Supplementary Material

S1. Descriptive statistics for all rhythm measures.

The goals of this descriptive analysis were to provide an overview of performance on different tasks and to identify the most sensitive dependent variables to include in PCA analyses. We additionally investigated whether the results obtained within our sample were comparable to those found in previous studies using the same tests. A direct comparison was only available for the BBA, the BAT, unpaced tapping (ITI and motor variability measures), synchronization-continuation (motor variability), and for the paced tapping measures (synchronization consistency (R) only). For the other tests, we were unable to find means reported in previous manuscripts with comparable samples.

Linear data were analyzed with repeated-measures ANOVAs and paired-sample *t*-tests (two-tailed). In the case of non-normal distributions, Wilcoxon signed rank tests with continuity correction (two-sided) were run (*wilcox.test* in R). Multiple comparisons were controlled with the Holm-Bonferroni correction, and the adjusted *p*-value after the correction is indicated with *p*'. Independent-sample *t*-tests (or Wilcoxon signed rank tests if data were not normally distributed) were used to compare performance across participants to zero where appropriate. Circular statistics measures of synchronization accuracy (i.e., angle) for the paced tapping measures (paced tapping to a metronome, paced tapping to music) were analyzed with Watson-Williams tests (as in Woodruff Carr et al., 2014; Dalla Bella et al., 2017; Falk et al., 2015; Kirschner & Tomasello, 2009; Sowiński & Dalla Bella, 2013). Note that the production data of participant #31 was not recorded due to a technical error, resulting in a sample size of 30 for the production tasks.

Perception Tasks

See Supplementary Table 1, Supplementary Figure 1, and Figure 1 in the manuscript for all perception results.

Supplementary Table 1
*Accuracy, Sensitivity, and Response Bias c for the Perception Tasks**.

		BBA			BAT			B*b*MAT-S	B*b*MAT-M
		Simple	Complex	All	Phase	Period	All		
Accuracy	*M*	S: 0.95 D: 0.86	S: 0.76 D: 0.81	S: 0.85 D: 0.84	0.77	0.72	0.74	Sy: 0.83 Un: 0.69	R: 1.00 I: 0.95
	SD	S: 0.12 D: 0.17	S: 0.20 D: 0.21	S: 0.12 D: 0.15	0.21	0.22	0.19	Sy: 0.16 Un: 0.18	R: 0.00 I: 0.12
Sensitivity (*d*')	*M*	3.55	2.30	2.49	3.00	2.74	2.80	1.87	4.32
	SD	1.25	1.37	1.16	1.19	1.20	1.05	1.22	0.70
Response bias *c*	*M*	0.26	-0.17	< .001	0.46	0.59	0.57	0.31	0.16
	SD	0.52	0.71	0.43	0.44	0.37	0.33	0.48	0.35

S = same, D = different, M = mean, SD = standard deviation, Sy = synchronized, Un = unsynchronized, R = Regular, I = Irregular, BMAT-S = BMAT-synchronized, B*b*MAT-M = B*b*MAT-Metric, BAT = beat alignment test, BBA = beat-based advantage. *anisochrony detection is not included here because the dependent variable is threshold estimation. Values reported in the text.

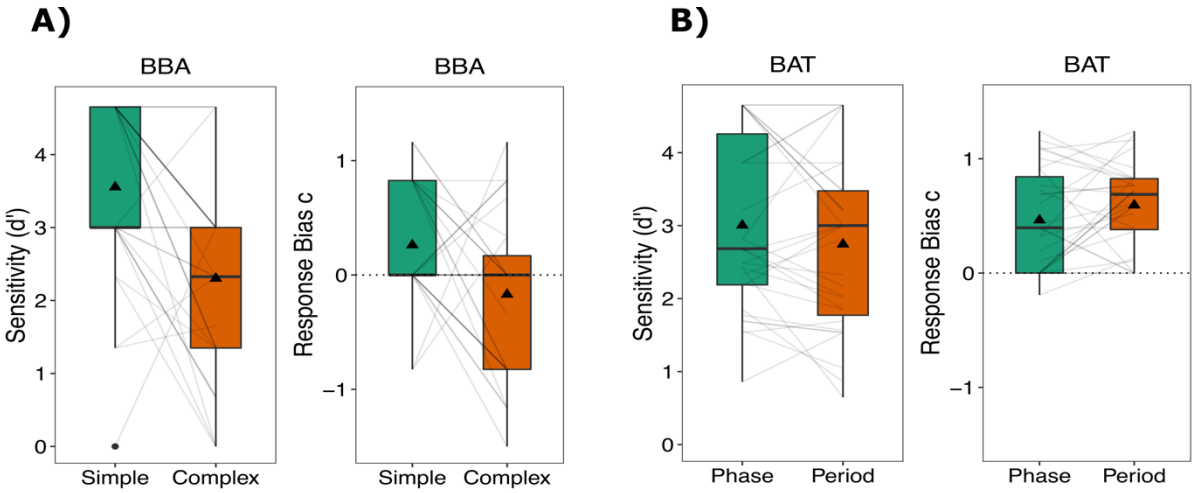
Anisochrony Detection

The average anisochrony detection threshold (as a percentage of the inter-onset-interval, 750ms) was 12.84 (*SD* = 5.60).

BBA

Collapsed across simple and complex trials, participants could distinguish *same* trials from *different* trials as their sensitivity *d'* values were significantly greater than zero, $V = 496$, $p' < .001$, $r = .88$. Between conditions, participants were more sensitive to differences in the simple compared to the complex rhythms, $V = 288.5$, $p' = .003$, $r = .63$ (Supplementary Figure 1A), as in previous research (Gordon et al., 2015; Grahn & Brett, 2007; Niarchou et al., 2021). Collapsed across simple and complex trials, participants were not biased to respond either same or different (response bias *c*), as the mean did not differ significantly

from zero, $V = 109.5$, $p' = .85$. However, it appears that in the simple condition, participants were more biased to respond *same* (though not significantly after controlling for six multiple comparisons), $V = 79$, $p' = .053$, $r = .45$. In the complex condition participants were not significantly biased to respond same or different, $V = 65.5$, $p' = .27$. The difference in response bias *c* between the two conditions was also marginally significant after controlling for multiple comparisons, $V = 234$, $p' = .053$, $r = .45$, as participants were more biased to respond same in the simple compared to the complex condition (see Supplementary Figure 1A). The current participants had higher sensitivity *d*' values ($M = 2.49$, $SD = 1.16$) than participants in a large internet-based study testing a 32-item version of the BBA on 724 adults ($M = 1.85$, $SD = 1.01$; Niarchou et al., 2021), $V = 373$, $p = .01$, $r = .44$.



Supplementary Figure 1. D prime and response bias *c* values for A) the BBA simple and complex conditions and B) the BAT phase and period conditions. The black triangles represent the mean, the black lines represent the median, and the grey lines between conditions correspond to individual participant data. The dotted black line in the response bias *c* graphs shows the 0-line representing no bias. The aggregated scores are presented in Figure 1 of the manuscript.

BAT

Collapsed across error types, a one-sample *t*-test showed that sensitivity *d*' was significantly above zero, suggesting that participants could distinguish aligned from non-aligned trials, $t(30) = 14.78$, $p' < .001$, $d = 2.65$. Between conditions, there was no difference in sensitivity depending on whether the error was a phase or period error, $t(30) = 1.66$, $p' = .22$. Collapsed across error types, response bias *c* revealed a bias to respond *aligned* as the mean was significantly superior to zero, $t(30) = 9.46$, $p' < .001$, $d = 1.70$, and this was true for both phase, $t(30) = 5.83$, $p' < .001$, $d = 1.05$, and period, $t(30) = 8.83$, $p' < .001$, $d = 1.59$ errors (see Supplementary Figure 1B). There was also no difference in response bias *c* between phase and period errors, $t(30) = 1.66$, $p' = .22$. Sensitivity *d'* values in the current experiment ($M = 2.80$, $SD = 1.05$) were marginally better than comparable data from 20 participants in Dalla Bella et al. (2017), ($M = 2.42$, $SD = 0.88$), $t(30) = 2.01$, $p = .053$, $d = 0.36$.

BbMAT-Synch

Participants could distinguish synchronized rhythms from unsynchronized rhythms, as sensitivity *d'* values were significantly above zero, $t(30) = 8.57$, $p < .001$, $d = 1.54$. Response bias *c* was significantly greater than zero, $t(30) = 3.56$, $p' = .001$, $d = .64$, suggesting that participants were biased to respond *synchronized*.

BbMAT-Metric

Only six participants did not score at ceiling (that is, with *d*' = 4.65). The range of these six participants was *d'* = 2.33 - 3.29. Across all participants, sensitivity *d*' values were significantly greater than zero, $V = 496$, $p' < .001$, $r = .93$, confirming that participants could distinguish pulsed from unpulsed rhythms. At the group level, there was a significant bias to respond regular, as response bias *c* was greater than zero, $V = 21$, $p' = .03$, $r = .44$; however, this finding was driven by the six participants not at ceiling.

Production Tasks

See Supplementary Table 2, Supplementary Figure 2, and Figure 2 in the manuscript for all production results.

Supplementary Table 2
Unpaced and Paced Tapping Measures from the BAASTA

	Task	Mean ITI	CV of ITI	Angle	*R*
Unpaced	Unpaced	774 (244)	0.17 (0.19)		
	Sync-Cont	607 (79)	0.14 (0.19)		
Paced	Metronome		0.10 (0.14)	-38.60 (0.16)	0.86 (0.22)
	Music 1		0.10 (0.14)	-7.95 (0.10)	0.83 (0.25)
	Music 2		0.20 (0.20)	-22.31 (0.12)	0.62 (0.31)
	Music Avg		0.14 (0.15)	-12.56 (0.09)	0.74 (0.26)

Note: Angle measure is in mean degrees. *SD* for angle is calculated using the *sample circular variance*, defined as 1 minus the sample *R* value. Values of 0 indicate no variance; values of 1 indicate equal tapping around the circle (Repp, 2005). All other reported values are the mean with standard deviation in brackets.

Unpaced Tapping

The mean ITI of 774 ms (*SD* = 244) was comparable to the mean ITI of the 99 participants in Sowiński & Dalla Bella (2013) (*M* = 719 ms, *SD* = 228.85[1]), V = 282, *p* = .32. Motor variability (*M* = 0.17, *SD* = 0.19) for unpaced tapping was also comparable to that observed in the previous study (*M* = 0.06, *SD* = 0.02), *V* = 293, *p* = .22.

Synchronization-Continuation

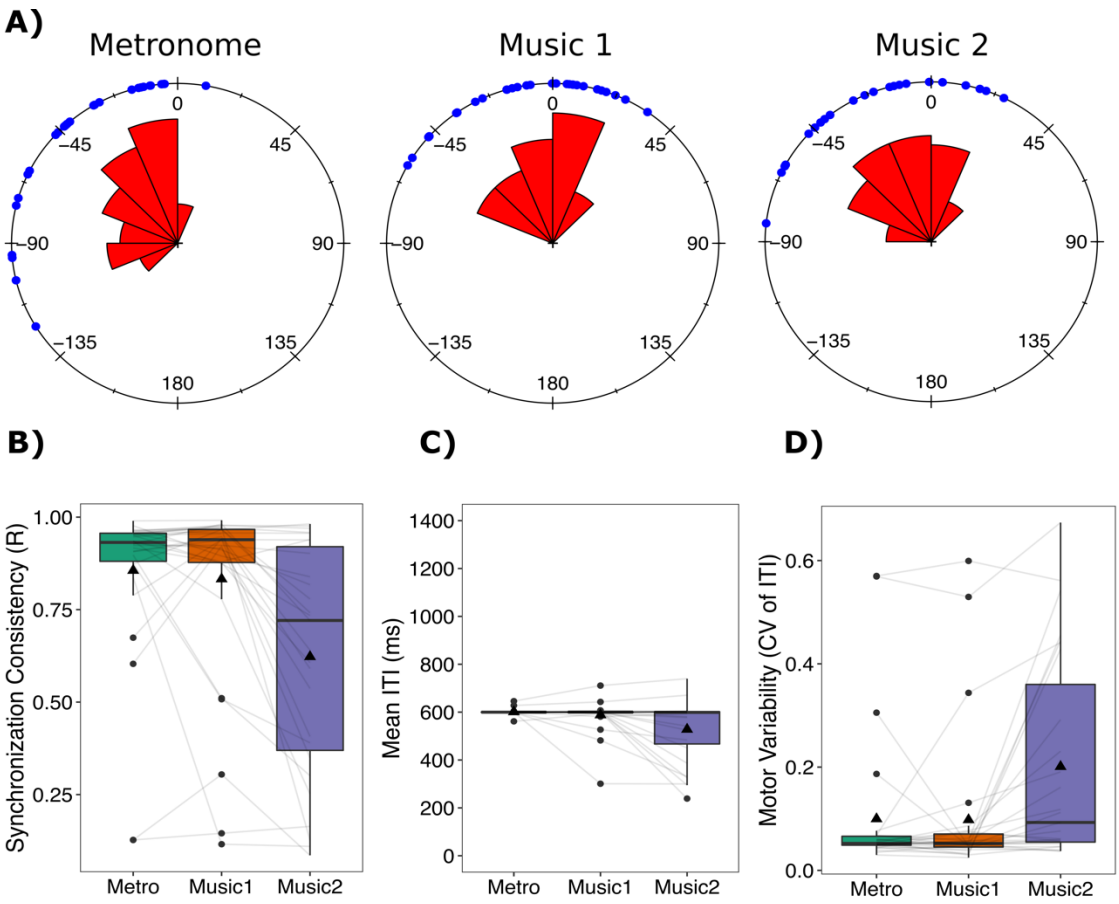
Motor variability for the continuation phase of the synchronization-continuation task (*M* = 0.14, *SD* = 0.19) was significantly more variable than values reported in Dalla Bella et al. (2017) for 20 participants (*M* = 0.04, *SD* = 0.01), *V* = 451, *p* < .001.

Paced Tapping

Motor Variability (CV of ITI). Overall, participants were less variable when tapping to the metronome compared to music (average of music 1 and music 2), *V* = 129, *p* = .03, *r* =

[1] Only standard error was reported in Sowiński & Dalla Bella (2013). To compare to our data, we transformed their *SE* values into *SD* using the formula $SD = SE * \sqrt{(n)}$.

.39. When separating music 1 and music 2, there was a significant difference in CV of ITI between the three conditions, $F(2.78, 72.40) = 9.26$, $p = .002$, $\eta_p^2 = 0.26$, as tapping was significantly more variable for music 2 than music 1, $t(26) = 3.27$, $p' = .009$, $d = 0.63$, and for music 2 than the metronome, $t(26) = 3.23$, $p' = .009$, $d = 0.62$ (see Supplementary Figure 2). There was no difference in tapping variability between metronome and music 1, $t(29) = 0.13$, $p' = .90$. Note that Falk et al. (2015) also reported that tapping to music 2 (the Rossini piece) was less consistent than music 1 (the Bach piece).



Supplementary Figure 2. A) Synchronization accuracy (i.e., angle) and rose plots for paced tapping measures: Metronome, Music 1 (Badinerie) and Music 2 (Rossini), represented with circular statistics. The zero point refers to when the beat occurred. Blue dots reflect individual participant responses. Negative values reflect taps before the beat, and positive values reflect taps after the beat. The rose diagram (in red) reflects the frequency of responses in each segment. Sixteens bins were specified, and the radius of each segment reflects the

square root of the relative frequency in each bin. See Pewsey et al. (2013) for more details. B) Synchronization consistency (vector length *R*) values where 0 = no consistency between taps and 1 = absolute consistency between taps. C) Mean inter-tap-interval (ITI) for the three paced tapping tasks (all ITIs were 600ms). D) Coefficient of variation (CV) of the ITI for the three paced tapping tasks. CV is measured as a percentage of the ITI (600ms). Boxplots represent the spread of data, as implemented in ggplot2 in *R*, with the black line representing the median, and the black triangle representing the mean. The box represents the interquartile range (quartile 1 to quartile 3), individual lines represent individual participant data, and individual dots represent participants who might be considered as outliers.

Synchronization Consistency (*R*). Participants were more consistent in tapping to the metronome compared to the music, $V = 343$, $p = .02$, $r = .42$. When separating music 1 and music 2, there was a significant difference across the three conditions, $F(2, 52) = 14.17$, $p < .001$, $\eta_p^2 = 0.35$, reflecting lower tapping consistency for music 2 compared to both music 1, $t(26) = 4.64$, $p' < .001$, $d = 0.89$ and the metronome, $t(26) = 4.25$, $p' < .001$, $d = 0.82$ conditions (as seen previously, e.g., Falk et al., 2015). There was no difference between consistency in tapping to the metronome and music 1, $t(26) = 0.08$, $p' = .94$. The data (before logit transformation for comparison) are comparable with data from 99 participants in Sowiński and Dalla Bella (2013): there were no significant differences in synchronization consistency to the metronome in the current study ($M = 0.86$, $SD = 0.22$) compared to the Sowiński and Dalla Bella study ($M = 0.94$, $SD = 0.10$), $V = 155$, $p = .11$, or to music in the current study ($M = 0.75$, $SD = 0.26$) compared to music in the previous study ($M = 0.83$, $SD = 0.30$), $V = 193$, $p = .43$, suggesting that our sample were typical tappers.

Synchronization Accuracy (Angle). There was a significant difference in synchronization accuracy[2] between the two materials: participants tapped earlier to the metronome compared to the music, $F(1, 54) = 10.26$, $p = .002$, as is commonly observed (Repp, 2005; Sowiński & Dalla Bella, 2013). There was a significant difference in synchronization accuracy between the three stimuli, $F(2, 76) = 7.14$, $p = .001$. Individual Watson-Williams tests showed that this difference was driven by metronome taps occurring at a significantly earlier time than taps to music 1, $F(1, 54) = 14.23$, $p' < .001$. There was no significant difference between the metronome condition and music 2, $F(1, 49) = 3.16$, $p' = .14$, or between music 1 and music 2, $F(1, 49) = 3.37$, $p' = .14$. Note that Sowiński and Dalla Bella (2013) also found that participants tapped earlier to a metronome than to music (a different musical piece), reflecting the negative mean asynchrony routinely observed when tapping to an isochronous metronome (Repp, 2005).

S2: Extra Analyses for Principal Components

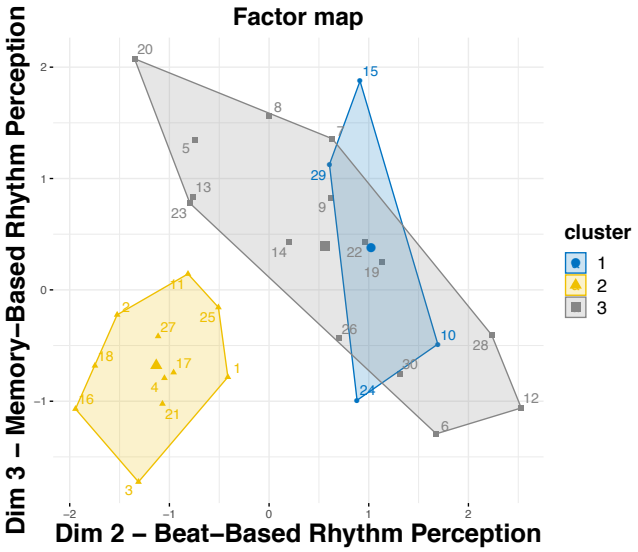
Supplementary Table 3

Correlations Between all Variables Entered into PCAs

	1	2	3	4	5	6	7	8
1. Anisochrony	-							
2. BBA	.008	-						
3. BAT	.37*	.29	-					
4. B*b*MAT-S	.18	.09	.24	-				
5. Unpaced	.26	.27	.34	.27	-			
6. Synch-Cont	.39*	.43*	.57**	.22	.66***	-		
7. Paced metro	.39*	.34	.46*	.19	.55**	.58***	-	
8. Paced music	.22	.28	.52**	.07	.54**	.66***	.59***	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$. Reversed values are included for the tapping measures and anisochrony detection, such that better performance is indicated by positive values. Tapping measures (unpaced tapping, synchronization-continuation, paced tapping to metronome and paced tapping to music) reflect motor variability (CV of ITI). Perception measures (BBA, BAT, B*b*MAT-S) reflect sensitivity *d*', and anisochrony detection reflects detection threshold. Spearman correlations reported as most variables were not normally distributed (except for BAT and B*b*MAT).

[2] Metronome: Participants 10 ($p = .50$, $R = 0.13$) and 15 ($p = .48$, $R = 0.13$) did not pass the Rayleigh test. Music 1: Participants 15 ($p = .31$, $R = 0.15$) and 18 ($p = .44$, $R = 0.12$) did not pass the Rayleigh test. Music 2: Participants 10 ($p = .78$, $R = 0.09$), 15 ($p = .30$, $R = 0.16$), 18 ($p = .42$, $R = 0.11$), and 24 ($p = .12$, $R = 0.13$) did not pass the Rayleigh test, and three participants tapped in anti-phase (5, 12, 13) so were also removed (R not calculated). Missing data were removed case-wise. The average music value was the average of music 1 and music 2 angle values. If there was only one value due to missing data, only this value was used.



Supplementary Figure 3. Cluster groupings for the perception + production PCA along dimensions 2 and 3. Cluster 1 reflects *weak tappers* (along Dimension 1, not shown here), Cluster 2 reflects *weak perceivers*, and Cluster 3 reflects participants with *strong rhythm (perception and production).*

Supplementary Table 4

The First Three Dimensions, Clusters, and Their Interpretation for the Production Principal Component Analysis (separate music 1 and music 2).

	Dim 1	Dim 2	Dim 3	Cluster 1	Cluster 2	Cluster 3
PCA Prod.	Tapping precision (general)	Tapping: beat/ metric extraction	Tapping: unpaced	Outliers Poor tappers: 10, 15	Outliers Poor tappers, complex tasks: 1, 24, 29	Good tappers: 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 30
Task	Unpaced Synch-cont Metro Music 1 Music 2	Music 1*	Unpaced	Unpaced* Synch-cont* Metro* Music 1* Music 2*	Synch-cont* Music 2*	Unpaced Synch-cont Metro Music 1 Music 2

*indicates negative correlation. Participant numbers (1-31) presented to show overlap between clusters. Synch-cont = synchronization-continuation. Metro = metronome. Prod = production. Note: we included music 1 and music 2 separately in the Production PCA to investigate if there was a difference between the two music excerpts (as music 2 appeared to be more difficult to synchronize with).

Supplementary Table 5

Training Information for Participants with Music and/or Dance Training and their PCA Clusters.

	Music Training					Dance Training		PCA Clusters	
N.	Yrs	Instrument	Age	Level	Active	Yrs	Age	Perception	Perc/Prod
1	2	Violin	6	3	No	9	6	Weak Perc.	Weak Perc.
3	2	Guitar/ Violin	8	1	No	15	3	Weak Perc.	Weak Perc.
4	2	Piano	12	4	No	0		Weak Perc.	Weak Perc.
6	6	Guitar/ Drums	13	3	No	2	19	Strong Beat	Strong Rhythm
8	11	Clarinet	6	4	Yes	4	4	Strong Mem.	Strong Rhythm
9	1	Piano	7	1	No	1	10	Strong Mem.	Strong Rhythm
10	0					8	8	Strong Beat	Weak Tapper
11	12	Piano	7	3	Yes	11	7	Weak Perc.	Weak Perc.
12	11	Guitar/ Piano	7	5	Yes	2	13	Strong Beat	Strong Rhythm
13	4	Piano	13	4	No	0		Strong Mem.	Strong Rhythm
14	7	Piano	8	1	No	8	7	Strong Mem.	Strong Rhythm
15	4	Piano	8	4	No	0		Strong Mem.	Weak Tapper
17	0					2	10	Weak Perc.	Weak Perc.
18	0					6	11	Weak Perc.	Weak Perc.
19	13	Trumpet/ Piano/ Guitar	6	3	Yes	0		Strong Beat	Strong Rhythm
21	0					2	13	Weak Perc.	Weak Perc.
23	3	Guitar	15	3	No	8	7	Strong Mem.	Strong Rhythm
25	11	Guitar	9	4	Yes	8	9	Weak Perc.	Weak Perc.
26	2	Piano	/	2	No	0		Strong Beat	Strong Rhythm
27	7	Guitar	10	4	Yes	0		Weak Perc.	Weak Perc.
28	6	Guitar/ Piano	8	5	Yes	13	4	Strong Beat	Strong Rhythm
29	0					5	8	Strong Mem.	Weak Tapper
30	2	Piano	9			0		Strong Beat	Strong Rhythm
31	6	Piano	8	4	Yes	0		Strong Beat	Weak Perc.

Notes: Level corresponds to the level indicated on the question "*how engaged with music are you? Singing, playing, and even writing music counts here".* Where 1 = I *am not engaged in music at all*; 2 = *I am self-taught and play music privately, but I have never played, sung or shown my music to others*; 3 = *I have taken lessons in music, but I have never played, sung or shown my music to others*; 4 = *I have played or sung, or my music has been played in public concerts in my home town, but I have not been paid for this*; 5 = *I have played or sung, or my music has been played in public concerts in my home town, and I have been paid for this*; 6 = *I am professionally active as a musician*; 7 = *I am professionally active as a musician and have been reviewed/featured in the national or international media and/or have received an award for my musical activities*. Yrs = years of training; perc. = perception; prod. = production; mem. = sequence memory. Active refers to whether the participant was currently playing music at the time of testing; age refers to starting age (years).

S3. Selected Questionnaire Questions
Supplementary Table 6
Selected Questionnaire Questions and their French Translation.

Original English Question	French Translation
Can you clap in time with a musical beat? 1. Yes 2. No 3. I'm not sure (Niarchou et al., 2021)	Savez-vous taper en rythme sur la musique ? 1. Oui 2. Non 3. Je ne suis pas sûr
I can sing or play music from memory 1. Completely Disagree 2. Strongly Disagree 3. Disagree 4. Neither Agree nor Disagree 5. Agree 6. Strongly Agree 7. Completely Agree (Müllensiefen et al., 2014)	Je suis capable de chanter ou jouer de la musique par cœur. 1. Pas du tout d'accord 2. Fortement pas d'accord 3. Pas d'accord 4. Ni d'accord ni pas d'accord 5. D'accord 6. Fortement d'accord 7. Tout à fait d'accord (Degrave & Dedonder, 2019)
I have <u>never</u> been complimented for my talents as a musical performer (**goldsmiths**) 1. Completely Disagree 2. Strongly Disagree 3. Disagree 4. Neither Agree nor Disagree 5. Agree 6. Strongly Agree 7. Completely Agree (Müllensiefen et al., 2014)	Je n'ai <u>jamais</u> été complimenté(e) pour mes talents de chanteur ou de musicien. 1. Pas du tout d'accord 2. Fortement pas d'accord 3. Pas d'accord 4. Ni d'accord ni pas d'accord 5. D'accord 6. Fortement d'accord 7. Tout à fait d'accord (Degrave & Dedonder, 2019)
At the peak of my interest, I practiced _____ hours per day on my primary instrument (**goldsmiths**) 1. 0 (or never played an instrument) 2. 0.5 3. 1 4. 1.5 5. 2 6. 3-4 7. 5 or more (Müllensiefen et al., 2014)	Au sommet de mon intérêt, je pratiquais mon instrument principal durant 0 / 0.5 / 1 / 1.5 / 2 / 3-4 / 5 ou plus heure(s) par jour 1. 0 (ou je n'ai jamais joué d'un instrument) 2. 0.5 3. 1 4. 1.5 5. 2 6. 3-4 7. 5 ou plus (Degrave & Dedonder, 2019)
How engaged with music are you? Singing, playing, and even writing music counts here. Please choose the answer which describes you best	A quel niveau êtes-vous engagés dans des activités musicales (chanter, jouer un (ou des) instrument(s), improviser ou composer de la musique) ? Choisissez la réponse qui vous décrit le mieux.

1. I am not engaged in music at all 2. I am self-taught and play music privately, but I have never played, sung or shown my music to others 3. I have taken lessons in music, but I have never played, sung or shown my music to others 4. I have played or sung, or my music has been played in public concerts in my home town, but I have not been paid for this 5. I have played or sung, or my music has been played in public concerts in my home town, and I have been paid for this 6. I am professionally active as a musician 7. I am professionally active as a musician and have been reviewed/featured in the national or international media and/or have received an award for my musical activities (Mosing et al., 2016)	1. Je ne suis pas engagé(e) dans la musique 2. Je suis un(e) autodidacte et je joue de la musique en privé, mais je n'ai jamais chanté, joué ou montré ma musique devant d'autres personnes. 3. J'ai pris des cours de musique mais je n'ai jamais chanté, joué ou montré ma musique devant d'autres personnes. 4. J'ai déjà chanté, joué, et/ou ma musique a déjà été jouée dans des concerts publiques dans ma ville, mais je n'ai jamais été payé pour cela. 5. J'ai déjà chanté, joué, et/ou ma musique a déjà été jouée dans des concerts publiques dans ma ville, et j'ai été payé pour cela. 6. Je suis un(e) musicien(ne) professionnel(le). 7. Je suis un(e) musicien(ne) professionnel(le) et des médias nationaux ou internationaux ont parlé de moi et/ou j'ai déjà reçu un/des prix pour mes activités musicales.

Note: Translations with a reference are validated translations, translations without a reference were translated by a native French speaker and validated with two other native French speakers.

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