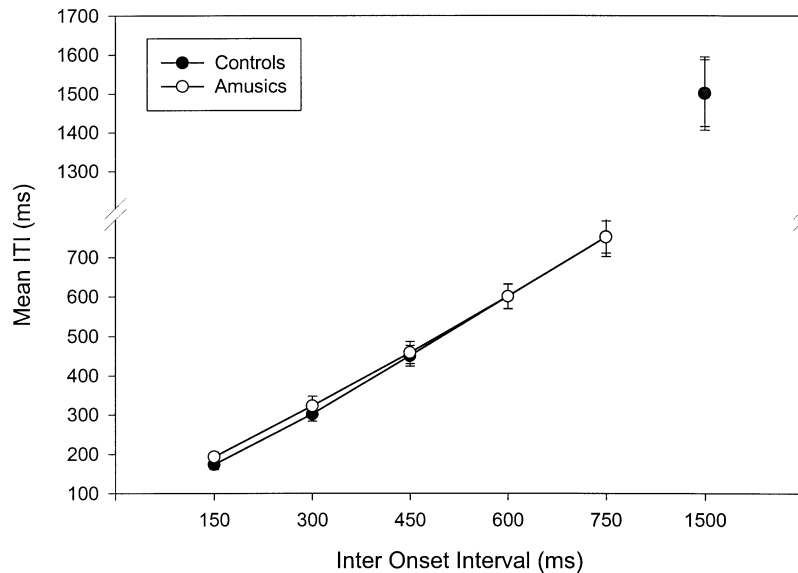
Tasks	A2	A3	A4	A7	A8	A9	A10	A11	Controls (SD)
<i>Ravel's Bolero</i>									
Taps ( <i>n</i> )	85	81	170	102	90	76	125	78	101(39)
Mean ITI (ms)	903	838	395	574	855	882	467	882	749 (235)
Standard deviation of ITI (ms)	75	176 <sup>c</sup>	59	60	41	26	63	36	46 (34)
Successful synchronizations ( <i>n</i> ) <sup>a</sup>	27	15	5 <sup>b</sup>	0 <sup>b</sup>	10 <sup>b</sup>	0 <sup>b</sup>	3 <sup>b</sup>	73	74 (31)
<i>La Bottine Souriante</i>									
Taps ( <i>n</i> )	100	106	171	90	95	101	97	101	113 (35)
Mean ITI (ms)	494	464	291	544	527	493	508	494	463 (88)
Standard deviation of ITI (ms)	25	39	33	41	32	22	40	21	29 (14)
Successful synchronizations ( <i>n</i> )	83	4 <sup>c</sup>	7 <sup>c</sup>	9 <sup>c</sup>	34 <sup>b</sup>	90	40 <sup>b</sup>	95	94 (27)
<i>Stayin' Alive</i>									
Taps ( <i>n</i> )	110	111	152	106	98	112	108	113	124 (37)
Mean ITI (ms)	578	575	423	592	658	580	578	580	546 (97)
Standard deviation of ITI (ms)	26	39	66 <sup>c</sup>	48 <sup>b</sup>	44 <sup>b</sup>	25	64 <sup>c</sup>	29	26 (8)
Successful synchronizations ( <i>n</i> )	100	27 <sup>b</sup>	0 <sup>c</sup>	26 <sup>b</sup>	12 <sup>b</sup>	93	32 <sup>b</sup>	102	111 (34)

<sup>a</sup>Number of successful synchronizations: number of taps occurring  $\pm 10\%$  of the inter-beat interval around the expected beat

<sup>b</sup> > 2 SDs from the mean of the control group.

<sup>c</sup> > 3 SDs.

(music condition); and (2) in time with isochronous sequences of noise bursts (isochronous condition). In the music condition, participants heard the beginning (about 1 minute and 30 seconds) of the recorded performance of three well-known musical excerpts: Ravel's *Bolero*, a piece of instrumental folk music from *La Bottine Souriante*, and Bee Gees' *Stayin' Alive*. In the isochronous condition, participants heard isochronous sequences of short noise bursts at six different tempi (inter-onset interval (IOI): 150, 300, 450, 600, 750, and 1500 ms), each for a duration of 45 seconds. In both conditions, participants were asked to tap in time to the auditory stimuli (music or isochronous sequences), as regularly as possible. Each tapping condition was performed twice. Tapping responses were recorded onto an IBM think-pad computer and aligned with the presented sound with 1-ms accuracy.



**FIGURE 1.** Performance obtained by amusic subjects and matched controls in the isochronous condition.

## RESULTS AND DISCUSSION

For each excerpt in the music condition, the number of produced taps, the mean and standard deviation (SD) from the mean of inter-tap intervals (ITI), and the number of successful synchronizations (number of taps occurring  $\pm 10\%$  of the inter-beat interval around the expected beat) are reported in TABLE 1. The performance of each amusic participant was compared to matched controls' average performance. As indicated by the larger SDs, amusic participants tapped in an irregular fashion along with music, compared to controls. This is particularly apparent with the third excerpt (*Stayin' Alive*). Moreover, most of the amusic subjects have marked difficulty in synchronizing with music, as attested by the smaller number of successful synchronizations compared to controls. By contrast, the amusics' performance closely matched that of controls when tapping with the isochronous sequences, as seen in FIGURE 1.

The present study supports our previous suggestion that congenitally amusic adults have difficulties with tapping in time to music. This evidence rests on objective data in the present study, whereas it was based on judges' evaluation in our prior work. Tapping performance was clearly abnormal in 6 of the 8 amusic subjects. The fact that all amusics can synchronize with sequences of nonmusical sounds suggests that the impairment does not arise from a poor ability to tap along with sounds in general. Rather, the difficulty is most likely due to the amusic subjects' deficit in music perception, which would prevent them from extracting the musical beat.

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