Reducing Linguistic Information Enhances Singing Proficiency in Occasional Singers

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In this study we examined the effect of reducing linguistic information on singing proficiency in occasional singers. Thirty-nine occasional singers were asked to sing from memory and to imitate three familiar melodies with lyrics and on the syllable /la/. Performances were analyzed with an acoustically based method yielding objective measures of pitch and temporal accuracy. Results obtained in production and imitation tasks revealed increased accuracy (e.g., fewer pitch interval errors and contour errors) when occasional singers produced melodies on a syllable as compared to singing with lyrics. This effect may be the result of reduced memory load and/or motor entrainment.

Key words: **singing proficiency; musical memory; poor singing; tone deafness**

Introduction

Singing proficiency is widespread in the general population.[1] Nonetheless, 10–15% of the general population exhibit poor singing abilities (i.e., they sing out of tune and, sometimes, out of time).[1,2] Poor-pitch singing has been often treated as the consequence of impoverished pitch perception abilities.[3] However, this condition has also been linked to deficits in sensorimotor integration,[2] and to memory disorders.[2,4,5] In particular, the possibility that poor-pitch singing is linked to memory disorders was recently confirmed by studying singing proficiency in individuals with congenital amusia (i.e., a neurogenetic disorder associated with impaired pitch perception).[6–8] Amusics with deficient incidental memory for musical material are less accurate when singing on a syllable than when singing with lyrics, thus suggesting low memory representation strength or faulty memory retrieval.[4]

In the present study we examined whether singing on a syllable is similarly more challenging than singing with lyrics in the general population. A group of occasional singers was asked to sing well-known melodies (e.g., "Brother John") from memory, and to imitate these melodies after they were presented at a slow tempo. The melodies were sung with lyrics and on the syllable /la/.

Materials and Method

Participants

Thirty-nine occasional singers (29 females and 10 males; age range, 19–39 years), mostly university students at the University of Finance and Management in Warsaw and without formal musical training, participated in the experiment for credit.

Procedure

The participants performed a *familiar melody production task* (hereafter referred to as *Production*

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task), and a *familiar melody repetition task* (hereafter referred to as *Repetition task*). In the Production task participants sang from memory the beginning (26 notes on average) of three highly familiar songs (i.e., "Brother John," "Jingle Bells," and "Sto lat") with Polish lyrics, and on the syllable /la/. In this task participants chose both the starting pitch and tempo. In the Repetition task, participants imitated the same songs as in the Production task at a fixed slow tempo. Prior to melody presentation, a metronome was sounded for 4 beats to indicate the tempo ("Brother John," 96 beats/min, quarter-note inter-onset interval (IOI) = 625 ms; "Jingle Bells," 125 beats/min, quarter-note IOI = 480 ms; "Sto lat," 80 beats/min, quarter-note IOI = 750 ms). The melody to be imitated was then presented twice together with the metronome, and after the metronome was turned off, participants imitated the melody. The melodies were presented within participants' vocal range.

Measures of Singing Proficiency

The pitch and time accuracy of sung renditions was computed using an acoustically based method.[1,4] This method, based on the analysis of vowel groups (e.g., "o" in "sto"), provides reliable estimates of pitch heights and note onset times, which served to compute the following measures of pitch and time accuracy.

Pitch Dimension Variables

Number of pitch interval errors indicates the number of errors in the production of musical intervals as compared to the musical notation.

Number of contour errors refers to the number of changes in pitch direction relative to musical notation. If pitch direction was different from that indicated in the musical notation, it was counted as an error. Contour errors were coded independently from pitch interval errors.

Pitch interval deviation measures the size of the pitch deviations from the notation by averaging the absolute difference in semitones between the produced intervals and the intervals prescribed by musical notation. Small deviation reflects high accuracy in relative pitch.

Initial pitch deviation (only for the Repetition task) indicates the amount of pitch transposition (i.e., absolute pitch difference in semitones between the first note of the melody to be imitated and the first note of the produced melody).

Time Dimension Variables

Tempo is the mean quarter-note IOI.

Number of time errors indicates the number of errors in the production of note durations. A time error was scored when the duration of the sung note was 50% longer or shorter than its predicted duration based on the preceding note, as prescribed by the musical notation.

Temporal variability measures the size of time deviations (i.e., coefficient of variation (CV) of the quarter-note IOIs). Small temporal variability indicates high accuracy in relative duration.

Tempo deviation (only for the Repetition task) measures the amount of tempo change (i.e., absolute difference in percent of the quarter-note IOI between the tempo of the melody to be imitated and the tempo of the produced melody).

Results and Discussion

Participants produced 468 complete renditions (234 in the Production task, and 234 in the Repetition task). For the two tasks, means and variability of pitch and time accuracy measures averaged across the three melodies, for renditions with lyrics and on /la/, are reported in Table 1. For each measure of pitch and time accuracy common to the two tasks, separate 2 (task) × 2 (condition) repeated-measures ANOVAs were run by taking Task (production versus repetition) and Condition (with lyrics versus on /la/) as the within-subject factors. As can be seen, occasional singers sang more in tune and more in time in the Repetition task than in the Production task. In the Repetition task participants made fewer pitch

TABLE 1. Mean and Variability of Pitch and Time Accuracy Variables Computed for Performances with Lyrics and on /la/, in the Production and in the Repetition Tasks

	Production task		Repetition task	
Variable	Lyrics *M* (SE)	/la/ *M* (SE)	Lyrics *M* (SE)	/la/ *M* (SE)
Pitch dimension				
No. of pitch interval errors	4.4 (0.5)	3.3 (0.4)	3.3 (0.5)	2.5 (0.4)
No. of contour errors	2.8 (0.3)	2.3 (0.2)	2.5 (0.2)	1.8 (0.1)
Pitch interval deviation (semitones)	0.6 (0.04)	0.5 (0.03)	0.51 (0.04)	0.45 (0.03)
Initial pitch deviation (semitones)	na	na	1.6 (0.2)	1.4 (0.2)
Time dimension				
Tempo (quarter-note IOI, ms)	431.4 (10.8)	447.3 (11.5)	610.7 (5.3)	601.8 (6.1)
No. of time errors	0.9 (0.1)	0.9 (0.1)	0.7 (0.1)	0.7 (0.1)
Temporal variability (CV IOIs)	0.20 (0.01)	0.19 (0.01)	0.16 (0.01)	0.15 (0.01)
Tempo deviation (% IOI)	na	na	5.4 (0.4)	6.0 (0.6)

na = not available.

interval errors ($F(1, 38) = 21.3$, $P < 0.001$), contour errors ($F(1, 38) = 5.6$, $P < 0.05$), and time errors ($F(1, 38) = 17.7$, $P < 0.001$) than in the Production task; in addition, occasional singers' renditions deviated less from the notation (i.e., in terms of pitch interval deviation, $F(1, 38) = 20.9$, $P < 0.001$, and temporal variability, $F(1, 38) = 52.1$, $P < 0.001$) in the Repetition task than in the Production task. Singing on a syllable was associated with higher accuracy, mostly on the pitch dimension, as compared to singing with lyrics. Occasional singers displayed fewer pitch interval errors ($F(1, 38) = 30.0$, $P < 0.001$), fewer contour errors ($F(1, 38) = 15.6$, $P < 0.001$), and smaller pitch interval deviation ($F(1, 38) = 36.2$, $P < 0.001$) when they sang on /la/ than when they performed the melodies with lyrics. Moreover, the melodies sung on /la/ were less temporally variable than the renditions with lyrics ($F(1, 38) = 5.4$, $P < 0.05$; yet, note that the number of time errors did not differ in the two conditions). Interactions between Task and Condition did not reach significance. Further analyses showed that occasional singers exhibited less pitch transposition in imitating the melodies on /la/ than with lyrics ($t(38) = 2.5$, $P < 0.05$). In sum, imitating a melody by singing it on /la/ increased accuracy mostly on the pitch dimension.

The advantage of singing on a syllable over singing with lyrics is a novel finding and deserves further consideration. The analysis of individual performances show that this effect is very robust. All the occasional singers showed a benefit (i.e., higher accuracy when singing on a syllable than with lyrics) either on the pitch or on the time dimension. The majority of occasional singers made fewer pitch interval errors and contour errors ($n = 29$ of 39 singers, 74%), smaller pitch interval deviation ($n = 31$, 79%), pitch transposition ($n = 28$, 72%), and temporal variability ($n = 26$, 67%) when they sang on a syllable than when they sang with lyrics. The advantage observed on the time dimension was in most of the cases (21 of 26) accompanied by improved pitch accuracy. Yet there were five occasional singers who showed reduced temporal variability when singing on /la/, in absence of other visible benefits on the pitch dimension. Conversely, 10 of 31 occasional singers exhibited reduced pitch interval deviation when singing on /la/ with no apparent benefits on the pitch dimension.

The present study provides compelling evidence that both producing from memory and imitating a melody on a syllable enhance pitch accuracy and time accuracy (i.e., at least in terms of temporal variability) in occasional singers as compared to singing with lyrics. This

advantage is likely the result of the reduced linguistic memory load when singing on a syllable. In this condition, singers can focus on the retrieval of melodic information, thus leading to improved production of pitch intervals and pitch direction. Reduced temporal variability when singing on a syllable is likely due to the regularization effect of repeating the same linguistic unit (e.g., possibly mediated by some form of beat entrainment).[9]

The positive effect of reducing linguistic information on singing proficiency contrasts with previous observations in congenital amusics, who found singing on a syllable more challenging than singing with lyrics.[4] The opposite pattern displayed by amusics lends additional support to the hypothesis that memory factors (e.g., re-coding a well-known melody in association with new speech segments, as when singing on a syllable) may be partly responsible for poor-pitch singing in this population.

Conflicts of Interest

The authors declare no conflicts of interest.

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