



INTRODUCTION

Congenital amusia is a developmental disorder, which is highly specific to the musical domain. This disorder is characterized by a deficit in discriminating sequential pitch variations (Peretz & Hyde, 2003). A recent study (Ayotte et al., 2002) also showed that amusics' ability to carry a tune is affected (i.e. their performances were qualitatively judged as impaired). The aim of the present study was to thoroughly examine sung performance in congenital amusics. For this purpose, amusics' sung performance was analyzed using a new computer-assisted method and compared to the performance of a group of matched controls.

GENERAL METHODS

➤ Subjects: Eleven congenital amusics (8 females, 3 males, $M = 57$ years of age; $M = 15$ years of education) and eleven paired-matched controls (see Hyde and Peretz, 2004, Ayotte et al., 2002).

➤ Task: subjects were asked to:

- 1) sing the chorus of a highly familiar tune (Gens du pays) twice;
- 2) hum the same melody twice on "ta ta ta".



SUNG PERFORMANCE ANALYSIS

The recording of each sung performance was submitted to a customized computer-guided analysis, in order to extract pitch and time variables

Pitch dimension variables

Pitch first note : pitch height of the first note in Hz.

Tonality stability : stability of the tonal center (i.e. the tonality). It is the difference between the produced pitch in the melody segment *a* and in the repetition *a'*. The larger this measure the more instable tonality will be.

Number of pitch errors : an error was scored when the produced interval was larger or smaller than at least 1 semitone as compared to the interval prescribed by the score.

Number of contour deviations : number of contour deviations with respect to the score.

Interval deviation : mean absolute interval deviation of the performance from the score.

Time dimension variables

Mean eight-note IOI : measure of tempo.

CV IOIs (coefficient of variation of the eight-note IOIs obtained by dividing the Standard Deviation of the IOIs by the mean IOI) : measure of temporal variability.

Number of time errors : an error was scored when the produced note was at least 50% longer or shorter than the duration predicted from the preceding note, as prescribed by the score.

Rubato : consistency of tempo variation within the musical piece. The eight-note IOIs for the segment *a* was correlated to the IOIs for segment *a'*. High correlation reflects high consistency in the rubato pattern.

1- Are congenital amusics as accurate as controls?

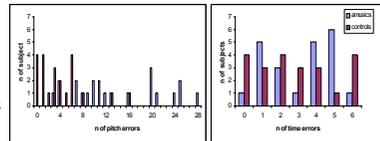
- All amusics were able to sing.
- Amusics were less accurate than controls in particular with regard to the pitch dimension variables.

Pitch dimension	Amusics	Paired ctrl
	M (SE)	M (range)
Pitch dimension		
Pitch first note (Hz)		
Males	122.0 (6.3)	188.0 (125-244)
Females	214.0 (9.5)	207.5 (115-288)
Tonality instability (semit.)	1.3 (0.2)*	0.4 (0.2-0.8)
N. of pitch errors	14 (1.63)*	4.1 (0-16)
N. of contour deviations	6.1 (1.4)*	1.3 (0-7)
Interval deviation (semit.)	1.6 (0.2)*	0.6 (0.33-1.07)
Time dimension		
Mean eight-note IOI (ms)	0.3 (0.01)	0.3 (0.26-0.37)
CV IOIs (ms)	0.18 (0.02)*	0.13 (0.08-0.18)
N. of time errors	3.1 (0.4)	2.77 (0-6)
Rubato	0.6 (0.07)	0.7 (0.39-0.95)

note: p<0.01 *

- For instance, amusics made more pitch errors than controls ($F = 13.9; p < .001$).

- However, amusics did not significantly differ from controls when considering the number of time errors.



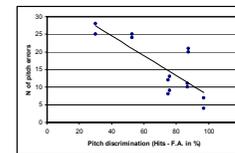
3- Are congenital amusics impaired when singing without lyrics?

- Only 5 amusics out of 11 could sing Gens du Pays on « ta ta ta ».
- Amusics' were again less accurate than controls in particular with regard to the pitch dimension variables.
- Amusics also sung at a bit faster tempo than controls.

Pitch dimension	Amusics	Paired ctrl
	M (SE)	M (range)
Pitch dimension		
Pitch first note (Hz)		
Males	115.7 (11.6)	181.2 (118-298)
Females	222.3 (17.9)	207.3 (125-229)
Tonality instability (semit.)	1.3 (0.2)**	0.5 (0.19-1.41)
N. of pitch errors	10.1 (1.8)**	4.2 (0-10)
N. of contour deviations	2.5 (1.1)	0.9 (0-4)
Interval deviation (semit.)	1.1 (0.2)*	0.5 (0.26-0.78)
Time dimension		
Mean eight-note IOI (ms)	0.3 (0.01)*	0.3 (0.25-0.35)
CV IOIs (ms)	0.15 (0.03)	0.1 (0.06-0.18)
N. of time errors	2.2 (1.0)	1.3 (0-5)
Rubato	0.6 (0.1)	0.65 (0.11-0.98)

note: p<0.01 **, p<0.05 *

2- Is amusics' deficit in pitch perception accounting for their deficient pitch production?



- Amusics' sung performance is correlated with their performance in a pitch discrimination task. In this task, subjects had to detect small pitch change (50 cents) on the fourth note of a five note sequence (see Hyde et Peretz, 2004).
- For instance, a negative correlation was found between the number of pitch errors in production and the performance on the pitch discrimination task ($r = -0.79, p < 0.01$).

- However, the number of pitch errors was also negatively correlated with the performance obtained in a time discrimination task ($r = -0.59, p < 0.01$).

CONCLUSIONS

- Congenital amusics were less accurate than controls when they sang a highly familiar melody. These difficulties mainly concerned pitch production (i.e. amusics' produced pitch was less stable and deviated from the score more than in the case of controls). The temporal dimension was less affected.

- Amusics' pitch performance is correlated with their deficient pitch discrimination. This suggests that similar mechanisms may underlie both pitch perception and production.
- Amusics were helped by lyrics when singing Gens du Pays. This is consistent with the idea that music and lyrics of familiar songs are tightly associated in memory.

REFERENCES:

- Ayotte, J., Peretz, I., Hyde, K. (2002). Congenital amusia. A group study of adults afflicted with a music-specific disorder. *Brain*, 125, 238-251.
- Hyde, K.L., & Peretz, I. (2004). Brains that are out of tune but in time. *Psychological Science*, 15(5), 356-60