The Influence of Prior Knowledge on Sensitivity to Statistical Information in Music

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BACKGROUND:

As a domain general mechanism, statistical learning interests both music and language cognition researchers (Patel, 2008). Recently, Siegelman, Bogaerts, Christiansen, and Frost (2017) proposed that statistical learning ability varies among individuals. As prior knowledge of music varies to a greater degree between individuals than prior knowledge of language, we have a unique opportunity to examine whether prior knowledge may influence statistical learning using musical stimuli. Prior knowledge of music may be acquired by either past informal exposure or formal music training. Here, we examine

(A) the correspondence between music training and statistical learning, and

(B) the influence of prior exposure to pitch distributional information through music exposure on participants' responses.

This will serve as the critical basis to enable studies tracing the trajectory of this knowledge, informing us about how the brain helps us learn about new music.

METHODS:

Twenty-eight participants listened to two blocks of 80 sequences, each sequence containing 34 isochronous tones of 150 ms each and followed by one of four possible probe-tones, *C, C♯, F♯, or G*. Participants judged each probe-tone's fit with the prior sequence. In one block, sequences were generated from an unfamiliar tone distribution; in the other, sequences were generated from a familiar distribution analogous to that of a piece written in C-major.

Probe-tones were physically identical for both blocks but differed in their congruency to the distributions, i.e., whether they had occurred during the tone sequence and thus were considered part of the distribution. Table 1 shows how we classified responses into hits and false alarms.

Table 1: Classification of responses into hits and false alarms, misses and correct rejections.

	participant: fits	*participant: does not fit*
congruent	hit	miss
incongruent	false alarm	correct rejection

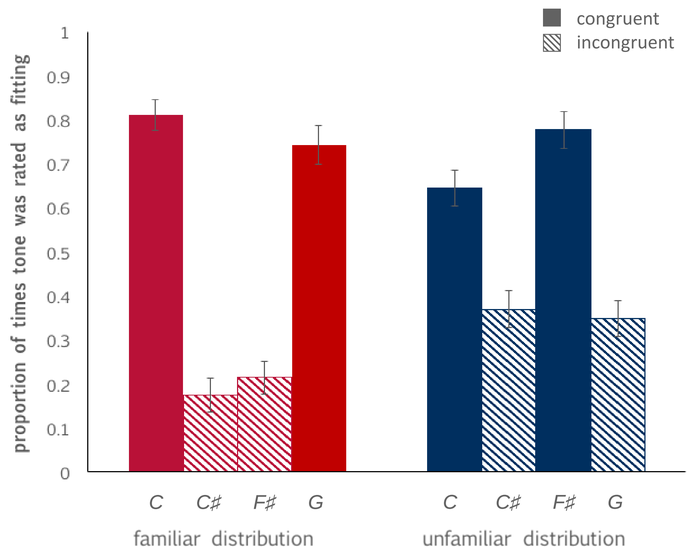

Figure 1: Proportion of times tones were judged as fitting in the familiar and novel conditions; *C* and *G* were congruent tones in the familiar distribution whereas *C* and *F♯* were congruent in the unfamiliar distribution. Solid bars denote congruent tones, striped bars show incongruent tones.

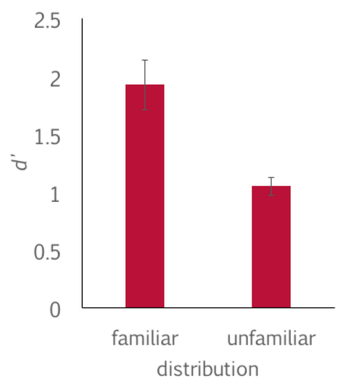

Figure 2: d' for the familiar and unfamiliar distributions

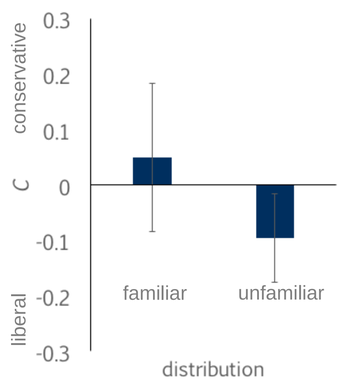

Figure 3: C for the familiar and unfamiliar distributions

RESULTS:

Congruent probe-tones were judged as "fitting" more often than incongruent probe-tones, with a stronger effect for the familiar distribution (see Fig. 1, $F(1,27) = 31.03$, $p < .001$). Hits and false alarm rates were converted to *d'* (measuring sensitivity) and *Criterion C* (measuring response bias). Both *d'* and *C* were higher for the familiar than for the unfamiliar distribution (Fig. 2 and 3, *d'*: $t(27) = 5.19$, $p < .001$, *C*: $t(27) = 2.83$, $p = .009$).

There was a positive correlation between years of music training and sensitivity only for the familiar distribution, $r(26) = .50$, $p = .006$. There was no significant correlation between years of music training and sensitivity for the unfamiliar distribution, or with *C* for either distribution, $p > .05$.

DISCUSSION:

The difference in *C* between distributions suggests that participants are more liberal when they encounter unfamiliar music. This difference, as well as the difference in sensitivity between distributions supports our hypothesis that prior knowledge influences participants' responses. In particular, the association between music training for the familiar distribution and the lack thereof for the unfamiliar distribution show

(A) music training does not influence statistical learning, but

(B) prior knowledge and music training jointly influence responses themselves.

Our results also show that music training does not influence the bias in responding, but only the sensitivity for known material.

These results have interesting implications for the field of language learning research – since statistical learning is a domain general mechanism, our results predict that prior experience in learning a language does not influence sensitivity for sound categories in an unrelated language but only for those in the learned or similar languages.

REFERENCES: Patel, A. D. (2008). *Music, language, and the brain*. New York: Oxford University Press.; Siegelman, N., Bogaerts, L., Christiansen, M. H., & Frost, R. (2017). Towards a theory of individual differences in statistical learning. Phil. Trans. R. Soc. B, 372(1711), 20160059.