EFFECTS OF MUSICAL STIMULUS HABITUATION AND MUSICAL TRAINING ON FELT TENSION

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EXTENDED ABSTRACT

As a listener habituates to a stimulus, its impact is expected to decrease over time; this research investigates the impact of repetitions and time on felt tension. Farbood [1] describes tension increase as "a feeling of rising intensity or impending climax" and decrease as "a feeling of relaxation or resolution." Musical tension has been linked to structural properties of music such as chord movements, tonality, and section boundaries; these connections have in turn informed the design of quantitative models for musical tension [2, 3, 5].

In a pilot study, 9 participants annotated their felt tension through a recorded live performance of Chopin's *Ballade No. 2 in F Maj, Op. 38*, and a collage of the ballade from the *Arrhythmia Suite* by Chew *et al.* The piece includes a calm triplet motif and a tense foil with frequent dissonance and variable features.

A Goldsmiths Musical Sophistication Index [4] determined participants' music experience. A moving slider was used to indicate felt tension from 0 (absolute calm or resolution) to 100 (absolute agitation or climax). The rating was continuously taken at 20 samples per second (see Fig. 1).

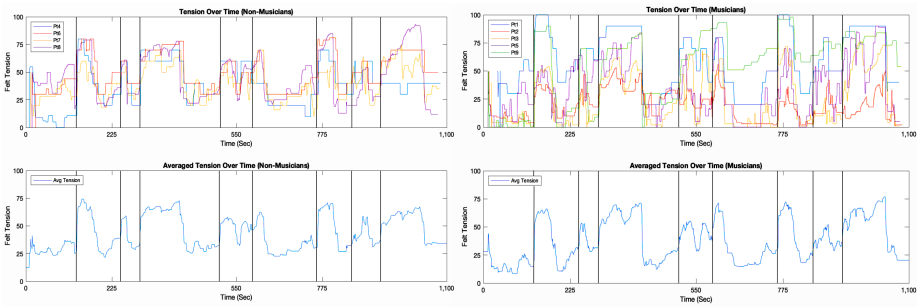

Figure 1. Participant annotations for non-musicians (top left) and musicians (top right), summed over time (bottom). Vertical lines mark the start of the unstable motif, accompanied by increased participant tension.

The difference in felt tension over time for musicians and non-musicians is found to be significant at 5%. In a comparison of means t-test, $H_0 : \mu_1 = \mu_2$ is rejected at 7 DOF ($t = -2.580, p = 0.0365$). In musicians, the range of annotated values is greater (68.46, non-musicians $= 61.75$), while mean tension over time is lower (22.33, non-musicians $= 35.24$), suggesting that musicians are more aware of the full emotional range of their felt tension and supports the heightened response of musicians to different musical stimuli [1].

Linear regression is performed for mean tension on the 100-point scale at measures of repeated material over time (see Fig. 2). The slope is mildly negative for both non-musicians (Eqn. 1) and musicians (Eqn. 2).

$$f(t) = -0.0035t + 59.8856, \text{ and} \quad (1)$$

$$f(t) = -0.0049t + 56.7197, \quad (2)$$

where t is time in seconds since listening began and $f(t)$ is the average tension of the repeated phrase.

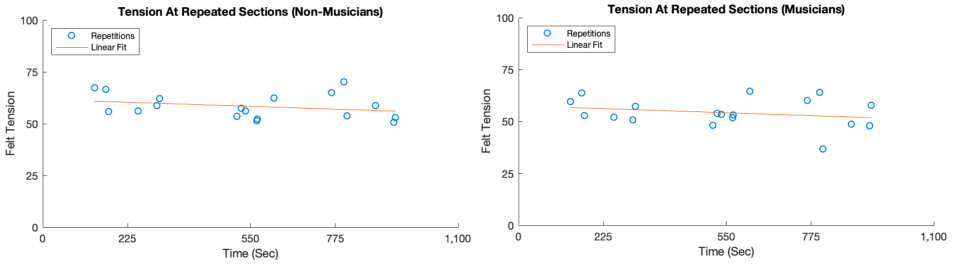

Figure 2. Tension over repeated phrases for non-musicians (Eqn. 1) and musicians (Eqn. 2)

This suggests that tension decreases more slowly for non-musicians than musicians, possibly due to musicians' heightened awareness of the musical structure; this awareness may lead to a higher rate of learning, recognizing repeats, and habituation for musicians. However, a hypothesis test ($H_0 : B_1 = 0$) at 16 DOF done for musicians ($t = -0.7204, p = 0.4110$), and non-musicians ($t = -0.6326, p = 0.5365$) indicates the possibility that repetitions have no effect on felt tension. The current data set is too small to determine significance; clearer trends may be observed in a larger data set using a piece with more examinable repetitions.

Empirical tension from this study was compared with the spiral array-based Herremans & Chew harmonic tension model [2], implemented in the Tension Visualiser software[1]. The model's output combined with one-hot classification of musicianship and time since the participant began listening (accounting for habituation) is determined (see Table 1). The prediction is most improved with both time and training information.

Parameters	Total Features	MSE	MAE	RMSE	R^2
MorpheuS Tension Visualiser (MTV)	3	0.016489	0.094689	0.12841	0.78
MTV + Musical Training	4	0.015877	0.0821	0.12601	0.78
MTV + Listening Time	4	0.007128	0.06843	0.087823	0.90
MTV + Both	5	0.0029443	0.024028	0.0542	0.96

Table 1. Performance with the inclusion of different features to the original Tension Visualiser features.

Although the current data does not suggest that repetition or time has a significant impact on felt tension, the inclusion of these features on predictive model accuracy suggests that they may be beneficial. We propose a full-scale study of repetition to determine true statistical significance in a larger sample size. Distinguishing between listeners with differing musical background and their habituation to musical stimuli may further explain rater variability of subjective music stimuli and improve other cognitive models of music emotion.

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