

Figure S1. Structure of Sung Reproduction Experiments, Related to Table S2 and Figure 1.

A. Schematic of structure of Experiments 1-3. Trials were grouped into sub-blocks in which a particular pitch interval was presented repeatedly, which in turn were grouped into blocks in which the stimuli were drawn from particular frequency registers. The pitch/frequency of the first stimulus tone of a trial was held constant across a block (but randomized across blocks and participants). B. Structure of trials within a block for experiments 1-3. The first tone was fixed within a block. C. Structure of trials within a block for experiments 4-10. The first tone was roved every sub-block.

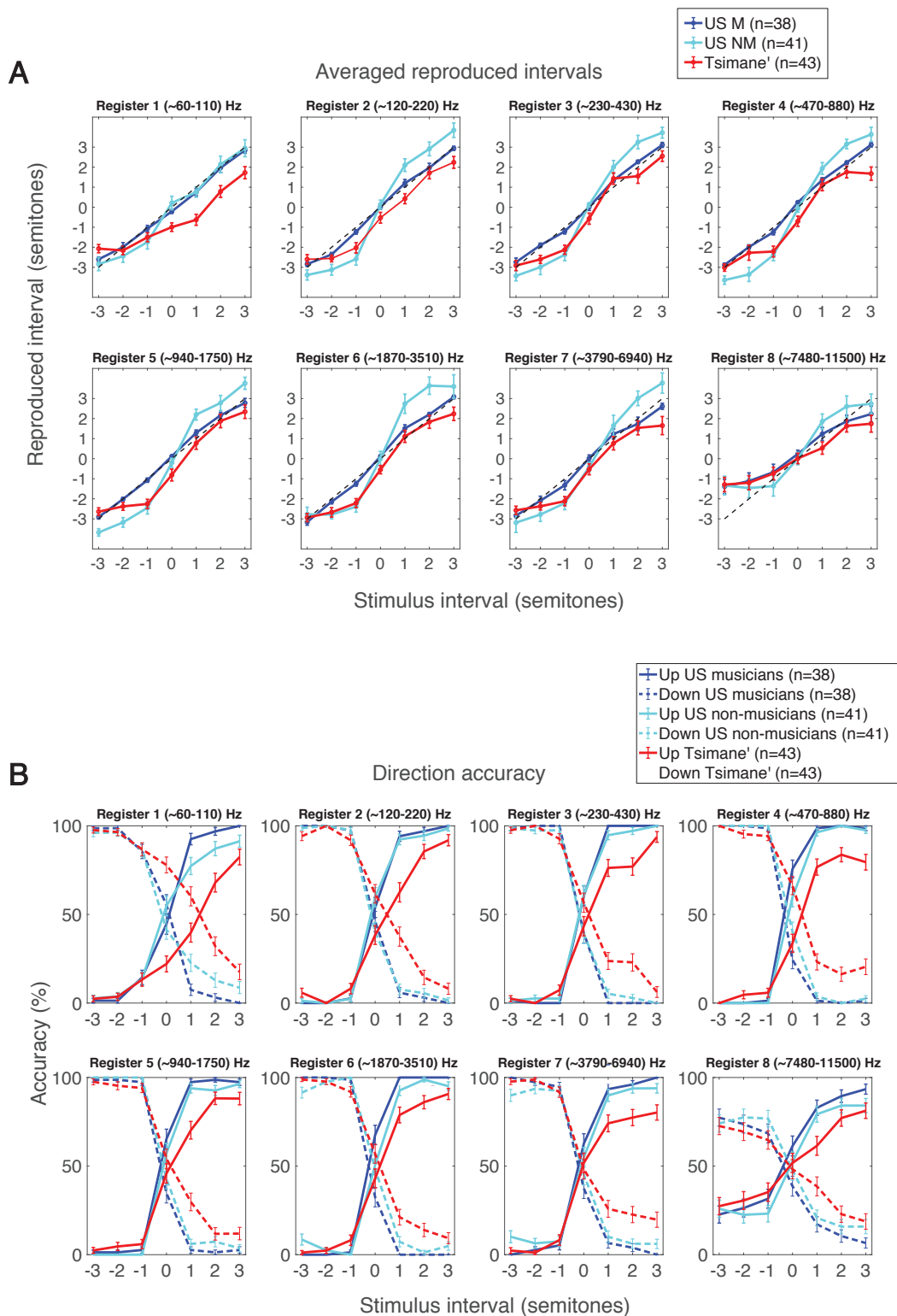


Figure S2. Average Sung Responses From Experiment 1 Separated by Stimulus Register, Related to Figure 3. A. Average sung response interval as a function of stimulus interval for Experiment 1, separated by stimulus register. Error bars plot SEM across participants. B. Percent of responses that were either ascending or descending for each stimulus interval. Error bars plot SEM across participants.

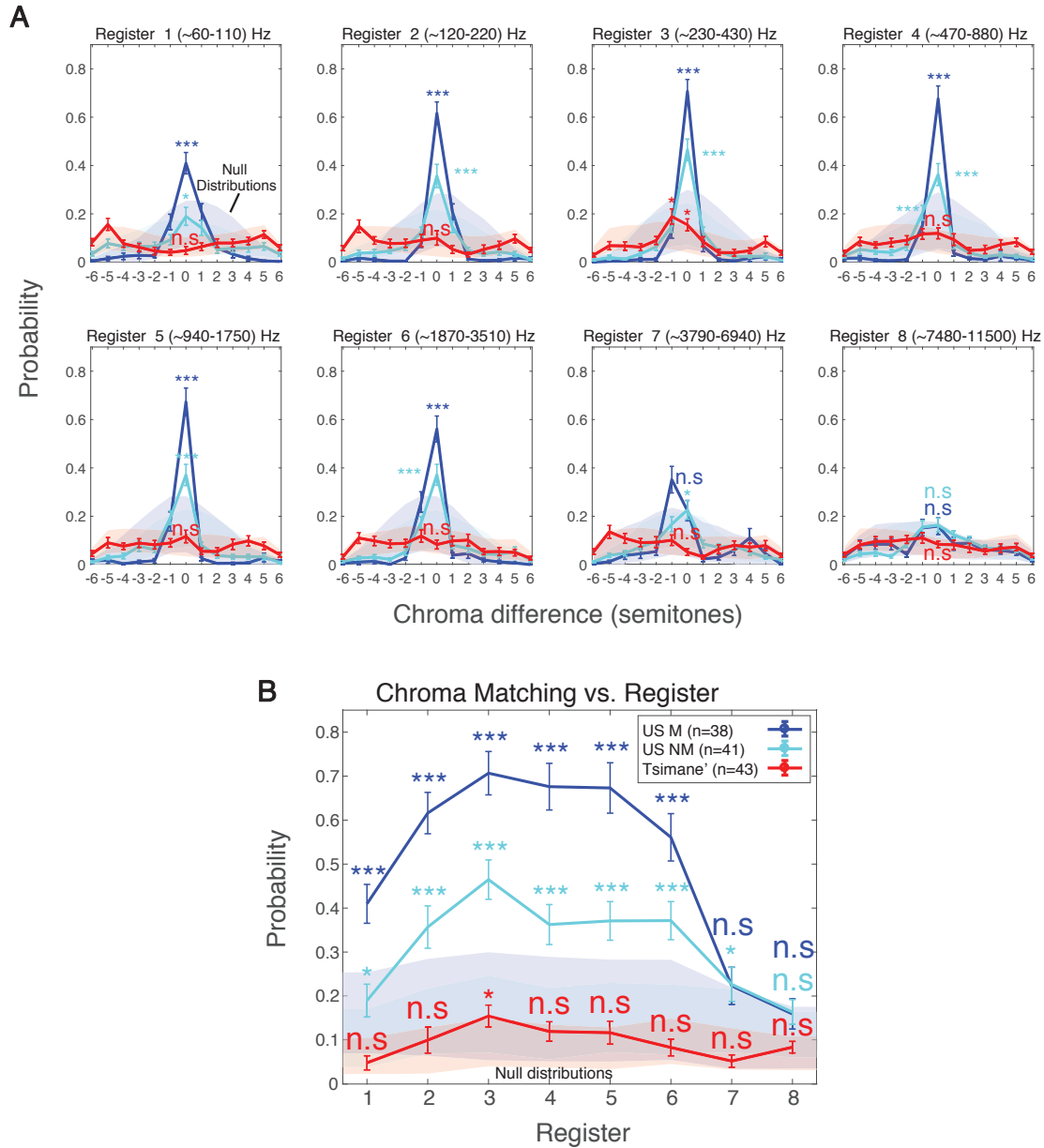
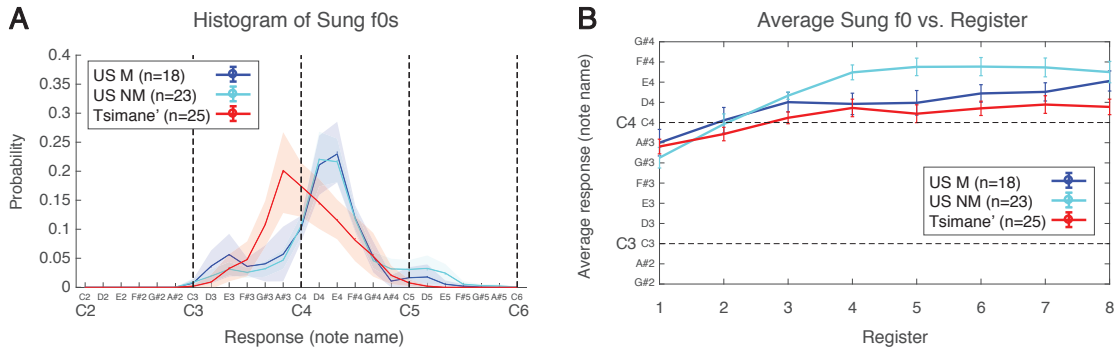


Figure S3. Effect of Stimulus Frequency on Chroma Matching, Related to Figure 4. A. Chroma matching histograms for each of the eight stimulus frequency registers (experiment 1). Same as Figure 4C but plotted separately for the different registers. Register 3 overlaps the singing range of many participants, and shows a small tendency to match the absolute f_0 in the Tsimane'. It is also apparent that chroma matching is reduced for very low and very high stimulus frequencies in Westerners. B. Summary of chroma matching, plotting the probability in the zero semitone bin (from histograms in A, spanning chroma differences of up to ± 0.5 semitones) vs. register.

Female participants



Male participants

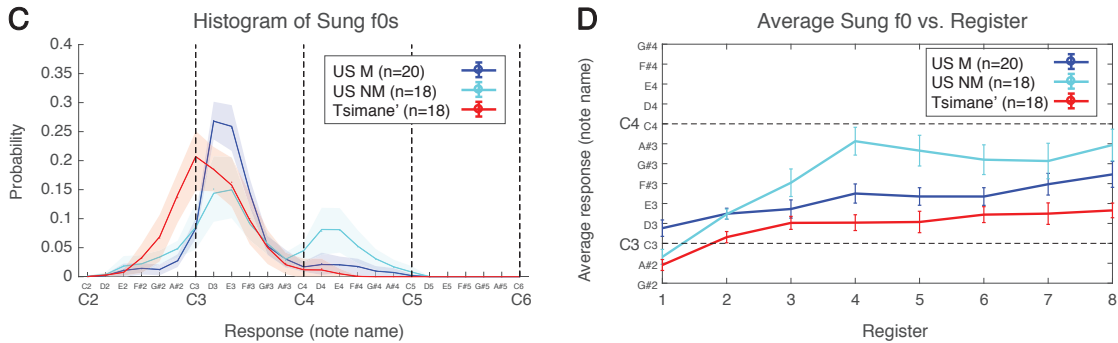


Figure S4. Distribution of Sung f0s, Related to Figure 4. A. Histograms of sung response f0s for female participants, aggregated over all sung responses from Experiment 1. The shaded region plots 95% confidence intervals of the histogram obtained via bootstrapping. Produced pitches were similar for Tsimane' and US females. B. Average sung f0 for the 8 different registers of experiment 1, for female participants. There is a trend for the reproduced f0 to increase slightly with stimulus register, but this effect was no greater for Tsimane' than US participants. Error bars plot SEM. C. Histogram of sung response f0s for male participants. Same conventions as A. Some male US participants used falsetto (typically one octave above the normal singing range). Tsimane' participants did not use falsetto voice. D. Average sung f0 for male participants. Same conventions as B.

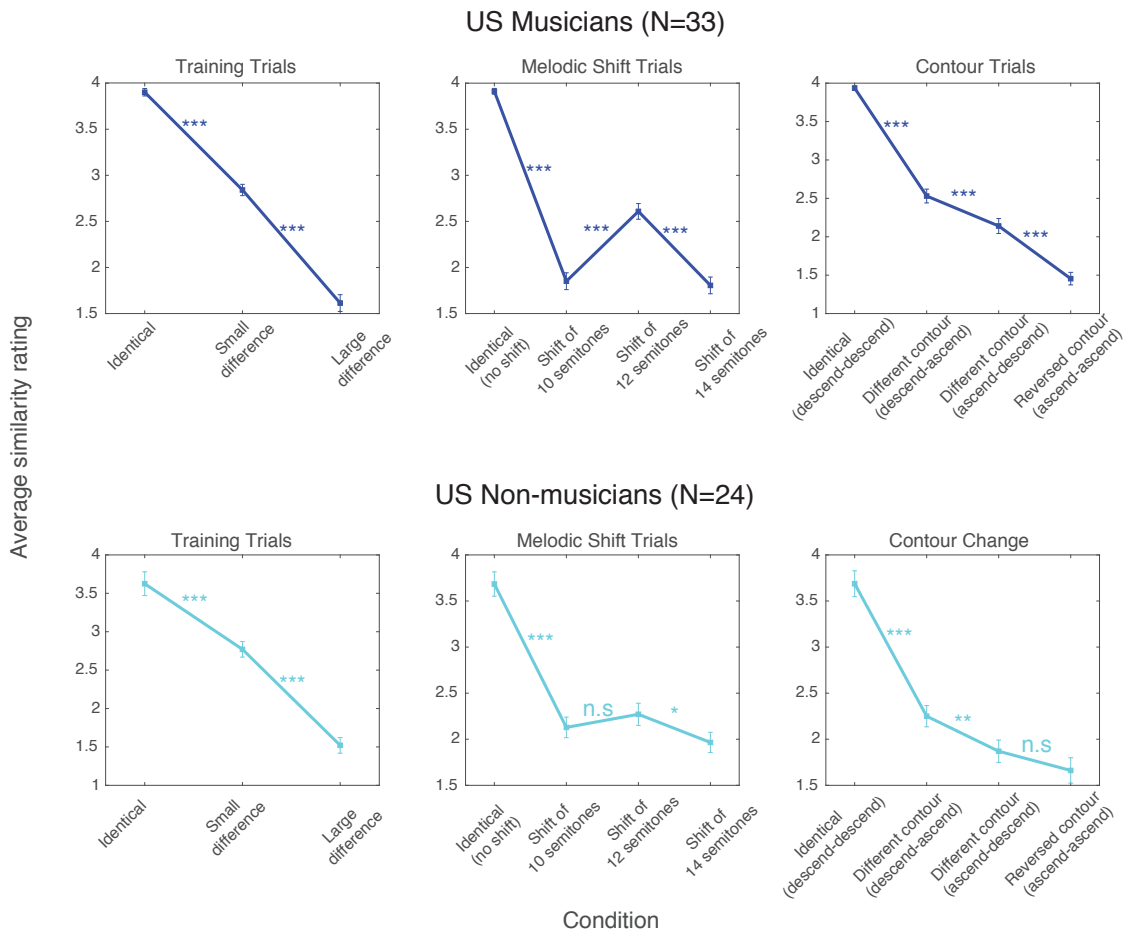


Figure S5. Average Ratings For All Conditions of Melodic Similarity Rating Experiment, Related to Table S3 and Figure 5.

Experiment	Group	Location	n	Female	Mean age (SD) [range]	Mean years of musical experience (SD) [range]	Number of participants reporting never having played a musical instrument or sung
1-3 (session 1)	Musicians	New York City	38	18	32.6 (11.5) [18-69]	20.21 (6.45) [10-38]	-
1-3 (session 1)	Non-musicians	New York City	41	23	33.1 (8.5) [22-50]	0.74 (0.92) [0-3]	21
1-3 (session 1)	Tsimane'	Mara, Moseruna, Anachere	43	25	26.4 (8.9) [18-50]	-	27
4 (complex tones)	Musicians	New York City	28	14	31.1 (10.5) [18-69]	19.18 (6.76) [10-38]	-
4 (complex tones)	Non-musicians	New York City	27	10	32.1 (8.4) [20-49]	1.08 (1.14) [0-3]	11
4 (complex tones)	Tsimane'	Mara, Moseruna, Anachere	22	12	27.5 (8.7) [18-42]	-	16
5 (three tones)	Musicians	New York City	24	12	30.4 (10.9) [18-69]	18.04 (5.47) [10-30]	-
5 (three tones)	Non-musicians	New York City	27	10	36.9 (10.2) [22-59]	0.83 (1.07) [0-3]	14
5 (three tones)	Tsimane'	Mara, Moseruna, Anachere, Iñañiare	23	17	27.9 (8.9) [18-40]	-	22
6 (melodic similarity)	Musicians	New York City	33	15	32.7 (12.1) [18-69]	19.85 (6.79) [10-38]	-
6 (melodic similarity)	Non-musicians	New York City	24	8	33.4 (9.8) [23-49]	0.99 (1.16) [0-3]	11
7 (pure tones)	Musicians	New York City	26	13	30.9 (10.9) [18-69]	18.88 (6.55) [10-38]	-
7 (pure tones)	Non-musicians	New York City	46	18	34.4 (10.1) [20-59]	0.94 (1.10) [0-3]	22
7 (pure tones)	Tsimane'	Mara, Moseruna, Anachere, Iñañiare	38	25	29.9 (10.0) [18-54]	-	29
8 (sung tones)	Musicians	New York City	26	13	30.9 (10.9) [18-69]	18.88 (6.55) [10-38]	-
8 (sung tones)	Non-musicians	New York City	35	14	35.7 (10.6) [20-59]	0.98 (1.07) [0-3]	15
8 (sung tones)	Tsimane'	Mara, Moseruna, Anachere, Iñañiare	23	16	27.6 (9.9) [18-40]	-	20
9 (Explicit pitch matching instructions)	Non-musicians	Boston	17	8	38.1 (7.9) [25-50]	0.59 (0.87) [0-2]	11
10 (feedback)	Musicians	New York City	18	8	33.3 (12.6) [18-69]	19.50 (6.97) [12-38]	-
10 (feedback)	Non-musicians	New York City	39	13	34.4 (10.1) [20-59]	0.96 (1.06) [0-3]	17
10 (feedback)	Tsimane'	Mara, Moseruna, Anachere	35	24	29.0 (10.4) [18-54]	-	26

Table S1. Participant Information for All Experiments, Related to STAR Methods.

	Experiment 4 (complex tones)	Experiment 5 (three tones)	Experiment 6 (melodic similarity)	Experiment 7 (pure tones)	Experiment 8 (sung tones)	Experiment 9 (explicit instructions)	Experiment 10 (feedback)
Experiment 1-3 (main)	28/15/6	24/7/3	33/7/-	26/17/15	26/14/3	0/0/-	18/7/14
Experiment 4 (complex tones)		24/5/6	28/14/-	26/23/13	26/17/9	0/0/-	14/15/11
Experiment 5 (three tones)			24/12/-	24/27/11	24/17/15	0/0/-	11/24/11
Experiment 6 (melodic similarity)				26/23/-	26/17/-	0/0/-	18/17/-
Experiment 7 (pure tones)					26/35/11	0/0/-	13/34/35
Experiment 8 (sung tones)						0/0/-	13/23/11
Experiment 9 (explicit instructions)							0/0/-

Table S2. Participant Overlap Between Experiments, Related to STAR Methods.

Overlap between participants in the experiments. The numbers in each cell (a/b/c) denotes the number of US musicians (a), US non-musicians (b) and Tsimane' (c) that ran in both experiments. Note that experiments in different sessions were never run on the same day as each participant took part only in one session per day. Sessions were separated by more than one day and up to 13 months.

	Register Centers (register number) $\{X^b\}$	Register centers (Hz) $\{X^b\}$	Register centers (midi) $\{X^b\}$	Roving pattern	Intervals $\{I^1\}$	Feed back	Duration of the response recording	Order of condition within blocks	Presentation levels (dB SPL)
Experiment 0 (Training) Singing	Female: 3 (singing range) Male: 2 (singing range)	Female: 320 Hz Male: 160 Hz	Female: 63.5 Male: 51.5	$Y^b \sim [X^b - 2.5, X^b + 2.5]$ (a)	0, ± 1 , ± 2 , ± 3 , ± 4 , ± 5	No	1950 ms	One of two fixed orders: [0, 0, -1, -2, -3, -4, -5, 0, 1, 2, 3, 4, 5, 0] or [0, 0, 1, 2, 3, 4, 5, 0, -1, -2, -3, -4, -5, 0]	92
Experiment 1 (All registers)	1, 2, 3, 4, 5, 6, 7, 8	80, 160, 320, 640, 1281, 2562, 5124, 10248 Hz	39.5, 51.5, 63.5, 75.5, 87.5, 99.5, 111.5, 123.5	$Y^b \sim [X^b - 2.5, X^b + 2.5]$ (a)	0, ± 1 , ± 2 , ± 3	No	1950 ms	Order randomized	1: 95, 2:92, 3:92, 4:89, 5:86, 6: 88, 7: 80, 8: 74
Experiment 2 (Context)	2, 3, 4, 5	160, 320, 640, 1281 Hz	51.5, 63.5, 75.5, 87.5	$Y^b \sim [X^b - 2.5, X^b + 2.5]$ (a)	a) 0, ± 1 , ± 2 b) 0, ± 2 , ± 4 c) 0, ± 1.3 , ± 2.6	No	1950 ms	Order randomized	2:92, 3:92, 4:89, 5:86
Experiment 3 (Smaller range)	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^b \sim [X^b - 2.5, X^b + 2.5]$ (a)	0, ± 1 , ± 2 , ± 3 , ± 4	No	1950 ms	One of two fixed orders: [0, -1, -2, -3, -4, 0, 1, 2, 3, 4, 0] or: [0, 1, 2, 3, 4, 0, -1, -2, -3, -4, 0]	2:92, 3:92, 4:89, 5:86, 6: 88
Experiment 4 (Complex tone)	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	0, ± 1 , ± 2 , ± 3	No	1950 ms	Order randomized	2:92, 3:92, 4:89, 5:86, 6: 88
Experiment 5 (Three tones)	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	$I^1, I^2 \sim U[-4, 4]$ Semitones	No	2620 ms	Order randomized	2:92, 3:92, 4:89, 5:86, 6: 88
Experiment 7 (Roving pure tones) These parameters were also used for singing section of Experiment 6	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	0, ± 1 , ± 2 , ± 3	No	1950 ms	Order randomized	2:92, 3:92, 4:89, 5:86, 6: 88
Experiment 8 (Sung stimulus)	Female voice: 3 Male voice: 2	Female: 320 Hz Male: 160 Hz	Female: 63.5 Male: 51.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	Intervals were approximately 0, ± 1 , ± 2 , ± 3 , ± 4 (c)	No	2350 ms	Order randomized	92
Experiment 9 (Explicit instructions)	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	0, ± 1 , ± 2 , ± 3	No	1950 ms	Order randomized	2:92, 3:92, 4:89, 5:86, 6: 88
Experiment 10 (Feedback)	2, 3, 4, 5, 6	160, 320, 640, 1281, 2562 Hz	51.5, 63.5, 75.5, 87.5, 99.5	$Y^{b,i} \sim [X^{b,i} - 6, X^{b,i} + 6]$ (b)	0, ± 1 , ± 2 , ± 3	Every trial (e)	1950 ms	Order randomized	2:92, 3:92, 4:89, 5:86, 6: 88

Table S3. Experimental Parameters. Related to STAR Methods.

Notes for Table S3:

(a) First tone (Y^b) is fixed within a block.

(b) First tone ($Y^{b,i}$) is roved within each trial i in block b .

(c) In this experiment pitches were rounded to the closest sample within the sound bank, the intervals were thus approximately 0, ± 1 , ± 2 , ± 3 , ± 4 (with less than 0.5 semitone deviation).

(d) The two intervals between the first tone and the second tone and the first tone and the third tone were uniformly randomized $I^1, I^2 \sim U[-4.5, 4.5]$ semitones.

(e) Feedback scheme for experiment 4: Condition a) No feedback (test). Condition b) Chroma feedback. Condition c) Interval feedback. Condition d) No feedback (retest).

Note: in all cases, the number of repetitions per condition was 2-4 per trial depending on the success of pitch extraction.

Block	Repetition	Condition	Tone 1	Tone 2	Tone 3	Pause	Tone 4	Tone 5	Tone 6
Duration (ms)			375 ms	375 ms	375 ms	1000 ms	375 ms	375 ms	375 ms
Train	4	Identical	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1$	$A_1 - I_2$
Train	4	Small difference	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1 + 4$	$A_1 - I_2$
Train	4	Large difference	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 + I_1 + 10$	$A_1 + I_2$
Test 1: melodic shift	12	Identical (no shift)	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1$	$A_1 - I_2$
Test 1: melodic shift	12	Shift of 10 semitones	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1 - 10$	$A_1 - I_2 - 10$
Test 1: melodic shift	12	Shift of 12 semitones	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1 - 12$	$A_1 - I_2 - 12$
Test 1: melodic shift	12	Shift of 14 semitones	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1 - 14$	$A_1 - I_2 - 14$
Test 2: contour change	8	Identical (descend-descend)	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1$	$A_1 - I_2$
Test 2: contour change	8	Different contour (descend-ascend)	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 - I_1$	$A_1 + I_2$
Test 2: contour change	8	Different contour (ascend-descend)	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 + I_1$	$A_1 - I_2$
Test 2: contour change	8	Reversed contour (ascend-ascend)	A_1	$A_1 - I_1$	$A_1 - I_2$	-	A_1	$A_1 + I_1$	$A_1 + I_2$

Table S4. Stimulus Parameters for Melodic Similarity Rating Experiment. Related to STAR Methods. Note: in all cases: $I_1 = U(5.15, 7.15)$, semitones, $I_2 = U(9.39, 11.39)$ semitones and (A_1) were randomized uniformly on a logarithmic scale from a frequency range of +/- 2 semitones around a central frequency of 736.7 Hz.

English	Tsimane'	Chroma feedback	Interval feedback
Try again	<i>Quivijjebada'</i>	We did not record two valid tones	We did not record two valid tones
Excellent!	<i>Anic jām'</i>	$ c^1 < 1, c^2 < 1$	If $I^S > 0$ (not a unison): $ I^S - I^R < 1$ if $I^S == 0$ (a unison): $ I^R < 0.5$
Good	<i>Jām'</i>	$(c^1 \geq 1 \text{ or } c^2 \geq 1)$ and $ c^1 < 2, c^2 < 2$	If $I^S > 0$ (not a unison): $\text{sign}(I^S) == \text{sign}(I^R)$ if $I^S == 0$ (a unison): $ I^R < 1$
OK	<i>Dam' jām'</i>	Otherwise	Otherwise

Table S5. Details of Feedback (Experiment 10). Related to STAR Methods.