

Introduction

Growing evidence demonstrates that rhythm skills predict grammar proficiency in children¹⁻², which might be underpinned by common temporal processing mechanisms³⁻⁴. Here we investigated the consequence of genetic variations on the rhythm-syntax connection with 3 candidate genes (COMT, DRD1, DRD2) responsible for dopamine functioning along the cortico-striatal temporal processing network.

Methods

150 participants (75 females, 18-37 years, 20.5 mean age) completed two grammar, three rhythm, and one working memory tasks, and were genotyped for COMT (rs4680), DRD1 (rs686), and DRD2 (rs1800497).

Sentence comprehension

64 Spoken sentences contained a subject- or object-relative clause.

Participants identified the gender of those performing an action, while ignoring those who love/adore/ dislike/hate others.

Sentence type	Example	Answer
Subject relative	Gentlemen that assist ladies adore children	Male
Object relative	Gentlemen that ladies assist adore children	Female
Subject relative	Gentlemen that adore ladies assist children	Male
Object relative	Gentlemen that ladies adore assist children	Male

Grammaticality judgment

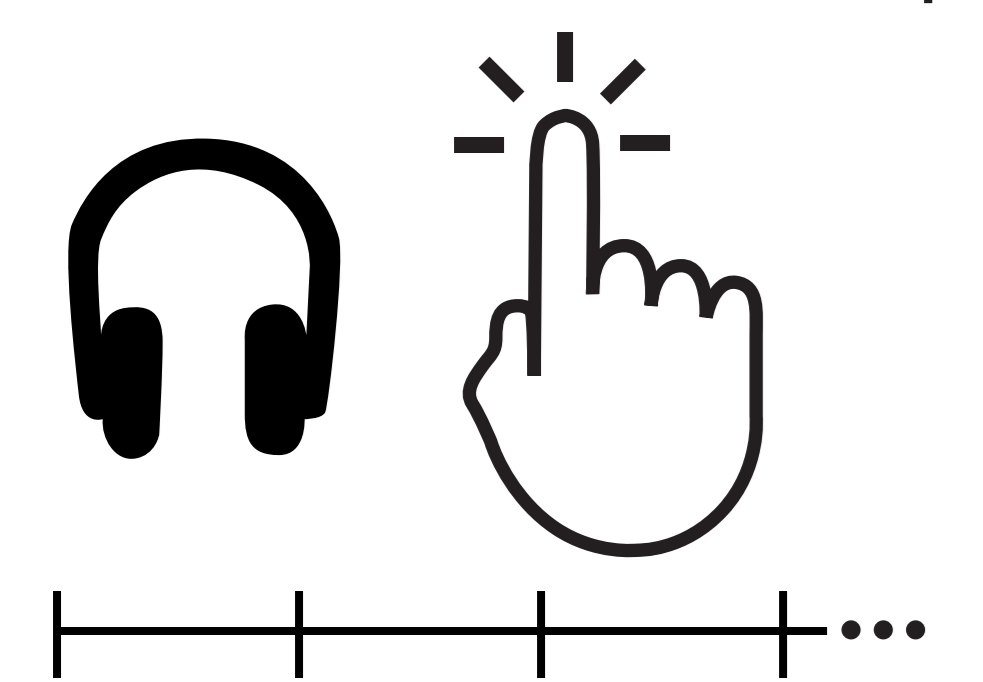
Half of 48 spoken sentences contained a morpho-syntactic error (a subject-verb agreement error or a past tense error). Participants indicated whether or not each sentence was grammatical.

Sentence type	Example	Type of error
Subject relative	The customer that tips (tip) the waitress saddles horses every day.	SVA (relative)
	Every year, the criminals that avoid the police go (goes) to the jail.	SVA (main)
	Yesterday, the father that keeps the boys wanted (wants) toothpaste.	Tense
Object relative	The student that the nephew trusts (trust) fixed the mistake yesterday.	SVA (relative)
	Every week, the ladies that the baby loves watch (watches) the movie.	SVA (main)
	The animal that the children dislike hunted (hunts) a prey last month.	Tense

Auditory beat tapping

[Synchronization] "Tap in synchrony with the metronome beat"

[Continuation] "Continue tapping at the same tempo after the metronome stops."

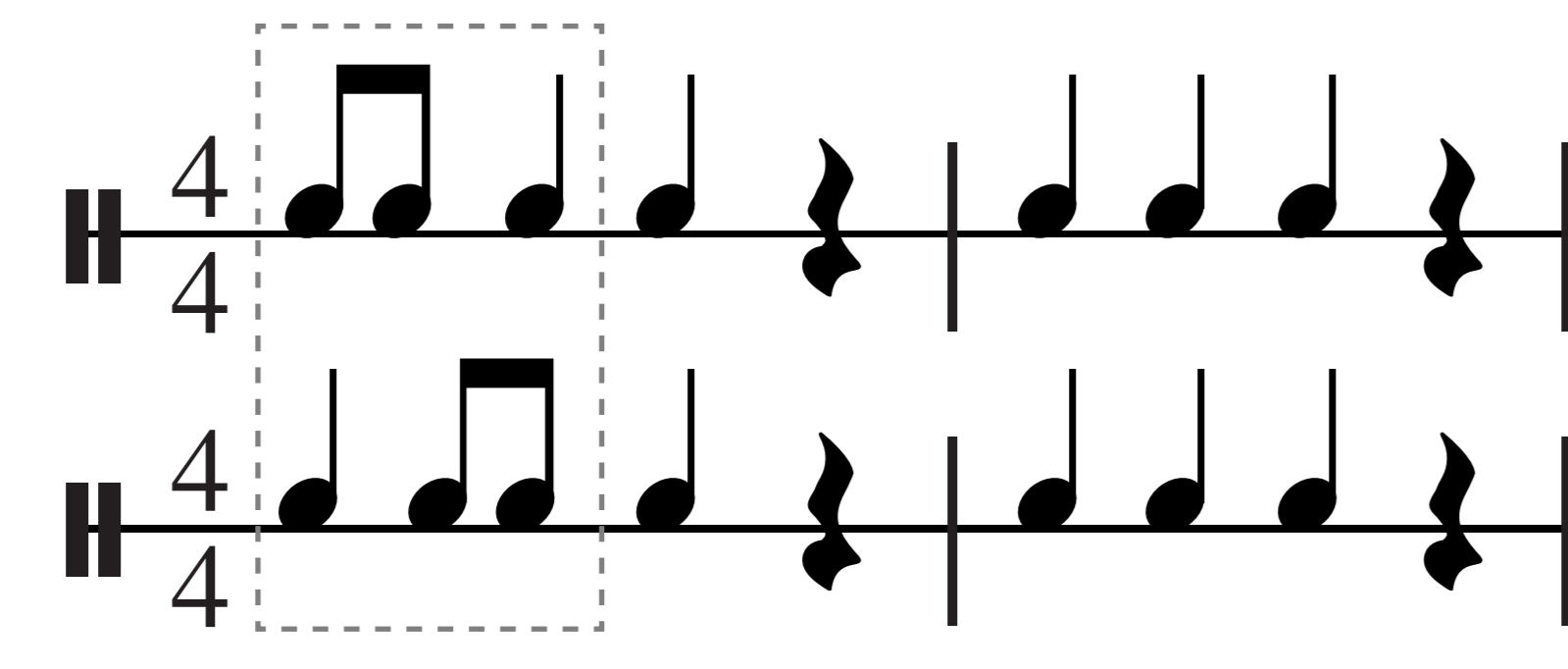


Spontaneous tapping

"Tap consistently at the most natural and comfortable rate." "not too fast or not too slowly, but in a tempo that you can keep tapping most consistently."

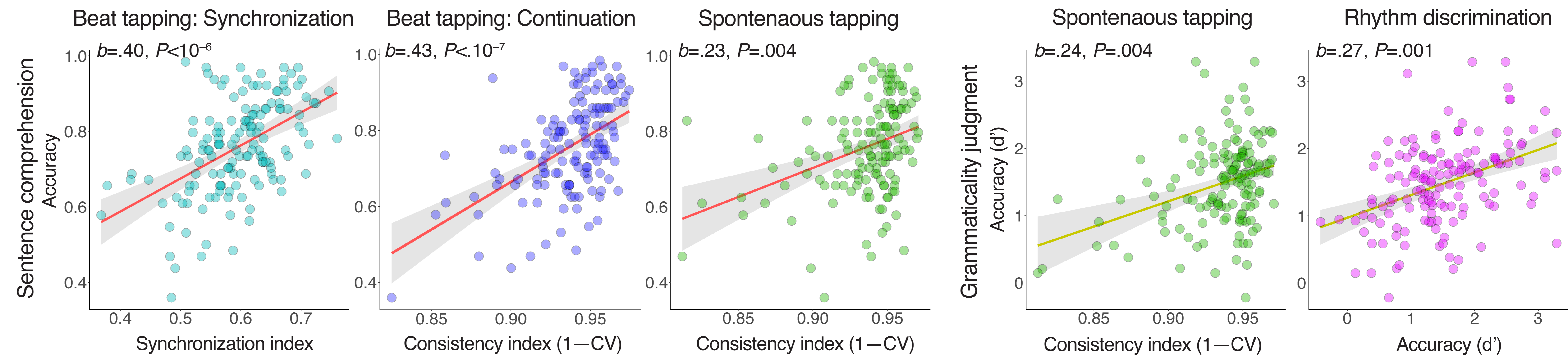
Rhythm discrimination

Participants indicated if the two rhythms were the same or different.



Results

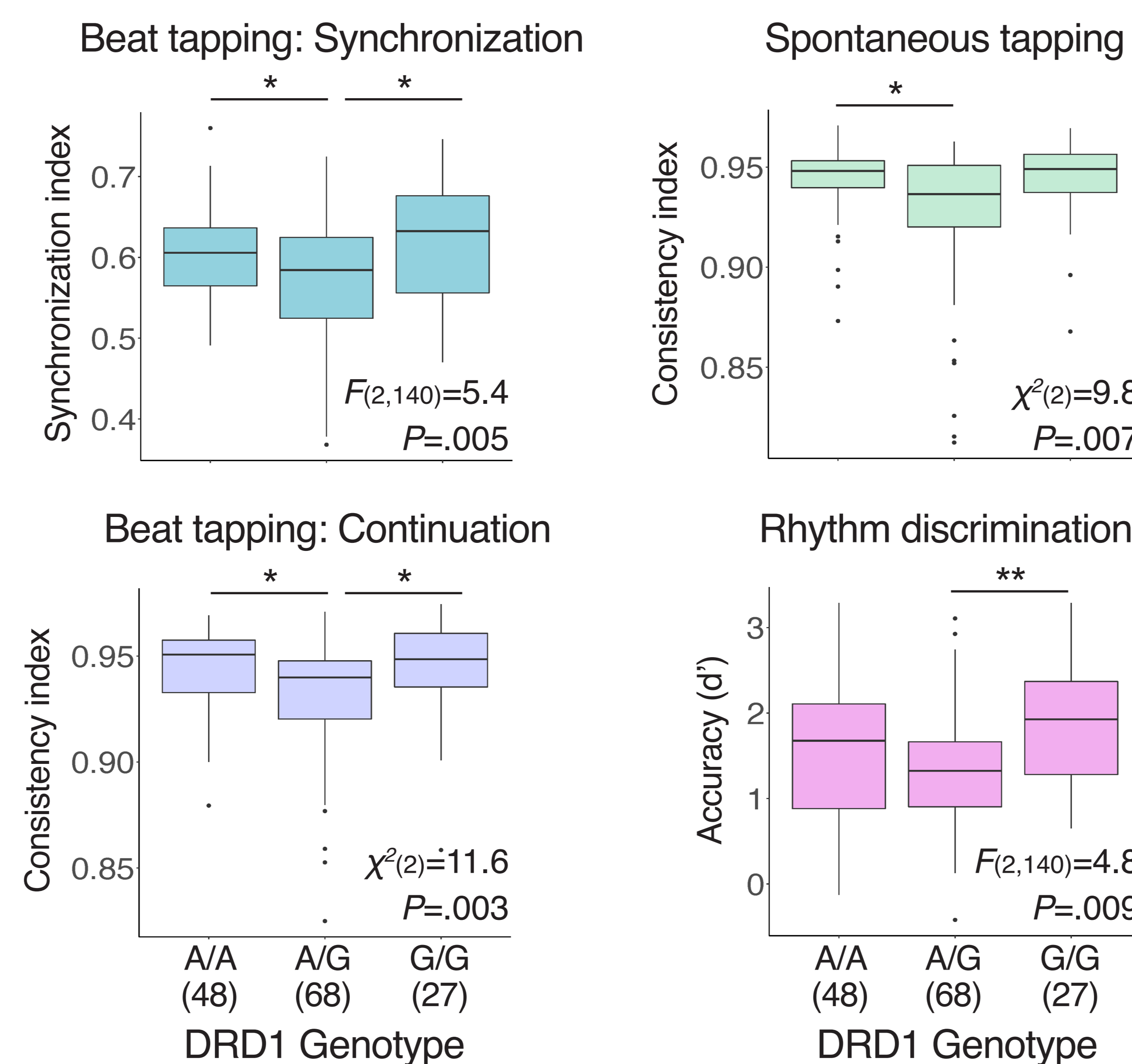
Associations between rhythm and syntax processing



Multiple regression with covariates (working memory, gender, age, musical experience) revealed significant associations between rhythm and syntactic performance.

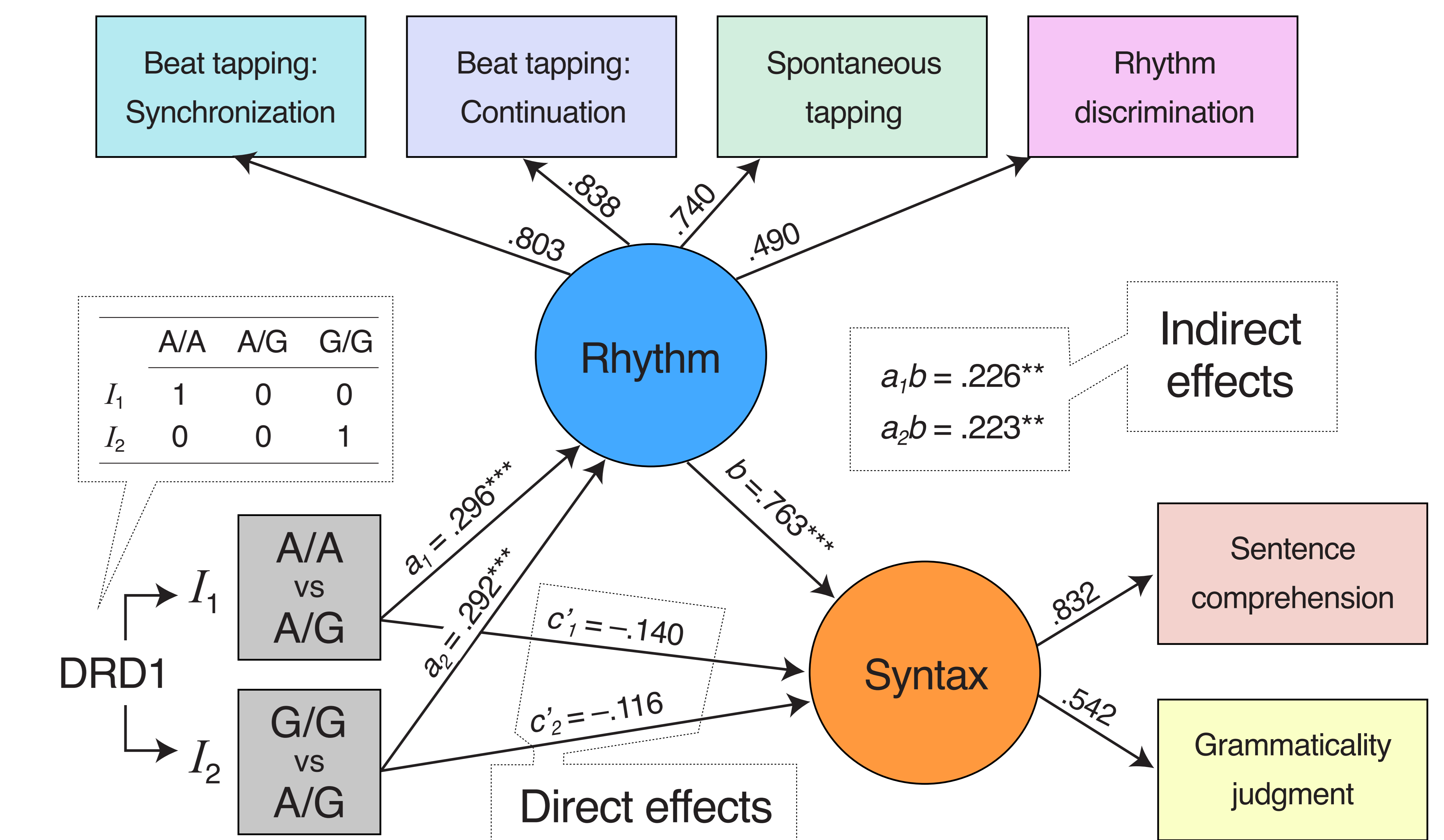
Influence of the DRD1 gene on rhythm processing

The DRD1 genotypes, but not DRD2 and COMT, influenced rhythm performance. No genetic influence on grammar performance ($P_s > .227$).



Indirect relation of the DRD1 gene to syntax via rhythm processing

A structural mediation model demonstrated that the DRD1 genotypes were associated with syntax processing indirectly through the influence on rhythm processing.



Discussion

- Multiple rhythm skills were predictive of auditory language comprehension and grammar skills in healthy young adults.
- Genotypes of DRD1, not DRD2 and COMT, indirectly modulated grammar performance via affecting rhythm performance.
- The present study shows behavioral-genetic associations between rhythm, syntax, and dopamine genotypes, providing an insight into the role of the dopaminergic system on music and language – temporal processing.

References

1. Lee et al. (2020). Dev. Psych., 56(9), 1632.
2. Gordon et al. (2015). Dev. Sci., 18(4), 635-644
3. Heard & Lee (2020). Neuropsychologia, 137, 107284.
4. Kotz & Schwartze (2010). Trends Cogn. Sci., 14(9), 392-399.

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