A Psychophysical Explanation for Why Major Chords are "Bright" and Minor Chords are "Dark"

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The oldest puzzle in traditional music theory concerns the affect of major and minor chords. Regardless of musical training, culture or subject age, major chords are evaluated as "bright and happy", and minor chords as "dark and sad". We have found that an explanation of the affective charge of the harmonic triads is possible based on Meyer's (1956) idea of harmonic "tension". Specifically, tension (ambivalent affect) is caused by the presence of two neighboring intervals of the same magnitude. There are only two ways to move away from such tension: an increase or decrease in the pitch of any of the tones. Without exception, a semitone ***increase*** in pitch leads to a ***minor*** chord and a semitone ***decrease*** leads to a ***major*** chord. Questions concerning harmonic affect can then be rephrased as: Why does a ***decrease*** in pitch from a state of harmonic tension imply ***positive*** affect, whereas an ***increase*** implies ***negative*** affect? The answer is already known from the "sound symbolism" of human languages and animal vocalizations: decreasing vocal pitch is used to indicate strength and social dominance (commands, assertions), whereas increasing pitch signals defeat and social weakness (questions, uncertainty). The affect of major or minor chords is thus inherently positive or negative because the tonal structures have ancient evolutionary implications of high or low social status.

Key words harmony, major, minor, tension, "sound symbolism"

Introduction

Only human beings are capable of true language and complex tool-usage – the hallmarks of humanity, but some affective processes are also unusually human. Noteworthy is the untrained ability to hear the affective valence of major and minor harmonies (chords, melodies, keys). Even non-musicians who claim they "know nothing" about music can hear the characteristic (dark, sad, negative) sonority of the minor mode and distinguish it from the (bright, happy, positive) sonority of the major mode. – suggesting that the ability to perceive harmony is an inborn trait (although perhaps not developed in some musical cultures). Whether harmony perception is inborn or awakened with exposure to diatonic music is uncertain, but the bias to hear a negative valence in minor chords and a positive valence in major chords is pervasive in the East and West.

We have studied the perception of harmony by non-musicians and developed a psychophysical model to explain the well-known affect of the familiar triads of so-called Western music. Here we report the behavioral regularities of harmony perception and address the longstanding question of why "minor sounds sad" and "major sounds happy".

Methods and Results

All of our experiments have been run with musically-untrained, Japanese college students. The musical sounds have been 2-tone intervals, 3-tone chords, 3-tone chord pairs or short melodies presented over headphones as sine waves (with or without upper partials) or grand piano MIDI sounds. Methodological details (Cook, 2001, 2002) are *unimportant*: the affect of major, minor and tension (diminished and augmented) chords is so salient to normal human listeners that similar results have been obtained from both musicians and non-musicians, children and adults, and peoples from various cultures over the course or more than a century using a variety of musical sounds. In other words, the perception of harmonic modality is ***not*** due to subtle acoustic features of the musical sounds, and is ***not*** dependent on extensive musical training. Typical results are shown in Fig. 1.

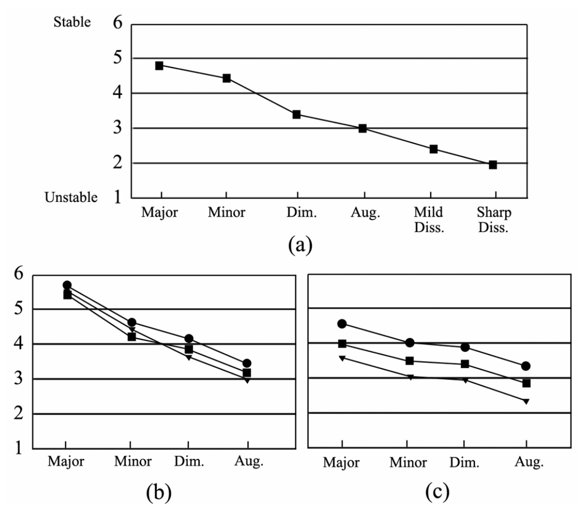

Fig. 1: Results of three experiments on the evaluation of the “stability” (~consonance) of triads. (a) shows data from Japanese non-musicians (Cook, 2002), (b) shows data from American musicians (Roberts, 1986), and (c) shows data from American non-musicians (Roberts, 1986). Different symbols indicate different inversions of the triads, but the same order (major, minor, diminished, augmented) is consistently found.

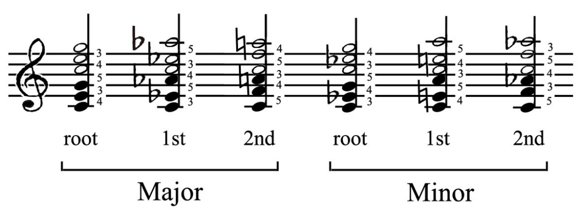

Fig. 2: The major and minor triads are shown as quarter notes, and the first set of upper partials shown as half notes. The interval substructure is shown in small digits.

Empirically, the positive or negative affect of major and minor chords is equally unambiguous. When asked to evaluate the emotional feeling of the chords shown in Fig. 2 along a dimension from “happy” to “sad”, normal subjects find major chords to be “happier” than minor chords. Musically-untrained children as young as 4-5 years also choose a “sad” face to match with a minor chord and a “happy” face to match with a major chord.

What can explain the consistency of the results on the perception of chords? It is known that the summation of the interval consonance (or dissonance) contained in these chords does ***not*** explain either their overall “stability” or the affective valence of the major and minor chords (Parncutt, 1989). If the summation of two-tone effects will not suffice, what about three-tone combinations? As shown in Fig. 2, all of the major and minor chords contain intervals of unequal steps (3, 4 or 5 semitones), whereas the diminished and augmented chords show repeating intervals of 3 or 4 semitones) (Fig. 3). Such repetition of interval size has been labeled “intervallic equidistance” by Meyer (1956), who argued that this is the source of the “tense”, “unresolved”, “unstable” character of these chords (and chromatic scales). In other words, when three-tones are equally spaced, the grouping of the middle tone with either the higher or lower tone is ambiguous. Similar to the instability of the Necker cube, three tones with intervallic equidistance is inherently unstable.

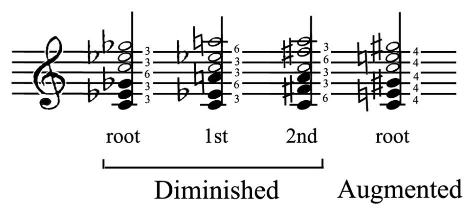

Fig. 3: The diminished and augmented chords with their interval substructure.

Affect

The oldest puzzle in traditional (Western) music theory concerns the affect of major and minor chords. Although many factors influence the emotional valence of musical compositions, notably tempo, pitch range and volume, a direct comparison of major and minor chords – holding all other factors constant – produces consistent results indicating a negative affect for minor chords and a positive affect for major chords.

We have found that an explanation of the affective charge of the harmonic triads is possible using Meyer’s (1956) idea of harmonic “tension” as the centerpiece for a psychophysical model of harmony perception. There are only two ways to move away from such tension: an increase or decrease in the pitch of any the tones. Without exception, a semitone ***increase*** in pitch leads to a ***minor*** chord and a semitone ***decrease*** leads to a ***major*** chord (Fig. 4 & Appendix). This is an indisputable fact of traditional harmony theory, but not mentioned in any of the classical texts!

The question about harmonic affect can then be rephrased as: Why does a ***decrease*** in pitch from a state of harmonic tension (affective ambivalence) imply ***positive*** affect, whereas an ***increase*** implies ***negative*** affect? The answer to this question is in fact already known from the "sound symbolism" (or "frequency code") of human languages and animal vocalizations: decreasing vocal pitch is used to indicate strength and social dominance, whereas increasing pitch signals defeat, social subordinance and weakness (Bolinger, 1978; Cruttendon, 1981; Juslin & Laukka, 2003; Morton, 1977; Ohala, 1984, 1994). The affect of major or minor chords is thus inherently positive or negative because they imply social strength ("happiness") or weakness ("sadness") (see Fig. 5).

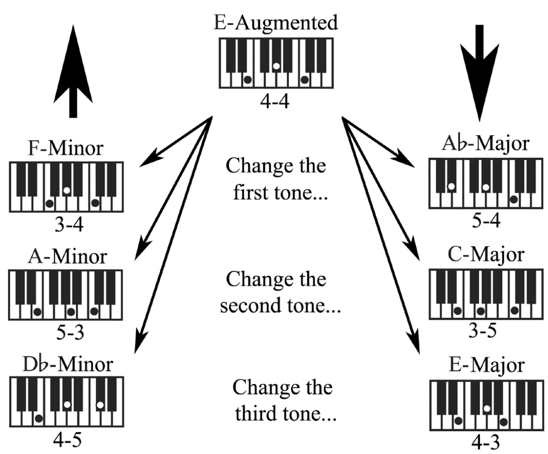

Fig. 4: Starting with any tension chord (e.g., E-augmented), a semitone increase leads to minor chords, whereas a semitone decrease leads to major chords.

The "frequency code" of rising or falling pitch in language has been documented by linguists and has been shown to have considerable cross-species generality in animal calls, as well. In avian and mammalian species, an increase in vocal pitch is indicative of inferior social status and submission, whereas a decrease in vocal pitch is indicative of superior social status and dominance. In human language, such pitch changes have been characterized as indicating "deference, politeness, submission or lack of confidence" and "assertiveness, authority, aggression or confidence", respectively. This relates to the cross-cultural tendency to use rising F0 in questions and falling F0 in statements – indications of "informational weakness or strength".

Conclusions

Most discussions of harmony focus on the resolved major and minor chords, but, from a psychophysical point-of-view, it is the inherent "tension" of the unresolved chords that is the most salient feature of three-tone chords, prior to the issue of the type of modal resolution. In relation to the unresolved (e.g., diminished and augmented) "tension" chords (i.e., triads with two intervals of equal size, or their inversions), minor resolution occurs with a semitone increase in pitch and major resolution occurs with a semitone decrease. Provided only that the dissonance of a semitone or whole-tone interval is not created, it can be said that there are no exceptions to this pattern (Appendix) and, indeed, it is well-known in traditional harmony theory (although normally stated in terms of the pitch decrease of minor relative to major chords, with complete omission of the "tension" chords).

By viewing the regularities of traditional diatonic harmony in relation to harmonic tension, one of the oldest conundrums of harmony theory finds an easy solution: minor chords are indicative of a semitone pitch increase and major chords are indicative of a pitch decrease. Starting from the affective ambiguity of chordal tension, the "meaning" of minor chords thus has an evolutionarily-ancient connotation of social weakness and submission, whereas major chords connote social dominance and strength. From that core meaning concerning social status, the psychological affect of these harmonies can be summarized (in first approximation) as "sad" and "happy". It is of course true that all pitch changes in both music and language are highly context-dependent and therefore meanings can be altered by contextual changes, but it is nonetheless a simple fact of diatonic harmonies that, starting with a minimal configuration of three-tone chords, the smallest (semitone) movement of one tone from a state of harmonic tension will lead to the positive affect of a major chord or to the negative affect of a minor chord, depending solely on the direction of pitch change.

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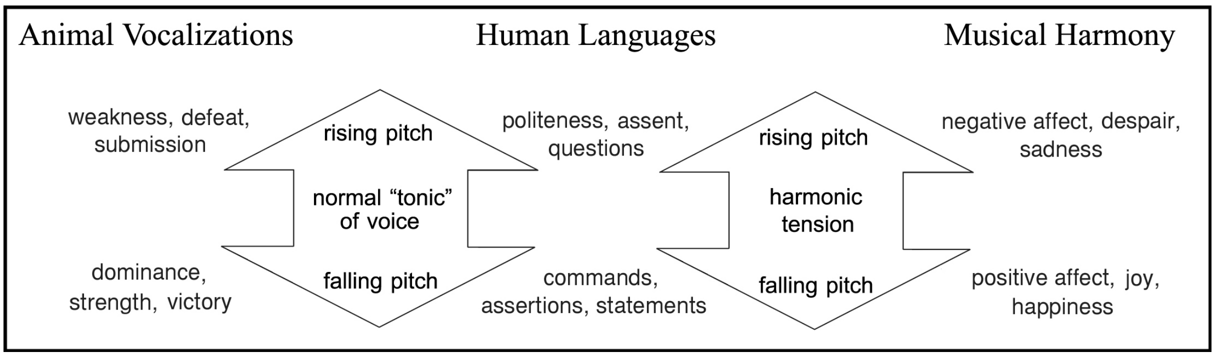

Fig. 5: The affect of pitch increases and decreases are similar among animal vocalizations, human languages and musical harmony.

Appendix

The Major and Minor Chords in Relation to the Tension Chords

Interval Structure (in semitone units, e.g., the major chord in root position is "4-3")

Chord after Lowering of One Tone			Tension Chord	Chord after Raising of One Tone		
n-n-d	n-d-n	d-n-n		n-n-u	n-u-n	u-n-n
3-2	2-4	4-3	**3-3**	3-4	4-2	2-3
4-3	3-5	5-4	**4-4**	4-5	5-3	3-4
5-4	4-6	6-5	**5-5**	5-6	6-4	4-5
6-5	5-7	7-6	**6-6**	6-7	7-5	5-6
7-6	6-8	8-7	**7-7**	7-8	8-6	6-7
5-1	4-3	6-2	(~5-2)	5-3	6-1	4-2
2-4	1-6	3-5	(~2-5)	2-6	3-4	1-5
8-7	7-9	9-8	**8-8**	8-9	9-7	7-8
9-8	8-10	10-9	**9-9**	9-10	10-8	8-9
3-5	2-7	4-6	(~3-6)	3-7	4-5	2-6
6-2	5-4	7-3	(~6-3)	6-4	7-2	5-3

Labels from Music Theory (alternatives are possible)

n-n-d	n-d-n	d-n-n		n-n-u	n-u-n	u-n-n
-	maj7	maj	**dim**	min	-	min7
maj	maj	maj	**aug**	min	min	min
maj	maj7	-	**sus4**	-	-	min
-	-	-	**tritones**	-	-	-
-	maj7	maj	**sus4**	min	-	-
-	maj	maj7	(sus4)	min	-	-
maj7	-	maj	(sus4)	-	min	-
maj	maj	maj	**aug**	min	min	min
maj	maj7	-	**dim**	-	-	min
maj	-	maj7	(dim)	min7	min	-
maj7	maj	-	(dim)	-	-	min

Key: d : Downward semitone shift (from the tension chord) u : Upward semitone shift (from the tension chord)
n : No change (from the initial tension chord) ( ) : Inversions of the tension chords