Revealing the Mystery of Emotions in Sounds

The Theory of Musical Equilibration Explains the Impact of Ordered Sounds as the Listener's Identification with Processes of Will

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Abstract

Science has long been concerned with the question of how it is possible for music to elicit emotions–so far, however, with only moderate success. The theory of musical equilibration shines a light on this problem from a new perspective. The theory was first proposed in 1997 by German music theorist, Bernd Willimek, who further developed it with his wife and fellow theorist, Daniela Willimek. Music itself, the theory goes, cannot generate emotions directly. Rather, emotions should be understood as a response to the processes of will that are encoded in music. By identifying with these processes of will, listeners experience music emotionally. This is comparable to the situation of moviegoers who identify with the protagonist on screen and thereby vicariously experience emotions. In this work, the affirmative character of the major triad and the negative character of the minor triad are substantiated. According to the theory of musical equilibration, the volume at which a minor chord is played determines whether it is perceived as sorrow or anger. Furthermore, the authors discuss issues such as why a diminished seventh chord is well-suited as the score for film scenes involving fear, or how an augmented chord can convey amazement and astonishment. To show the practical application of the theory of musical equilibration, the authors carried out tests with school (K-12) and university students (basic test part A, basic test part B, Rocky test).

Keywords:

Theory of musical equilibration, Strebetendenz-Theorie, music, emotions, music theory.

Introduction

As far as previous attempts to explain the emotional effect of sounds are concerned, the BRECVEM model by Juslin and Västfall (2008) deserves special mention. Since the most important theories to explain the emotional effects of music were integrated into the BRECVEM model, we use this model when contrasting the theory of musical equilibration

to other work. The BRECVEM model introduces seven (later eight) mechanisms that explain the emotional impact of music.

One mechanism concerns the brainstem reflex (Juslin, 2013), which alerts the listener to potentially important and urgent incidents based on elementary acoustic events, such as a suddenly loud sound. Then the authors name the rhythm to which the heart rate can adapt, which results in arousal in the listener. Other mechanisms concern conditioning and emotional contagion. Here, it is assumed that we react to musical characteristics imitatively and automatically, as if the musical stimulus was actually been uttered by a human being. The authors also name the visual image that arouses emotions in the person listening to music, the personal memory of an experience that coincided with a piece of music previously heard, and emotional sensations that arise due to fulfilled or unfulfilled listening expectations.

Juslin (2013) added an eighth mechanism in a revised version, the aspect of ”aesthetic judgment“ and ”aesthetic emotion“, which could manifest itself in ”feelings of appreciation“ and ”admiration“.

In summary, it remains undisputed that the eight mechanisms mentioned can influence the emotional experience of music. It can be stated that some of the eight mechanisms mentioned are not specifically applicable to music: they may also apply to other things which should thus logically create an equally emotional effect. Moreover, none of the eight mechanisms adequately explains the different emotional effects of chords, intervals, or tone sequences. Overall, the model does not deal with musical parameters in any detailed fashion. Only the opposite attributes of loud-quiet and dissonant-consonant are dealt with here. Music is treated as a monolith.

Lahdelma and Eerola (2016) conducted studies that examined the emotional impact of chords. In these tests, subjects assigned different sounds (major chords, minor chords, seventh chords, diminished and augmented triads) to specific terms (valence, energy, tension, nostalgia, melancholy, interest, happiness, tenderness, and liking). While diminished and augmented triads were perceived as particularly tense, major chords and minor chords corresponded, as expected, to the qualities of happiness and sorrow. Remarkably, the major chord with a major seventh was mainly correlated to the word pair longing/nostalgia. This corresponds to the description of the subdominant with a major seventh by the theory of musical equilibration (see Willimek, 1998, p. 7).

Since Lahdelma and Eerola also do not explain the cause of the emotional effect of harmonies, the following statement by Gabrielsson and Lindström (2012, p. 393) still remained valid: ”... there is practically nothing on how different kinds of chords...may affect expression.“

Other recent investigations have increasingly focused on brain research. For example, Koelsch (2014) found brain areas which are active while listening to music and "that are known to be crucially involved in emotion, such as the amygdala, nucleus accumbens, hypothalamus, hippocampus, insula, cingulate cortex and orbitofrontal cortex." Previously, Altenmüller (2001) had shown the variety of brain regions involved in music processing, which are active both individually and in interaction with each other.

The theory of musical equilibration approaches this problem in a different way by tracing emotional impulses when listening to music back to will processes that are encoded in the music. In the following chapters, these processes of will are first theoretically derived, then described in connection with musical elements such as leading tones, and finally illustrated in their application to chords.

What kind of music are we talking about? In this paper, we address major-minor tonal music as well as its variants and further progressions. We discuss music solely in its sonic quality, i.e., without accompanying lyrics or images.

1 The theory of musical equilibration: processes of will produce the emotions in music

According to the theory of musical equilibration by Willimek (1998), music cannot generate emotions directly, which is why the search for an immediate connection is basically doomed to failure. Rather, there is an intermediate link between music and emotions, namely the processes of will which are encoded in music and which the listener identifies with. By identifying with processes of will, listeners can experience music emotionally. Identifying with the content of the will as discussed in the theory of musical equilibration is comparable to a moviegoer identifying with the content of the will of the protagonist represented in the film. In both cases one experiences feelings, which are not one's own, emotionally. Anne Bartsch (2011, 61ff; 2012) speaks in this context of meta-emotions, i.e. feelings about feelings. Through the idea of meta-emotions one can also explain why one can feel different feelings than those a medium communicates. The main difference between music and film is that in music there are usually neither actions nor protagonists. In music, there are only sounds that can serve as symbols.

But how can frequencies be symbols? Ernst Kurth (1969, p. 1) pointed out that sounds are not experienced as frequencies, even though they are frequencies. He mentioned an inner objectification of sounds when listening to music. Hermann von Helmholtz (1913, p. 593) made similar observations. Therefore, a sound that we experience as music is no longer merely a frequency, but rather something indeterminate. This would explain why sounds can serve as symbols.

1.1 Philosophers described the importance of the will in music

The importance of the will in music was already described by philosophers such as Arthur Schopenhauer and Friedrich Nietzsche in the 19th century. According to Schopenhauer (1958), music is ”as *immediate* an objectification and copy of the whole *will* as the world itself is, indeed as the Ideas are, the multiplied phenomenon of which constitutes the world of individual things. Therefore music is by no means like the other arts, namely a *copy* of the Ideas, but a *copy of the will itself*, the objectivity of which are the Ideas. For this reason the effect of music is so very much more powerful and penetrating than is that of the other arts, for these others speak only of the shadow, but music of the essence.“,[1] while Nietzsche (1871) postulated that ”*the Will is the object of music but not the origin of it* , that is the Will in its very greatest universality, as the most original manifestation, under which is to be understood all Becoming. That, which we call *feeling*, is with regard to this Will already permeated and saturated with conscious and unconscious conceptions and is therefore no longer directly the object of music; it is unthinkable then that these feelings should be able to create music out of themselves.“[1]

1.2 How to understand the processes of will in music?

Processes of will, according to the theory of musical equilibration, are usually denoted by terms such as “suspension”, ”leading tone”, or ”striving tone”. These terms refer to tones that noticeably tend to change into other tones. In this context, Kurth (1969, p. 13) mentioned a ”huge pulling force“,[1] Herzfeld (1965, p. 309) described a ”tone that strives towards neighboring tones into which it wants to dissolve”,[1] and Moser (1955; p. 685) detected a ”certain electromagnetic force of motion“.[1] However, the theory of musical equilibration denies that such tendencies are perceptible or imaginable, and justifies this in the following thought experiments (see chapter 1.3).

The identification with will-related content in music entails envisioning the person listening to music as someone who is mentally able to imagine themselves in a situation where they want to influence the perceived musical events, such as the duration of a note. This sense of identification can also be carried out with passion, but usually someone listening to music knows that identifying with the music (in the same way the moviegoer identifies with the protagonist) does not have an effect on their real life and they can distance themselves from this scenario.

1.3 Leading tones cannot “strive”

Leading tones cannot perceptively “strive“ because ”striving“ tendencies are generally not capable of being perceived in physical states. To illustrate this, let us try to imagine a heavy suitcase ”striving“ down to the ground. What happens? We imagine how it feels to stand upright and carry a heavy suitcase. This means that we did not imagine a weight

[1] Translated from the original German text

that is striving down, but rather that we identified with a force of will that was contrary to the weight of the suitcase. We have essentially reached into a box of tricks and exchanged an impossible idea for a possible one. Something similar happens when we try to imagine a tone ”striving” to change pitch. Again, we reach into the box of tricks and identify with a force of will that is opposed to the ”striving“ of the tone, that is, we identify with the determination to keep the tone unchanged. This means that the leading tone effect is nothing more than our identification with the will to prevent a pitch change. This is illustrated by Figure 1.

Another example: A driver is sitting in a compact car, parked on a very gentle downward slope. The parking brake is not on, but the car does not roll down the hill, because the passenger is standing in front of the car and using all of their might to keep it in place. The passenger claims to feel how hard the car is ”striving”, i.e. attempting to move down the hill, but this claim can easily be refuted. Assuming the car is not in motion, the passenger would not even notice if the driver secretly put on the parking brake. Because the passenger does not notice when the handbrake is applied, they cannot have previously felt that the car was striving downwards. This example means that ”striving“ tendencies are not capable of being perceived in physical states.

1.4 Embodied cognition

Recent work on cognition research is increasingly concerned with the notion of embodied cognition (Glenberg, 2015; Proffitt, 2006; Witt & Proffitt, 2008; Zwaan, 1999a, b; Leman & Maes, 2015; Mazurkiewicz-Sokołowska, 2020). In contrast to the traditional conception of cognition, embodied cognition is understood as embodied action. According to this view, cognition involves actions embedded in the biological, psychological and cultural context. Embodied means that cognition is the experience of the body and its sensorimotor skills. Connections between the idea of embodied cognition and the research on music perception were created, for example, by Matyja (2016), Leman & Maes (2015), van der Schyff et al. (2018), and Kozak (2020). Here, among other things, physical effects on individual musical parameters are investigated.

The leading tone representation in the theory of musical equilibration suggests a new connection with the research on embodied cognition. Here, the question arises to which extent the processes of will described here are shifted into the corporeal (see Figure 1). Are leading tones and the will processes reflected in sensorimotor perceptions? Such investigations could be the subject of future research and lead to new insights. Thereby, links back to the work of Ernst Kurth (1969) and his explanations on the perception of tones as something similar to matter also might became possible.

Figure 1

The leading tone effect

Note: This symbolic image illustrates the leading tone effect in the sense of the theory of musical equilibration. The listener does not experience the leading tone as striving away but identifies with the will to maintain the leading tone.

1.5 What is the origin of leading tones?

There have been many attempts to explain the phenomenon of the leading tone effect, but to this day, there is no clear answer. Since sounds that come close to pure tones are usually perceived as boring, weak, and devoid of energy (von Helmholtz, 1913, p. 594), it seems likely that leading tone develop from overtones, possibly as an interplay of conscious and unconscious perceptions. A root and its overtones are perceived as a unit, but, in contrast, the perception of overtones as individual tones remains unconscious (Abel, 1982, p. 10).

A logical explanation of the leading tone effect could be the effect of the dissonant second intervals, which are formed by lower overtones. In the usual continuation of leading tones, these second intervals resolve, partially, into primes.

The unpleasant effect of minor seconds has been described several times (Kungel, 2008, p. 76; Lack, 1999, p. 150). However, since the concerning seconds are partly perceived unconsciously in the overtone range, one could assume that the partly unconscious urge to clean up the unpleasant seconds is the actual origin of the leading

tone effect. The psychological notion of the existence of the conscious and the different unconscious part of the psyche makes imaginable that the leading tone effect appears in consciousness as identification with a resistance, i.e., with the will to counter the leading tone's resolution.

One could also say: Since a leading tone continues to sound for some time despite the unconscious will to dissolve it, an incomplete situation arises for the listener at this moment. This is because the listener does not perceive the resistance that could explain the short-term lingering of the leading tone. Therefore, they intervene correctively in the perceived situation and create emotional resistance against the leading tone's resolution by identifying with the resistance. This could be explained by the brain's effort to meaningfully fill in what is missing in perceived impressions (Dölger, 2016; Ilg, 2017). See also the work on acoustic illusions by Diana Deutsch (1975).

With simple leading tone phenomena, which only occur between two tones or with the third of a major chord, such connections can be easily identified. It becomes more complicated with more complex sounds. It should also be noted that learning processes could also play a role.

Using the example of the minor ninth, one could imagine this principle as follows: In the case of the minor ninth *c – d¹ flat,* this would be the overtone *c¹* of the tone *c* and the tone *d¹ flat* of the interval *c - d¹ flat*, which merge into the prime *c¹ - c¹* as the ninth progresses into the octave *c - c¹*.

According to the theory of musical equilibration, the listener perceives, while the interval *c – d¹ flat* sounds, the minor second between the overtone *c¹* and the tone *d¹ flat* of the interval *c – d¹ flat* as a disturbance. If this disturbance is not consciously experienced, then the listener identifies with the will to keep the tone *d¹ flat*, and the leading tone effect occurs. If, in contrast, the tones *c* and *d flat* are played simultaneously, then the listener consciously perceives the minor second as a disturbance, and there is no leading tone effect (see Honegger & Massenkeil, 1981, p. 92).

Corresponding minor seconds are found at fourths (4. and 3. overtone), minor sixths (2. and 1. overtone) and minor sevenths (4. and 2. overtone). These minor seconds resolve in unison when the upper tone of the interval takes a minor second step downwards. As for major thirds (3. and 2. overtone) and major sevenths (1. overtone and root), this happens when the upper interval tone takes a minor second step upwards. As for tritones, there are minor seconds between the 2. and 1., as well as between the 3. and 2. overtone which both could resolve in unison.

For more complicated sounds (e.g. diminished seventh chord, augmented triads,

subdominant with added sixth), in addition to the minor seconds, other factors could also play a role, e.g. learning processes, different ways of interpreting the tones as a root (see Schmid, 2012), or functional interpretation. These factors should be the subject of further investigation. In the following chapters, some applications of the theory of musical equilibration to sounds are shown.

2 Applying the theory of musical equilibration

When applying the theory of musical equilibration to ordered sounds as described below, it should be clear that other factors may also play an important role in the effect of music on a listener. The volume, melody, or tempo of a piece can contribute to the sensation (Berg & Wingstedt, 2005; Fernández-Sotos et al., 2016; Bresin & Friberg, 2011). Other factors to consider are the personal characteristics of the listener such as his background, social environment, character, current mood, level of concentration, musical knowledge, preferences, and acquired associative links between music and emotions (Vuoskoski & Eerola, 2011; Castro & Lima, 2014; Demorest & Morrison, 2003). Therefore, the theory of musical equilibration should be applied with caution.

When we apply the theory of musical equilibration to ordered sounds, we use the following model: We assume that on leading tones, the listener volitionally identifies with a resistance to ”striving”. Leading tones, in the conventional sense, include major thirds of the major chord (e.g., c^1 and e^1 in C major), minor sixths (e.g., c^1 and a^1 flat), sevenths (e.g., c^1 and b^1), ninths (e.g., *c* and d^1 *flat*) and suspended notes (e.g., f^1 about c^1) (see Honegger & Massenkeil, 1981, p. 92).

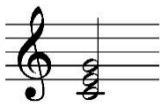
2.1 Major chords are happy, and minor chords are sad

Major chords (see Figure 2) have always been considered as happy, and minor chords as sad (see Cooke, 1959, p. 50f; Parncutt, 2013, p. 1). According to the theory of musical equilibration, the reason for this contrast lies in the leading tone effects of the sounds. In the triad c^1-e^1-g^1, the tone e^1 is a leading tone (see Honegger & Massenkeil, 1981, p. 92). In the sense of the theory of musical equilibration, here the listener identifies with a will that resists a change. Therefore, the major tonic is an expression of consent and is commonly described as ”affirmative“[2] (Herzfeld, 1965, pp. 149 a. 351; Dent, 1927, p. 119, Kloppers, 2012, p. 143).

[2] Translated from the German.

Figure 2

Major chord



Note. The major tonic can express a feeling of consent.

Often, the minor chord (see Figure 3) is not understood as an independent harmony, but rather, because of the minor third, as a weary version of the major chord (see Hindemith, 1940, p. 101; Bernstein & Capellen, 1993, p. 89). In the sense of the theory of musical equilibration, in minor chords the feeling of consent is also exhausted and becomes a feeling of lack of consent. The listener identifies with the sentiment “No more!”. When the words “No more“ are barely and slowly whispered, they sound sad, and when loudly and fast shouted, they sound angry (see Vankova, 2011, p. 47). Accordingly, quiet and slow minor chords are perceived as sad, and loud and fast ones as angry (see Bresin & Friberg, 2000, p. 46; Livingstone et al., 2010, p. 46; Chong et al., 2013; Varwig, 2020, p. 8; Saarikallio et al., 2014, p. 11; Turner & Huron, 2008, p. 64). Regarding the different perception of major and minor chords, comparative studies within embodied cognition would be of particular interest (see Chapter 1.4).

Figure 3

Minor chord

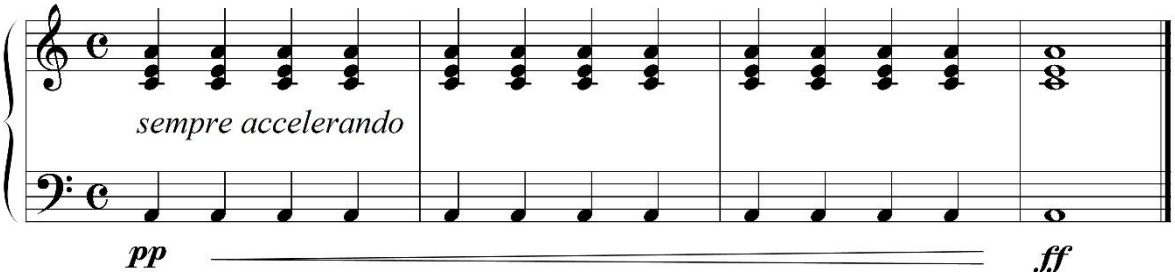
Note. Depending on the volume, a minor chord can sound sad or angry.

When you repeat minor chords first quietly, and then louder and faster, you can experience a transformation of the expression from grief into anger (see Figure 4).

In the basic test part B, task 2 (see chapter 3.2), the participants were asked which of the following statements best describes the example in Figure 4: “Sorrow turns into anger”, “sorrow turns into joy”, or “anger turns into sorrow”. All of the 23 participants preferred the first statement.

Figure 4

Minor chords sempre accelerando



Note. Repeating a quiet minor chord louder and faster creates the impression that grief turns into anger (*D. Willimek & Willimek, 2019,* p. 26).

2.2 Major chords can sound sad too

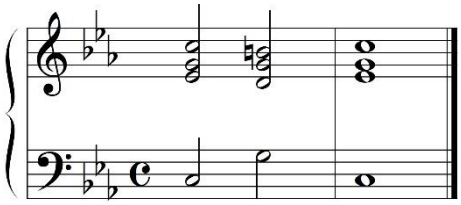
Even if the notion of happy major and sad minor chords is widespread, it is undisputed that even major chords can sound sad, too. For example, when a G major dominant follows a c minor tonic (see Figure 5), the major dominant can take on the sad character of the minor tonic. Cadences, pieces, modes, and keys in minor are described as sad or by other unpleasant emotional terms, without differentiating whether they contain major dominants or not. They are evaluated uniformly in their emotional character (This is a sad piece) and not individually according to the current chord (This piece is sad, happy, sad, happy...) (see Huron, 2011, p. 151; Turner & Huron, 2008, p. 67; Kawakami et al., 2014, p. 1; Görner & McLaughlin, 2007, p. 157; Urecki et al., 2011; Marisi, 2020, p. 6; Parson, 2021).

The theory of musical equilibration explains this as follows: when the major dominant of a minor tonic sounds, the listener identifies with a will to resist change, because the dominant is a major chord. However, since the listener expects a minor tonic to follow the dominant, this change is characterized by the return to the minor tonic. Therefore, the minor tonic also shapes the character of the preceding major dominant,

which sounds as sad as the anticipated minor. As a result, the major chord has no brightening effect. This means that major dominants in minor keys can sound just as sad as the minor tonic itself.

Figure 5

Sad major chord

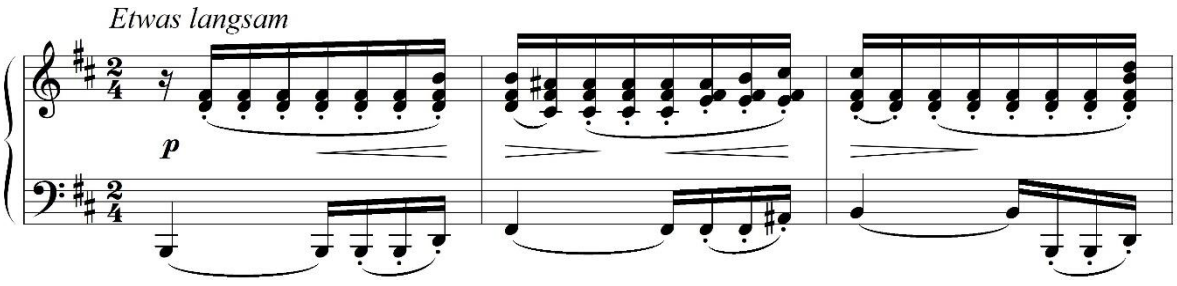


Note. Here the major chord can be perceived as sad as a minor chord (*D. Willimek & Willimek, 2019*).

An example of a piece of music in which major and minor chords sound equally sad is the prelude to the song *Die liebe Farbe* [The beloved color] from the song cycle *Die schöne Müllerin* [The beautiful maid of the mill] by Franz Schubert (see Figure 6).

Figure 6

Excerpt from "Die liebe Farbe" by Franz Schubert



Note. In the prelude to the song *Die liebe Farbe* [The beloved color], the major chords sound as sad as the minor chords. From *Die schöne Müllerin* [The beautiful maid of the mill], [Musical score] by F. Schubert and W. Müller, 1985. In D. Fischer-Dieskau (Ed.), *Franz Schubert: Lieder* (Vol. 1). C. F. Peters, p. 46.

2.3 Exciting and adventurous: The Aeolian minor scale

The tones *a, b, c^1, d^1, e^1, f^1, g^1*, and *a^1* are an Aeolian minor scale. Music in the Aeolian mode is preferably used in theme songs of thrillers, action movies, science fiction, and for the background of exciting scenes. An example is the theme song of the German television crime series “Tatort“ (“Crime Scene”).

Frank Lehmann (2016, p. 37) writes about Hans Zimmer’s music in the film “Gladiator”: “Natural minor/aeolian harmony is nearly obligatory for action marcatos, resulting in an emphasis on the minor dominant (v) and subtonic (bVII). The aeolian cadence [f#: iv7 to v to i] in m. 4 of Example 2.4 is characteristic. As with other Zimmer musical fingerprints, the leading-toneless minor mode is favored for its connotations of masculine stoicism.”

The adventurous effect of the Aeolian mode is also popular in pop music (see Jaedtke, 2000, 210ff; Björnberg, 2007; Scholz, 2014, p. 313). Björnberg (2007, p. 5) says that Aeolian minor is used in connection with lyrics ”dealing with subject matters such as historical and mythical narratives, static states of suspense and premonition, alienation in life and in personal relationships and fear of, but also fascination by, the future and modern technology and civilization“.

In the basic test part B, task 1 (see chapter 3.2), the authors played two similar cadences, one in Aeolian minor, the other in harmonic minor. The question was: which piece sounds more adventurous? 70 % preferred the example in Aeolian minor as better matching the term ”adventurous“.

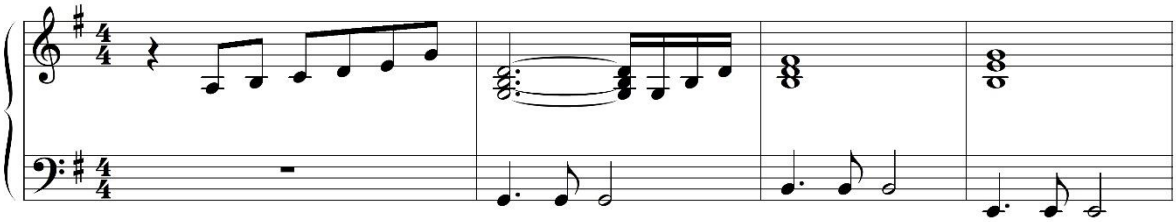
How can the effect of the Aeolian mode be explained? The special feature of music in the Aeolian mode is the lack of a dominant leading tone. In the note sequence “*a, b, c^1, d^1, e^1, f^1, g^1*, and *$a^{1''}$*, for example, the leading tone *g^1 sharp* is replaced by the note *g^1*. In the sense of the theory of musical equilibration, the leading tone, if not replaced, would be associated by the listener with a will against the return of the minor tonic, since the listener would expect a minor tonic to follow the major dominant. But because the leading tone in the Aeolian minor scale is lacking, the impression of resistance which the leading tone could convey is also missing. This can create the impression that a return to the minor tonic is accepted without resistance, as if a difficult situation is being met voluntarily. Therefore, the Aeolian mode suits situations that require courage and adventurousness. This explains the frequent use of the Aeolian

mode in thrillers.

An example for Aeolian minor is *Samba pa ti* by Carlos Santana (see Figure 7). Here, the minor scale does not sound sad, but stimulating.

Figure 7

Excerpt from "Samba pa ti" by Carlos Santana



Note. The minor chords of *Samba pa ti* do not sound sad, but stimulating. From *Samba pa ti* [Samba for you] by C. Santana, 1970, [Piano & guitar score], [Digital sheet music]. Musicnotes. Universal Music Publishing Group (https://www.musicnotes.com/sheetmusic/mtd.asp?ppn=MN0152750).

2.4 Wonder and amazement: The augmented triad

An augmented triad consists, for example, of the tones *c^1-e^1-g^1 sharp*. The special characteristic of this sound is that it is not possible to clearly perceive which of its tones are leading tones (La Motte, 1983, p. 54). As soon as the listener identifies one of the three tones as consonant, another appears as dissonant. Therefore, the listener cannot clearly identify with an encoded will and assumes a questioning attitude. Augmented triads (see Figure 8) can express a sense of wonder, surprise, and magic.

In the literature, the augmented triad is described by terms as "unexpected" (Klobnak, 2013), "unbestimmbar" (Moßburger, 2018), "nebulös" (Roidinger, 2015, p,115), "magic" (*Magic Family*, n.d.; Monelle et al., 1979, p. 184; Hoffman, 2010; Martinez, 2021, p. 47) "disorienting and ambivalent" (F. M. Lehman, 2014); "Mehrdeutigkeit" (Cohn, 2012, p. 57), "ambiguity" (Kim, 1999, p. 27; McKinney, 1993, p. 39).

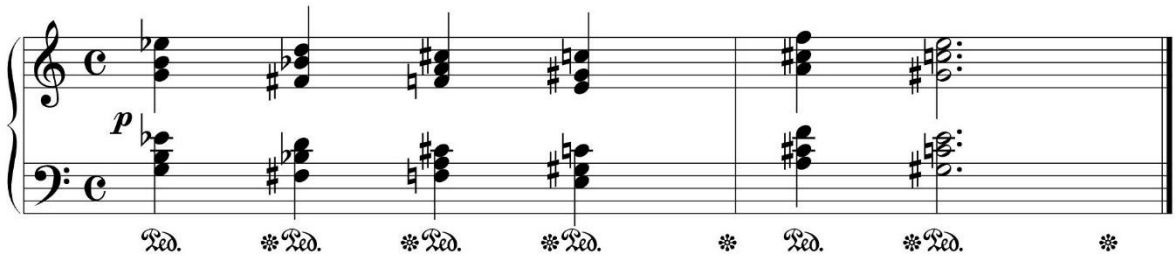
In movies, the chord is often used for scenes that show a wonderful, magical event. An example is the moment in the movie "Two times Lotte" by Josef von Báky when twin girls who were separated at birth meet for the first time as nine-year-olds.

The twins are stunned and cannot cope with the miraculous sight. The scene is accompanied by augmented triads.

In the basic test part A, (see chapter 3.1), 96 % of the participants assigned augmented triads to the term ”magical transformation”.

Figure 8

Augmented triads



Note. These augmented triads can suggest a feeling of magic (*D. Willimek & Willimek, 2019,* p. 75).

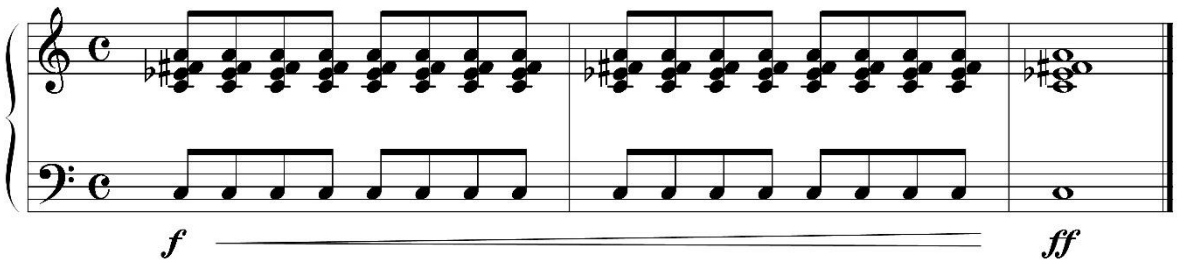
2.5 Symbol of horror: The diminished seventh chord

Arnold Schönberg (1922, p. 288) pointed to the use of the diminished seventh chord to express terror and horror. How can this effect be explained? The diminished seventh chord consists, for example, of the tones c^1 - e^1 *flat* - f^1 *sharp* - a^1 (see Figure 9). The chord contains several leading tones (see Honegger & Massenkeil, 1981, p. 92f). The theory of musical equilibration interprets these leading tones as multiple prompts to identify with a will to resist any resolution to the tonic. When the chords are played loud, this can create the impression of a panicked defense against an impending change. Therefore, the diminished seventh chord is a suitable expression of horror and terror

In the literature, the diminished seventh chord is described as ”terrifying” (Hill, 1996, p. 529; Fee, n.d.; Philip, 2018, 384), ”shuddering” (Philip, 2018, p. 891; Morrison, 2018), ”shocking” (Ferraguto, 2010, p. 74), ”gruesome” (Engel, 1917, p. 496), ”startling” (Miller, 1995, p. 72; Mirka, 2009, p.126; Faucett, 2012, p. 57). In this context, studies on sensorimotor perception of diminished seventh chords might be particularly promising (see Chapter 1.4).

Figure 9

Diminished seventh chords



Note. When loud, diminished seventh chords can suggest a feeling of horror (*D. Willimek & Willimek, 2019,* p. 52).

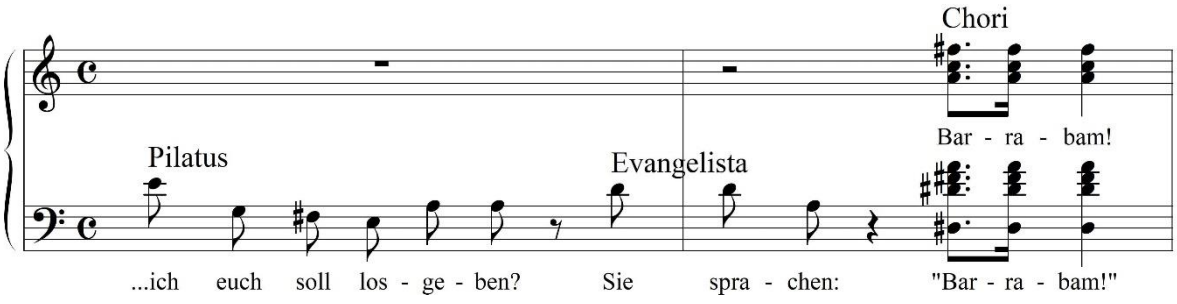
In the basic test part A (see chapter 3.1), 87 % of the participants assigned crescending diminished seventh chords (see Figure 9) to the term “despair”.

In the Rocky test, task 4 (see chapter 3.3), the authors played a piece with major chords and a similar piece with diminished seventh chords. 88 % of the participants assigned the piece with the diminished seventh chords to a scene of despair.

A music example is the Barrabas scene from the *St Matthew Passion* by Johann Sebastian Bach (see Figure 10). The diminished seventh chords at the word ”Barrabam” express the horror of this moment.

Figure 10

Excerpt from the ”St Matthew Passion” by Johann Sebastian Bach



Note. Because of the diminished seventh chords, the word "Barrabam" sounds horrific. From *Matthäus-Passion: BWV 244* [Musical score], by J. S. Bach, A. Dürr, and M. Schneider, 1973, p. 200.

2.6 Major chords with major sevenths can express wistfulness

The tones *f-a-c*^{1}*-e*^{1}, for example, form a major chord with a major seventh (see the last chord in Figure 11). Such sounds are suitable to expressing a feeling of longing and nostalgia (see Cooke, 1959, p. 90; Lahdelma, 2014). With regard to the major seventh chord, Huron (2007, p. 144) describes the ”strong sense of precariousness or instability mixed with some urgency and accompanied by feelings of yearning or aspiring upward”. Elsewhere, the major seventh and the major seventh chords are described by terms as ”aspiration“ (Buravenkova et al., 2018, p. 556; Kaygusuz & Zuluaga, 2018, p. 2; Raghu, 2018 p. 79), and ”longing“ (Maher, 1980, p. 321; Raghu, 2018, p. 79; Makeig et al., 2011, p. 490).

The effect of wistfulness can be explained by an overlay of two different emotional impressions, namely a pleasant one, due to the major chord, and an unpleasant one, due to the dissonant major seventh. The combination of the two emotional impressions evokes a melancholic yearning, which corresponds to the definition of wistfulness given in the Dorsch Lexicon of Psychology (see Wirtz, 2014, p. 1033), as a mixture of a pleasant and an unpleasant feeling.

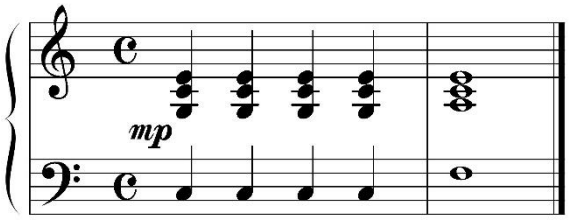
It is conceivable that this combination of positive and negative mood cannot be experienced meaningfully by untrained listeners at first and is only experienced as an expression of longing after a learning process. This could be explained by the brain's endeavor to interpret perceived impressions in a meaningful way (Hessbrueggen, 2011; Stettner, 2018; Rüschemeyer, 2011).

In tests, Lahdelma and Eerola found, that ”the major seventh chord was, from seven chords [major, minor, diminished, augmented triads and dominant, major and minor seventh chords], rated as the most nostalgic chord alongside the minor triad“(see Lahdelma & Eerola, 2016, p. 14). The offered emotions were valence, energy, tension, nostalgia, melancholy, interest, happiness, tenderness, and liking.

In the basic test part A (see chapter 3.1), 91 % of the participants assigned the term ”dreams of summer” (wistfulness) to the example with the major seventh chord (see Figure 11).

Figure 11

Subdominant with a major seventh

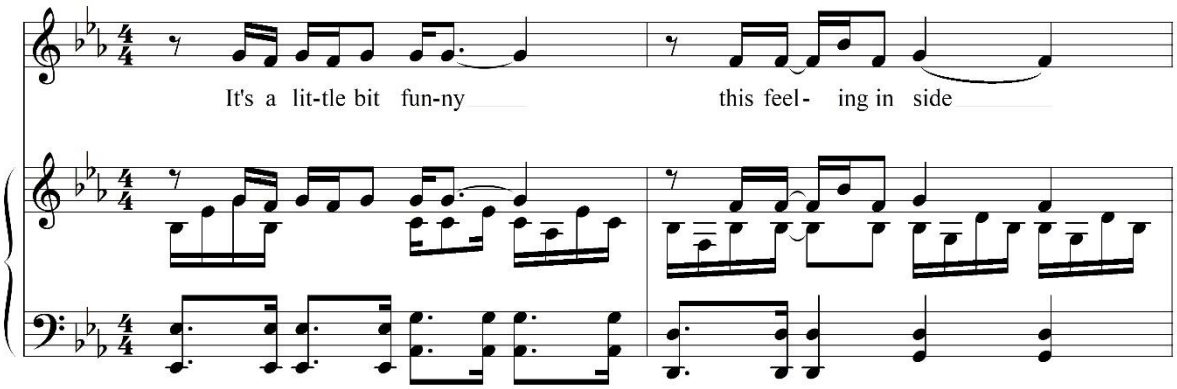


Note. The last chord of this example, the subdominant with a major seventh, can suggest a feeling of wistfulness (*D. Willimek & Willimek, 2019,* p. 82).

Examples of music containing the subdominant with a major seventh are Elton John's *Your Song*, on the word ”funny” (see Figure 12), and the second bar of the *Air* from the *Third orchestral suite* by Johann Sebastian Bach (1992).

Figure 12

Excerpt from ”Your Song” by Elton John and Bernie Taupin (1969)



Note. Your song by Elton John and Bernie Taupin produces the wistful effect of the subdominant with the major seventh at the word “funny”. From *Your Song* by E. John, and B. Taupin.

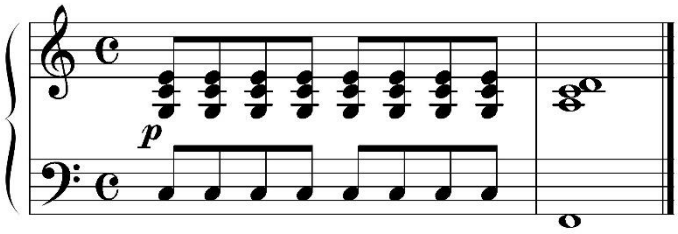
2.7 The subdominant with an added sixth: A feeling of warm security

In C major, the subdominant with an added sixth consists, for example, of the tones *F-a-c*^{1}*-d*^{1} (see the last chord in Figure 13). Music theorist Diether de la Motte (1983, p. 54) described the effect of the fifth and sixth of this sound as a *"striving apart"*. In the sense of the theory of musical equilibration, the term "strive apart" becomes its opposite: the will to stay together. This explains the sense of warm security and togetherness that this sound can evoke.

In the literature, the subdominant with an added sixth is described with terms as "sweet" (McGowan, 2011, p. 181; Barham, 2018, p. 383; France, n.d.), "doux accord de sixte ajoutée" (Tranchefort, 1987), "warm added sixth chord, symbolically united" (Manning, 1999, p. 34), "kitsch" (Bannister, 2013, 695), "erotic" (Barham, 2010, 192), or "Geborgenheit" (Rothe & Braun, 2017).

Figure 13

Subdominant with an added sixth



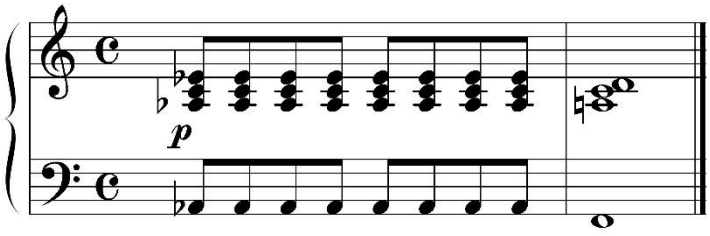
Note. The last chord of this example can create a feeling of warm security (*D. Willimek & Willimek,* 2019, p. 87).

However, this feeling is not based on the sound itself, but is caused by the subdominant's leading tones, as shown when the sound is introduced in a way that is not subdominant. Then it no longer sounds safe, but rather lost (see the last chord in Figure 14).

In the basic test part B, task 4 (see chapter 3.2), the authors played the music examples in Figure 13 and Figure 14. The question was: in which of the two pieces does the final chord convey a stronger sense of warmth and comfort? 95 % of the participants preferred the first example although the two chords were identical.

Figure 14

Major chord with an added sixth



Note. The last chord of this example cannot suggest a feeling of warm security, although it is identical to the last chord in Figure 13 (*D. Willimek & Willimek, 2019*, p. 87).

2.8 Whole-tone music can suggest a feeling of weightlessness

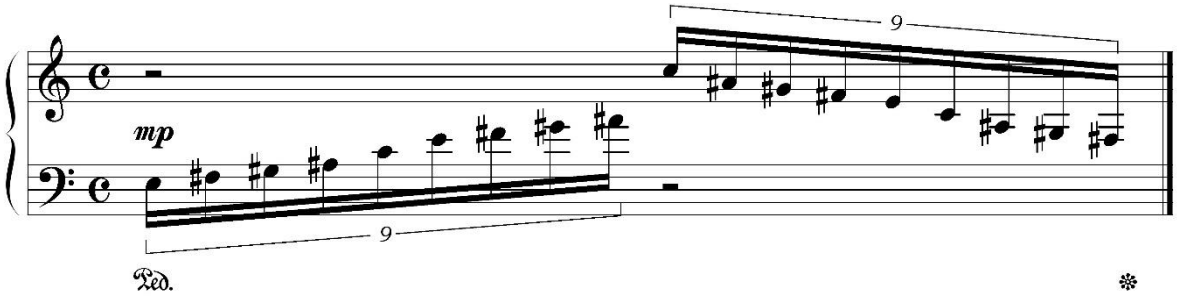
In Impressionism, composers used whole-tone music (see Figure 15). In whole-tone music, there are no pitches in the minor second-spacing, nor are there fundamental tones or leading tones (see La Motte, 1983, p. 250). Whole-tone music is therefore suitable for creating a feeling of weightlessness and is used in film music for scenes that depict weightlessness, such as scenes under water.

In the literature, the whole tone scale is described by terms as ”schwerelos“ or ”Schwerelose“ (Poggel, 2019; Straub, 2018, p. 2; Bruhn, 2017, p. 96), ”float“ (Persinger, 2014; Betuw van, 2017; Taylor, 2018, p. 18; Judd, 2020; Downey, 2016; McPherson, 2016, p. 7), and ”stream“ (Johnson, 2020, p. 2). In this context, studies on sensorimotor perception of whole-tone-music might be particularly promising (see Chapter 1.4).

In the basic test part B, task 5 (see chapter 3.2), the authors played two similar cadences, one diatonic and the other in whole tone music. The question was: what piece would go better with an underwater scene? 95 % preferred the example in whole tone music.

Figure 15

Whole-tone music



Note. Whole-tone music can suggest a feeling of weightlessness (*D. Willimek & Willimek, 2019, p. 102).*

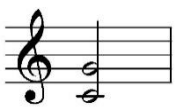
2.9 The fifth can sound lifeless and eerie

If listeners perceive the fifth (see Figure 16) as a chord without a leading tone, this interval can sound lifeless and eerie (see Gutmann, 1970, p. 42; Zentner, 1991, p. 200; Herzfeld, 1965, p. 431). Aside from that, the fifth is described by terms as ”gespenstisch“ (Walther, 2018; Badelt, 2018; Lehmann, 2009, p. 71; Friedrich, 2012, p. 29; ”Die Herrschaft Der Zahlen (1),” 2007, p. 32), ”ghostly“ (Alexander, 1979, p. 144; Wagnerian, 2013; Del Nevo, 2017, p. 158).

In this case, the major third is missing, which according to the theory of musical equilibration would otherwise have enabled the listener to identify with processes of will. The decisive factor here would be that the listener misses the third as the missing leading tone here, the note sensible, which would have breathed a sense of liveliness into the chord. The fifth can therefore evoke an impression as devoid of life as stone pillars in a desert landscape.

Figure 16

The fifth



Note. The fifth can sound lifeless and eerie.

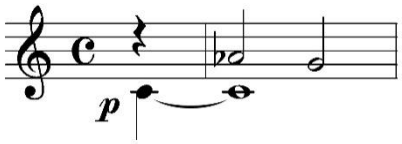
2.10 The minor sixth can sound fearful

The sound of the minor sixth (e.g., *c^1- a^1 flat*) can evoke fear (see Cooke, 1959, p. 90). How can this be explained? In a certain context, the upper tone of the minor sixth, as a leading tone, generates the expectation of dissolution into the fifth (see Figure 17). The fifth itself has been described as lifeless and eerie (see Gutmann, 1970, p. 42; Zentner, 1991, p. 200; Herzfeld, 1965, p. 431). In the sense of the theory of musical equilibration, at the minor sixth the listener identifies with a will against dissolution into the fifth, i.e., dread of an eerie, lifeless, or ghostly situation. This explains the fearful character of the minor sixth.

In the literature, the minor sixth is described by terms as ”anguish“ or ”anguished“ (Kaygusuz & Zuluaga, 2018, p. 2; Chase, 2006; Keays, 2015; Collins, n.d., p. 4; Martinho, 2001, p. 69; Thompson & Quinto, 2011, 363), ”anxiety” or ”anxious” (Imada, 1999, p. 61; Hall, 2017, p. 59; van Orden, 2018, p. 22) or ”doom and gloom” (Davis, 2019).

Figure 17

Minor sixth



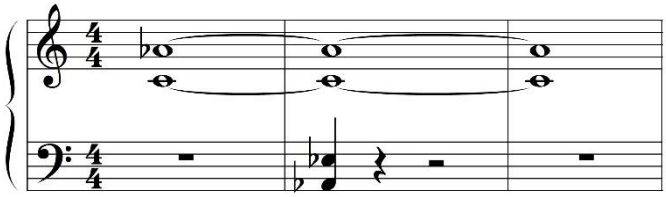
Note. The minor sixth can suggest fearfulness.

In the basic test part B, task 3 (see chapter 3.2), the minor sixth in Figure 17 was exchanged by the major sixth. All participants preferred the minor sixth as better matching to the term ”threatening”.

If one plays, while the minor sixth sounds, another interval which defines the minor sixth as part of a major chord (see Figure 18), the leading tone is no longer a leading tone. Therefore, the minor sixth no longer sounds fearful, but harmless.

Figure 18

Minor sixth with tones in the bass



Note. Due to the tones in the bass, the minor sixth no longer sounds fearful.

2.11 Tritone: Diabolus in musica

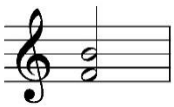
The tritone (e.g., f^1-b^1, see Figure 19) used to be called ”diabolus in musica“. And still today, the sound can remind of a chilling sense of latent, lurking danger that is not localizable (see Cooke, 1959, p. 90).

In the literature, the tritone is described as ”menacing“ (Donington, 1990, p. 31; Vestergaard, 2020, p. 14; Walker, 2019, p. 18), ”scheußlich“ (Kircher, 2018, p. 91), ”hässlich“(Kiesewetter, 1846, p. 4; Krattenthaler, 2014; Weber, 2021), ”scheinheilig“ (Hindemith, 1940, p. 106), ”unangenehm“ (Bond, 2021), ”devilish“ (Klionsky, 2011, p. 4; Lerk, 2017, p. 7; Mellers, 2002, p. 48, 91, 187), ”duplicitous“ (Mellers, 2002, p. 49).

The peculiarity of the tritone is that its leading tones cannot be clearly defined. Before other harmonies enter, the listener cannot decide, which of the two tones are leading tones upwards or downwards. It is not known which of the two tones is the third and which is the seventh (Honegger & Massenkeil, 1982, p. 169f). In the sense of the theory of musical equilibration, this ambivalence is the cause of the tritone’s character.

Figure 19

The tritone



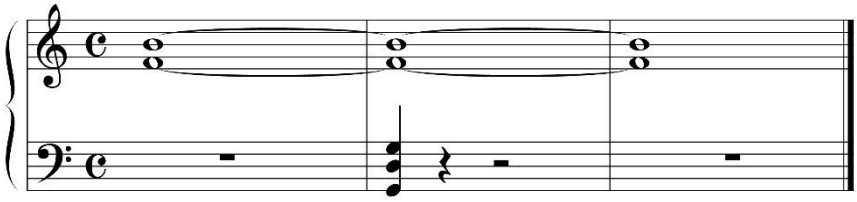
Note. The tritone used to be called "diabolus in musica".

If one plays, while the tritone sounds, another sound, as in Figure 20, the tritone

is clearly defined as the third and the seventh of a dominant seventh chord. Now the tritone has lost its ambivalent character.

Figure 20

Tritone with tones in the bass



Note. Due to the bass notes, the tritone has lost its ambivalent character.

3 Parallels to harmonic associations – the tests

To show how the theory of musical equilibration can be applied in practice, we carried out three tests, the basic test part A, basic test part B, and Rocky test. These are briefly presented below.

3.1 The basic test part A

Part A of the basic test should show that it is possible to achieve a high degree of agreement in the assignment of tonal sounds to emotional terms with very short sound sequences if one uses the appropriate harmonies. Here, an attempt was made to present harmonies in a simple form to largely exclude the influence of other factors. 18 pupils (K-12) and 5 students were asked to match five short cadences with five emotional terms. Table 1 shows the assignments in the basic test part A.

Table 1

Results of the basic test part A

Emotional Content	Chord	Association in %
1. Despair	Diminished seventh chord	87
2. Wandering	Tonic – dominant	87
3. Loneliness	Minor with added sixth	96

4.	Magical transformation	Augmented triads	96
5.	Dreams of summer	Major seventh chord	91
	Overall		92

Note. Part A of the basic test achieved a high degree of agreement in the assignment of tonal sounds to emotional terms with very short sound sequences.

The five students from this group (2 male, 3 female, the youngest 22 years old, the oldest 44 years old) scored an overall hit rate of 100% on the basic test part A, while the 18 pupils (K-12, 6 male, 12 female, the youngest 7 years old, the oldest 18 years old) scored an overall hit rate of 90% on the basic test part A.

The details of this test can be found in the e-book ”Music and Emotions. Research on the Theory of Musical Equilibration” (D. Willimek & Willimek, 2013, p. 28ff), via the following link: https://www.willimekmusic.de/music-and-emotions.pdf

3.2 The basic test part B

Part B of the basic test goes into more detail. It was intended to show that, even with very similar tonal music examples, you can achieve a high rate of assigning sounds and emotional terms if you use the appropriate harmonies. Here, an attempt was made to present harmonies in a simple form to largely exclude the influence of other factors. 18 pupils (K-12) and 5 students were given five tasks, and in task 1, 3, 4, and 5 they had to select one of two options which they felt was a better match for a particular term. For task 2, the participants had to select a multiple-choice response which best expressed their response to changes in a repeating minor chord that grew louder and faster. The statements were: ”sorrow turns into anger”, ”sorrow turns into joy”, and ”anger turns into sorrow”. All of the 23 participants preferred the first statement. The participants made the following assignments:

Table 2

Results of the basic test part B

Emotional Content	Chords	Association in %
1. Adventurous	Aeolian instead of harmonic minor	70
2. Sorrow turns into anger	Crescending minor chords	100
3. Threatening	Minor sixth instead of major sixth	100
4. Comforting	Major subdominant with added sixth instead of the identical chord when not subdominant	96
5. Scene under water	Whole tone instead of diatonic sound	96
Overall		92

Note. Part B of the basic test achieved a high rate of assigning sounds and emotional terms with very similar tonal music examples.

The five students from this group (2 male, 3 female, the youngest 22 years old, the oldest 44 years old) scored an overall hit rate of 92% on the basic test part B, while the 18 pupils (K-12, 6 male, 12 female, the youngest 7 years old, the oldest 18 years old) scored an overall hit rate of 93% on the basic test part B. Also, the basic test part B yielded a high number of matches when it comes to distinguishing similar music examples in their emotional statement.

More details of this test can be found in the e-book ”Music and Emotions. Research on the Theory of Musical Equilibration” (D. Willimek & Willimek, 2013, p. 34ff), via the following link: https://www.willimekmusic.de/music-and-emotions.pdf

3.3 The Rocky test

The Rocky test shows that, when the appropriate harmonies are used, it is possible to achieve a high degree of correlation between the assignment of tonal sounds to emotional scenes of a fairy tale with short sound sequences. Over 2000 participants (9 – 19 years) of German schools (K-12) in Europe, Asia, Australia, North and South America took part in the Rocky test. At a mean of 87 %, the Rocky test yielded a high number of matches when it comes to assigning tonal music examples to scenes of a fairy tale if one uses the appropriate harmonies. This was a preference test which presents a musical fairy tale featuring various scenes with emotional content, such as feelings of comfort,

despair, courage, or weightlessness. The authors developed a test CD for the Rocky test which tells the musical fairy tale of Sleeping Beauty and Prince Rocky. The fairy tale contained eight scenes with varying emotional content. Each of these scenes was accompanied by a particular piece of music and then repeated with a different score. Only one of these pieces contained typical harmonies which the theory of musical equilibration linked to the emotions in question. Table 3 shows the assignments in the Rocky test.

Table 3

Results of the Rocky test

Scene	Main chords	Results in %
1. Thorns began to grow (miracle)	Augmented instead of dominant	68
2. Happily, Rocky began his wandering (motion)	Major instead of minor	85
3. Rocky dived into the water (weightless)	Whole tone instead of major	84
4. The thorns grabbed the princes (panic)	Diminished seventh chords instead of major	88
5. Rocky raced towards the thorns (courage)	Aeolian minor instead of major	92
6. Rocky and the Princess in love (comfort)	Major subdominant with added sixth instead of diminished seventh chords	93
7. Rocky must leave (wistfulness)	Major seventh chord instead of major	93
8. The Princess is lonely (loneliness)	Minor subdominant instead of major	91
Overall		87

Note. The Rocky test achieved a high degree of correlation between the assignment of tonal sounds to emotional scenes of a fairy tale with short sound sequences.

In the Rocky Test, the role of factors other than harmony could certainly play an important role. The results of the young people in different countries showed no significant differences. However, it must be pointed out that around half of the young people in German schools (K-12) abroad were of German origin and the proportion of young people of foreign origin mostly had contact with the European culture.

The factors age and sex of the participants did not play a significant role here in the selection of the music examples judged to be suitable. The hit rate of the girls was slightly higher than that of the boys, it increased slightly for both genders with increasing age, it was also somewhat higher for musically active pupils.

More details of this test can be found in the e-book ”Music and Emotions. Research on the Theory of Musical Equilibration” (D. Willimek & Willimek, 2013, p. 41) via the following link: https://www.willimekmusic.de/music-and-emotions.pdf

4 Outlook

As an explanation for the emotional character of musical harmonies, the theory of musical equilibration provides a practical model for understanding the emotional impact of music. This theory could be applied as basic guideline in many areas of musicology. A reorientation in the field of music therapy is especially conceivable since patients can often be reached emotionally (see Jernigan, 2021; Huang & Chen, 2021; Pellitteri, 2009). To present the emotional effect of musical harmonies in an even more differentiated way, further research is necessary which focuses on the interaction of different musical parameters in the development of feelings when listening to music. Too, the question of the extent to which cultural differences are noticeable in the perception of chords could not be adequately answered by our work and requires further research.

For future work, establishing a link between the findings shown here and research on embodied cognition seems particularly promising. Are the emotional characters and the associated processes of will reflected in the corporeal? The investigation of such questions could forge new links with Ernst Kurth's accounts of the perception of material-like phenomena in music, which have faded into the background in recent decades, and ultimately lead to a comprehensive theory of the perception of music.

For more information on applying the theory, see the German book *Musik und Emotionen: Studien zur Strebetendenz-Theorie* (D. Willimek & Willimek, 2019).

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