

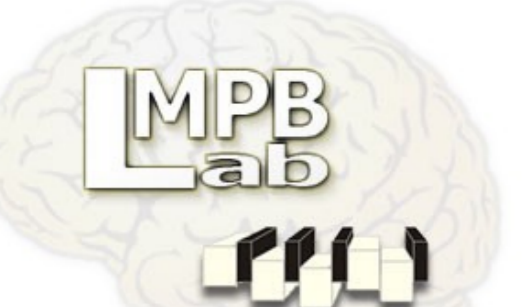


Accurate singers better synchronize with isochronous stimuli than poor singers

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Introduction

Singing is a universal form of vocal expression. Most occasional singers can sing in tune and in time (Dalla Bella et al., 2007), and can successfully imitate tones and short melodies (Pfordresher & Brown, 2007). Yet, important individual differences have been observed, with some individuals (i.e., poor singers) singing out of tune and/or out of time (e.g., Dalla Bella & Berkowska, 2009; Pfordresher & Brown, 2007). A possibility is that such variability among occasional singers is related to their ability to synchronize with a beat. Indeed, it has been suggested that beat entrainment may have emerged during evolution as the result of selection for vocal learning (Patel, 2008). This hypothesis has received some support in recent studies on sensorimotor synchronization in bird species, which are vocal learners (Patel et al., 2009; Schachner et al., 2009).

Goal

Examine whether accuracy in sung performance is associated with accuracy in sensorimotor synchronization tasks (i.e., requiring motor entrainment).

Method

Participants

49 occasional singers (14 males and 35 females), mostly university students, aged between 19 and 39 years ($M = 25.1$ years), with general education = 12.3 years on average and without formal musical training.

Tasks

Familiar Melody Imitation Task:

Participants sang 3 familiar melodies with lyrics (i.e., Brother John, Jingle Bells, Sto lat) and the same melodies on the syllable /la/ at a given slow tempo (quarter note = 100 beats/min) as indicated by a metronome.

Paced tapping Task (synchronization):

Participants tapped with their index finger along with 3 sequences formed each by 35 isochronously presented stimuli. The inter-onset-interval (IOI) was 600 ms. The task was performed once before and once after singing.

Unpaced tapping Task:

Participants tapped with their index finger for one minute in a regular fashion and at the rate which seemed most natural to them (without a sounded sequence). The task was performed once before and once after singing.

Measures of singing and tapping accuracy

Interval deviation

Measure of accuracy in imitating/producing pitch intervals (i.e., difference between the sung intervals and the intervals to be imitated in the melodies).

Calculated by averaging the absolute difference in semitones between the produced intervals and in the intervals prescribed by the notation.

Participants were divided into two groups (*Accurate singers* and *Less-accurate singers*) by performing a median split based on *Interval deviation*.

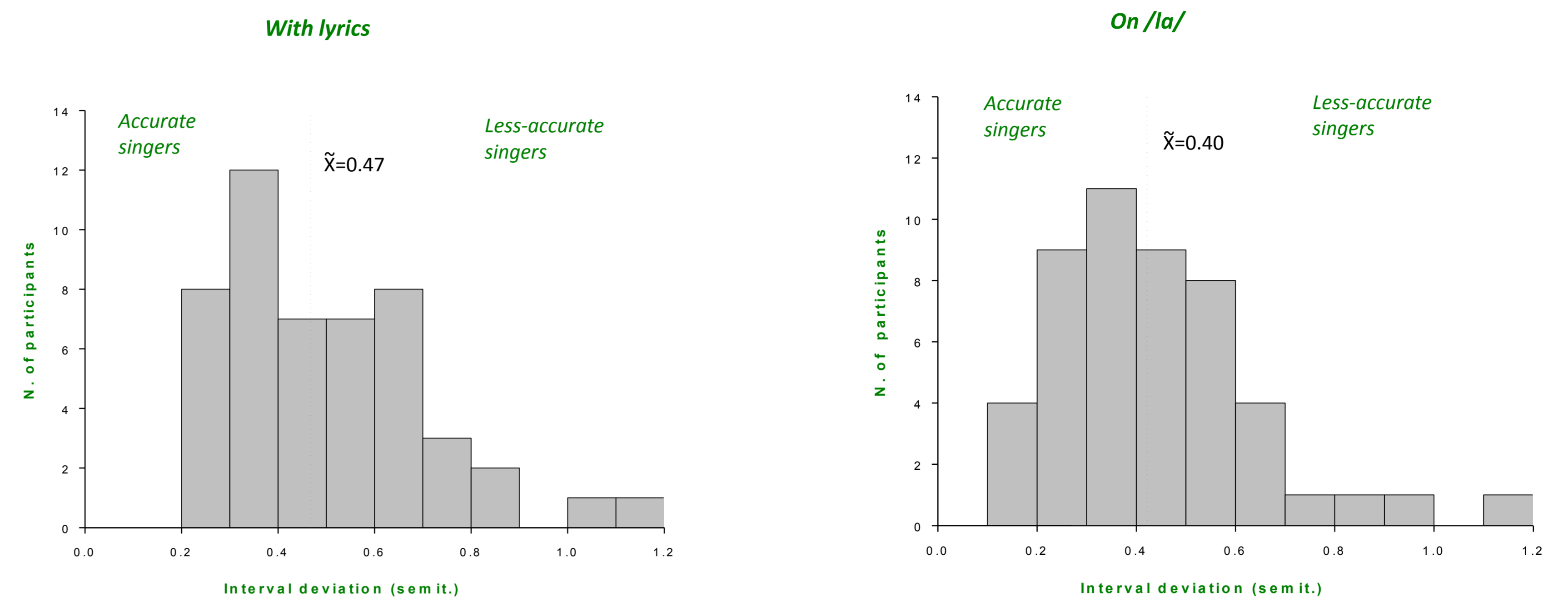
Mean absolute asynchrony (% IOI) – Paced tapping task:

Average of the absolute asynchronies between the taps and pacing stimuli. This measure reflects accuracy in synchronization (i.e., small asynchrony indicates high accuracy).

Coefficient of Variation (CV) of the ITIs – Unpaced tapping task:

The CV of ITIs indicates accuracy in producing regularly repeated time intervals (i.e., the smaller the CV of the ITIs, the more accurate is the performance).

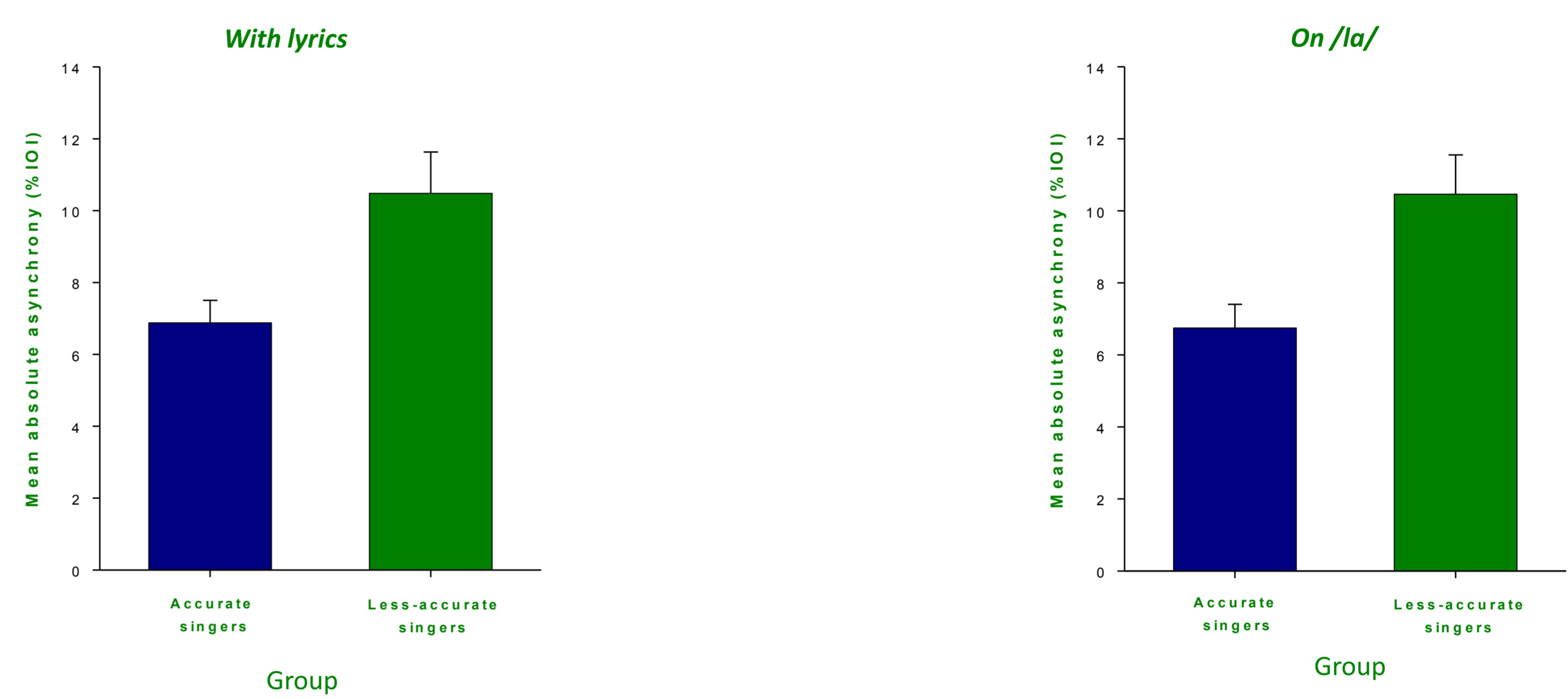
GROUPS: Accurate singers and Less-accurate singers



In both conditions, average interval deviation was significantly greater (i.e., indicating lower accuracy) for Less-accurate singers than for Accurate singers (with lyrics, $t(47) = 9.08$, $p < .001$; on /la/, $t(47) = 8.04$, $p < .001$).

Question 1:

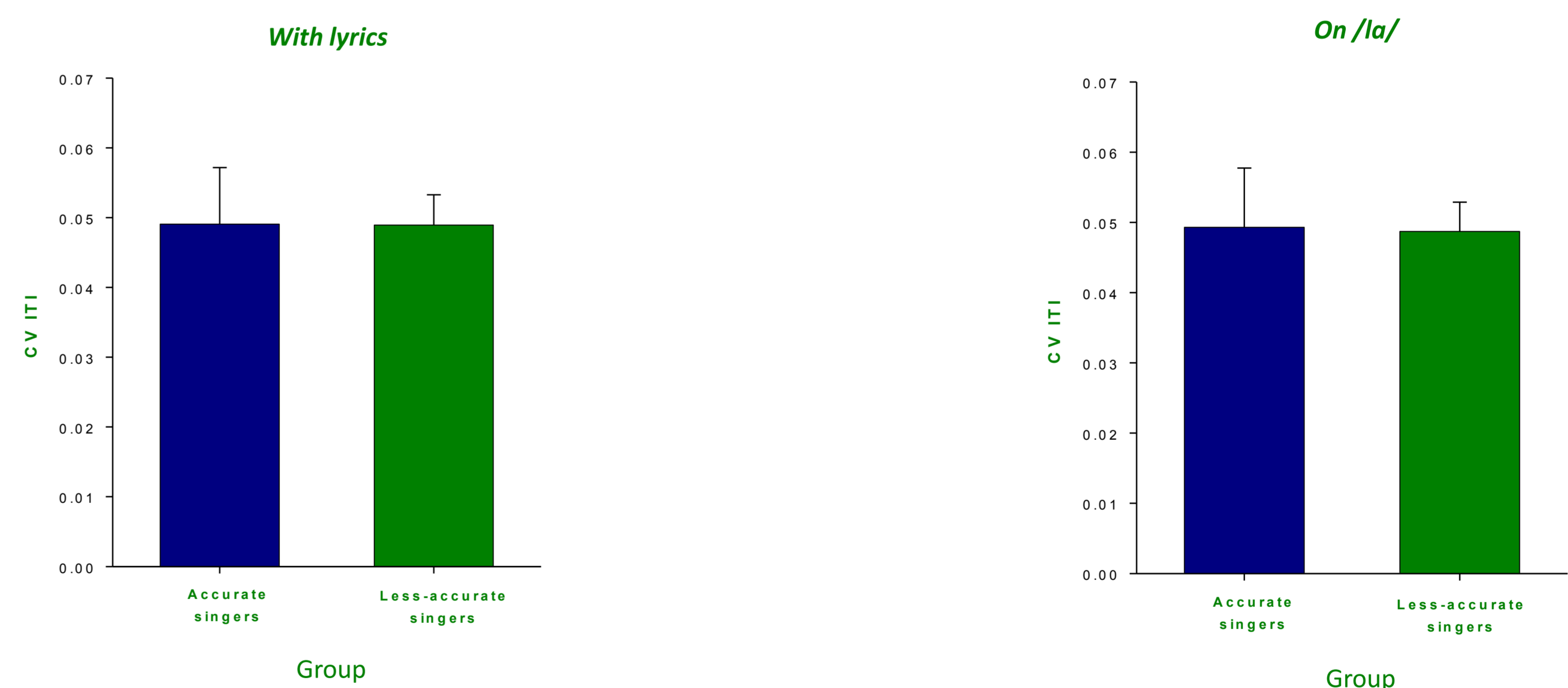
Were Accurate singers more accurate in the paced tapping task than Less-accurate singers?



Accurate singers tapped more in the vicinity of the metronome sounds than Less-accurate singers (with lyrics, $t(47) = -2.76$, $p < .01$; on /la/, $t(47) = -2.88$, $p < .01$).

Question 2:

Were Accurate singers more accurate in the unpaced tapping task than Less-accurate singers?



There were no differences between Accurate and Less-accurate singers in terms of temporal accuracy (i.e., CV of the ITIs) in the unpaced tapping task.

Conclusions

- Singing proficiency varied with accuracy in the synchronization task. Moreover low accuracy in the synchronization task was associated to large error in imitating intervals in the context of well-known melodies. This association was observed both when participants were classified based on their performance with lyrics and on a syllable.
- Beat entrainment covaries with singing proficiency in the general population. This finding supports the vocal learning and rhythmic synchronization hypothesis (Patel et al., 2009; Schachner et al., 2009).
- The same auditory-motor integration mechanisms allowing the conversion of auditory pitch information into appropriate phonation targets during singing (Pfordresher & Brown, 2007) may be crucial in beat entrainment. Inaccurate auditory-motor integration may in parallel lead to poor-pitch singing and inaccurate sensorimotor synchronization.

References

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