

EVALUATING THE CONSONANCE AND PLEASANTNESS OF TRIADS IN DIFFERENT MUSICAL CONTEXTS

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Abstract

This study examines whether the consonance and pleasantness of triads (major, minor, augmented, and diminished) varies according to the musical context in which it is presented. The level of consonance and dissonance (C/D) of each chord when they were played alone without any musical contexts was judged. Following this, each chord was accommodated in a different position in a short cadence, and the level of C/D for each chord was judged. Additionally, the C/D and the pleasantness and unpleasantness (P/U) of the whole sequence were rated on a 7-point scale. The results show that, for major and minor triads, there was no significant difference in C/D levels between the 'without musical context' and the 'with musical context' conditions. However, both augmented and diminished triads were judged less dissonant when they were played in isolation than when in a cadence. Augmented triads were rated most dissonant and unpleasant when on the tonic, while diminished triads were most consonant and pleasant when on the subdominant. We interpret this result as reversely reflecting the stability of chord function.

Keywords: consonance, pleasantness, musical schemata

1. Introduction

The purposes of this study are to investigate the influence of musical context on the perception of triads in terms of pleasantness and consonance, and to explore the relationship between pleasantness and consonance. Pleasantness is one of the most responses to stimuli (approach or rejection) and a principal dimension that differentiates emotions (Russel, 2003). Such basic responses seem to include rejection of dissonance and appreciation of consonance in musical contexts. However, actual pleasantness experience of consonance-dissonance (C/D) in terms of pleasantness of chords is likely to be complicated than a simple one to one mapping.

The sensation of C/D can be explained with reference to psychoacoustic theories such as frequency ratios, beats and roughness (Helmholtz, 1877/1954), and the relation to critical

bandwidth (Plomp and Levelt, 1965. Kameoka and Kuriyagawa, 1969). At the same time, the perception of C/D is also susceptible to cultural influences and a posteriori factors. According to Lundin (1947) and Cazden (1980), judgments of C/D are determined not only by acoustical features of what is heard, but also by the musical rules of the culture and the listener's familiarity with these rules, or musical schemata in cognitive terms. A listener judges musical events based on musical schemata he has been developing through a lot of amount of exposure to particular styles of music. So judgement of C/D is influenced by what the listener's musical schemata - which are in turn determined by the rules of music he listens to - define as C/D. An acoustically identical chord can be consonant for one, but dissonant for the other depending on their musical schema-

ta. Additionally, the context in which a chord appears might also be an influential factor in determining C/D perception. Roberts (1986) shows that the chord can be more consonant when it is in a 'traditional' harmonic progression than when in a 'non-traditional' harmonic progression.

This study focuses on differences in the C/D perception of chords, and in particular augmented and diminished chords in different musical contexts and with different chord functions. Chord function may affect C/D perception of augmented and diminished chords in two ways. The first hypothesis is that they will sound most consonant when heard on their most familiar function, such as the tonic or dominant for augmented chords, and the dominant for diminished chords. The subdominant is the least familiar for both chords. It is for this reason that augmented chords often act as neighboring or passing chords in the progressions I-I+-IV, I-V+-I, and diminished chords often function as leading tone chords. The second hypothesis is based on the violation of the stability of the chord function. According to the hierarchy of chord function (Krumhansl, 1990), the tonic is the most stable function, followed by the dominant, while the subdominant is the least stable. Accordingly, an unexpected chord on the tonic might sound more dissonant than the same chord on the subdominant because it would represent a greater violation of stability for the tonic to be unstable than the subdominant.

The second aim is to test the relationship between listeners' perceptions of C/D and P/U. It is reported that there is a congruency between C/D and P/U perceptions, such as C/D and P/U perceptions of dyads (Guthrie and Merrill, 1928), dissonant dyads and negative word connotation (Costa, Bitti, and Bonfiglioli, 2000), and faster and more accurate judgments of positive and negative words when positive words are paired with consonant chords, and negative words with dissonant chords (Sollberger, Reber, and Eckstein, 2003). From this C/D and P/U congruency, it is hypothesised that if the C/D level of the same chord differs according to its function, the P/U level of the chord should also change.

2. Experiment 1. Chords in isolation

2.1. Participants

36 adults (Male: 16, Female: 20. Age range: 21-74, with a mean age of 33.72), all with a moderate amount of musical experience, were recruited.

2.2. Materials

Materials consisted of major, minor, augmented and diminished triads played in all 12 keys, and all played in root and close position, thus making a total of 48 triads. Each triad was made using a piano sound, created by software, *Cubase*. The duration of each chord was approximately 1 second.

2.3. Procedure

48 single triads in root position and close position, each one either a major, minor, augmented or diminished triad, and utilising all 12 keys, were played in a random sequence. Participants were asked to judge whether each chord was either consonant or dissonant by pressing one of two keys on a computer keyboard as quickly as possible. Participants' response times were also recorded.

2.4. Results

Figure 1 shows the mean judgment of C/D and the standard deviation for each chord. As can be seen, major triads were judged to be the most consonant type of triad, followed by minor triads, and then diminished triads, while augmented triads were the most dissonant triad. This result is consistent with Helmholtz (1874/1955) and Roberts (1986). One-way ANOVA with Repeated Measure found a main effect of Chord Types: $F(3, 105)=59.04, p=.000, r=.79$. Pairwise comparison revealed that all of the four types of chords are different from each other with the exception of major and minor triads ($p < .001$). Augmented and diminished triads are significantly different from each other, and both major and minor triads are significantly different from both augmented and diminished triads ($p < .001$).

Reaction times were analysed using a one-way ANOVA for Repeated Measures after log-transformation of the reactions times. No main effect of Chord Type on response time was found ($p > .05$).

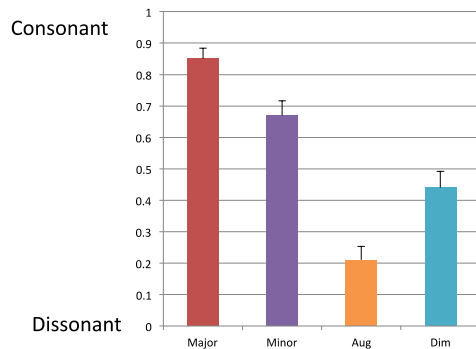


Figure 1. Mean and Standard Deviation for C/D judgements of four types of chords

3. Experiment 2. Chords in a cadence

In Experiment 2, the perception of four triads in different musical contexts and with different harmonic functions was examined. As discussed above, it is thought that the C/D perception of augmented and diminished chords might vary according to the musical context and the chord's harmonic function. As we have seen, it has been hypothesised that both augmented and diminished chords will sound more consonant when heard in a familiar/typical scenario, or when heard on the subdominant, as this is the least stable chord function. In this experiment, both augmented and diminished chords appeared in a scale consisting of three chords, IV-V-I, and the perception of these chords in terms of their C/D and P/U levels was examined.

3.1. Participants

The participants were the same individuals who took part in the previous experiment.

3.2. Materials

72 chord sequences with 12 keys were used. Each chord sequence is preceded by a diatonic scale in order to present the key to the participant, which is then followed by the following three chords: IV-V-I. All chord sequences con-

tained one target chord, which was either an augmented or diminished triad, or neither – in which case either a major or minor triad was played depending on the mode of the context.

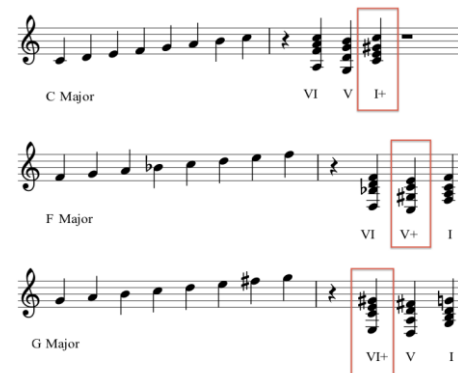


Figure 2. Example of the sequence

Target chords were put in either the tonic, dominant or subdominant position in each chord sequence (Figure 2), although normally occurring harmonic patterns were avoided in order to rule out their effect, thus allowing the effect of functions to be seen more clearly. Sound materials were all played using a piano sound. The duration of each sequence was 6.74 seconds, and the tempo and loudness of all materials were kept constant throughout.

3.3. Procedure

72 chord sequences consisting of a scale and three chords were presented. Participants were asked to judge whether each of the three chords they heard was either consonant or dissonant, which they did by pressing one of two keys directly after each chord was played.

After each sequence, participants rated the C/D and pleasantness levels of the whole sequence on a 7-point scale, with 1 being extremely dissonant/unpleasant and 7 being extremely consonant/pleasant.

3.4. Results

3.4.1. C/D judgment of target chords

Figure 3 shows the mean judgments for major, minor, augmented, and diminished triads in terms of dissonance (0) and consonance (1).

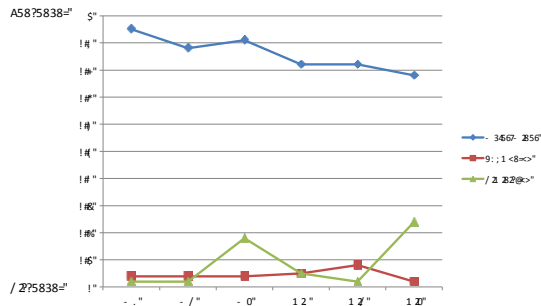


Figure 3. The mean of C/D judgement of each chord presented in musical context. M=major mode, mi= minor mode, T=tonic, D=dominant, S=Subdominant

A three-way ANOVA with repeated measures indicated a main effect of Chord Types: $F(2, 70)=445.698, p=.000, r=.096$, and both major and minor target chords were judged very consonant, while augmented and diminished chords were very dissonant. There was also a significant interaction between Mode and Chord Types; $F(2, 70)=12.440, p=.000, r=.51$, and between Chord Type and Function: $F(4, 140)=6.375, p=.000, r=.39$. The effect of Function varies according to Chord Type, with diminished chords being judged more consonant when on the subdominant in both major and minor contexts ($p<.001$). As participants merely chose either 'Consonant' or 'Dissonant' and the data was therefore not normally distributed, a non-parametric test (related-samples Friedman's two-way analysis of variance by ranks) was performed to confirm the result. Diminished triads on the subdominant in major and minor contexts were significantly different from those on both the tonic and the dominant ($p=.002$, and $p=.000$ respectively), while no significant difference was found in either augmented or control triads (major and minor triads).

Participants' reaction times (the length of time between the end of the sound stimuli and participants' responses) were also analysed after log-transformation of the reaction times. A three-way repeated measures ANOVA indicated a significant main effect of Function: $F(1.68, 59.02)=14.720, p=.000, r=.54$. Participants responded quickest to dominant chords ($p<.001$), followed by chords on the tonic, and then the subdominant.

3.4.2. Overall consonant/dissonant level

After listening, participants rated C/D and pleasantness levels, and the mean rating for C/D can be seen in Figure 4. A three-way ANOVA with repeated measures was performed to test the effect of Mode (major vs. minor), Chord Type (augmented, diminished, and control), and Function (tonic, dominant, subdominant). There was a significant main effect of Mode: $F(1, 35)=11.29, p=.002, r=.49$, as major chords were rated more highly (in other words, were considered more consonant) than minor chords. Both major and minor triads were rated higher than either augmented or diminished triads ($p<.000$); Chord Type: $F(1.24, 43.39)=155.21, p=.000, r=.90$. There was a significant interaction between Mode and Chord Type: $F(2, 70)=12.52, p=.000, r=.51$. As for the effect of Function, this had a significant main effect: $F(2, 70)=15.50, p=.000, r=.55$. There was significant interaction between Chord Type and Function: $F(3.32, 116.19)=15.11, p=.000, r=.54$, also as pairwise comparison revealed that the effect of Functions varied according to Chord Type. Augmented triads on the tonic in a major context were rated significantly lower (more dissonant) than those on other functions ($p<.001$), while diminished triads on the subdominant in both major and minor contexts were significantly more consonant than those on either the tonic or dominant, replicating the results of the evaluations of specific chords reported above ($p<.001$).

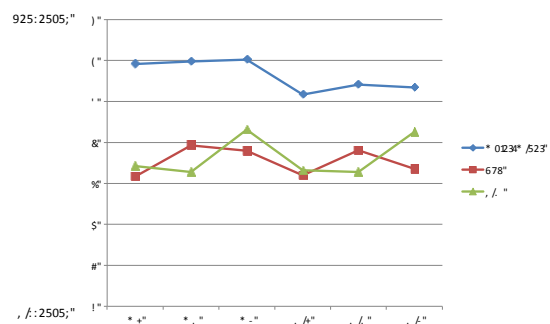


Figure 4. The ratings for overall C/D level

As for reaction times for C/D rating, there was a significant main effect of Chord Type: $F(2, 70)=18.565, p=.000, r=.58$. Control chords (major and minor triads) were rated quickest among the three types of chord, and significantly quicker than diminished chords ($p<.001$). The effect of Chord Types varies according to Mode, and control chords in a major context (all of which are major triads) were processed significantly quicker than augmented and diminished triads ($p<.001$), although there was no difference in reaction time between minor triads, and augmented and diminished triads. An interaction between Mode and Chord Type was also found: $F(2, 70)=9.04, p=.000, r=0.45$.

3.4.3. Overall pleasantness

Figure 5 displays the mean pleasantness rating for all sequences containing target and control chords. A three-way ANOVA with repeated measures was performed again. All factors were found to be significant: Mode: $F(1, 35)=4.51, p=.041, r=.33$, Chord Type: $F(1.21, 42.62)=88.37, p=.000, r=.84$, Function: $F(2,$

$70)=17.51, p=.000, r=.57$. The general trend is very similar to that for overall C/D ratings. There were significant interactions between Mode and Chord Type: $F(2, 70)=11.22, p=.000, r=.49$, and between Chord Type and Function: $F(4, 140)=18.072, p=.000, r=.58$. The effect of Function varied according to Chord Type, as augmented triads on the tonic were significantly different from the same triads on the dominant and subdominant. Also, the sequences with diminished triads on the subdominant were the most pleasant ($p<.001$).

As for reaction times, there was only a main effect of Chord Type: $F(2, 70)=13.23, p=.000, r=0.52$. Responses for control chords were the quickest among the three types of chord, and were significantly quicker than responses for augmented triads ($p<.000$).

3.4.4. Chords Without and With Musical Context

The data for C/D judgments were compared with those from the previous experiment for single chords, in order to see how judgments

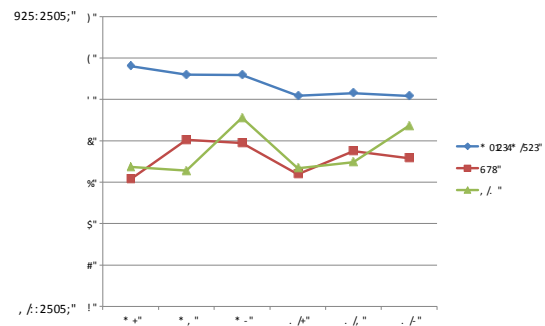


Figure 5. The ratings for overall P/U level

differ between chords without and with musical context. C/D judgments for single triads were compared with judgments for triads on the tonic, dominant, and subdominant. Data for all four types of chords were analysed separately. A one-way ANOVA with repeated measures indicated no significant effect of musical context for major triads and minor triads ($p>.05$). However, in the case of augmented triads, there were main effects of musical context: $F(6, 108)=4.60, p=.000$. These were judged to be most consonant when presented alone. The same was true in the case of diminished triads: $F(6, 108)=7.91, p=.000$.

3.4.5. Correlation between C/D and P/U

Pearson's product-moment coefficient revealed that C/D ratings were significantly correlated with P/U ratings: $r(647)=.43, p=.000$. As for the correlation in each condition, major triads on the tonic had the highest positive correlation between C/D and P/U ratings: $r(35)=.748, p=.000$, while minor diminished triads on the dominant had the least positive: $r(35)=.264, p=.120$.

4. Discussion

Across all tasks, the control chords (major and minor triads) were rated higher than both augmented and diminished chords. This is consistent with the results of Helmholtz (1877/1955) and Roberts (1986). This result seems to validate the typical categorisation of consonant and dissonant chords, according to which major and minor chords are considered more consonant than augmented and dimin-

ished ones. Major chords were rated most consonant/pleasant and were processed most quickly.

The difference between functions was strong in the case of diminished chords in both major and minor contexts. Diminished chords on the subdominant were always judged and rated more consonant and pleasant than the same chord appearing in any other function. As for augmented chords, these were given their lowest C/D and P/U ratings when they were played on the tonic in a major key. These results support the second hypothesis, based on the stability of chords. According to this theory, chords are most stable when they are on the tonic, followed by when on the dominant, and they are least stable when on the subdominant (Krumhansl, 1990). The results of Experiment 2 map quite neatly onto this theory, suggesting that C/D judgments of augmented and diminished chords have an inverse relationship with chord stability. In other words, the more stable a chord function is, the more dissonant an augmented or diminished chord played on that function is likely to be. As such, we should expect an augmented or diminished chord in an unexpected context to be most consonant when played on the subdominant, followed by the dominant, and least consonant of all when on the tonic. This is because the level of C/D is inversely proportional to the amount of stability violation, and so the smaller the violation the more consonant the chord will sound, and, likewise, the bigger the violation the more dissonant it will be. However, that diminished triads on the subdominant were judged most consonant and pleasant might be partly due to familiarity, as a diminished triad on the subdominant is identical to a diminished seventh chord built on the supertonic (II) of the key without the root, which is often followed by V and I chords to make a common harmony progression.

The comparison of data showing C/D judgments of chords both without and with musical context reveals something of the unique character of each type of chord. As was predicted, major chords maintain their consonance level in whatever musical context they find themselves. On the other hand, musical context had an influence on both augmented

and diminished triads: both were judged more consonant when played alone than when they were played with musical context.

As the general trend for C/D and P/U ratings are very similar, with a positive correlation between the two, it seems likely that participants perceived them similarly. This supposition is consistent with the findings of Guthrie and Morrill (1928), who noted that judgments of the consonance and pleasantness of intervals were very similar. However, the data revealed that the degree of correlation varies according to the condition.

Experiment 2 demonstrated the influence of context and function on the C/D and P/U levels of chords. Both the influence of the stability of chords and familiarity were seen clearly in the results, which lent support to both the first and the second hypothesis.

Which hypothesis best applies may vary according to the type of chord in question: for instance, the results for augmented chords lend support for the stability of chords theory, whereas in the case of diminished chords both hypotheses clearly apply. Finally, the data also revealed a positive correlation between C/D and P/U ratings, although this varies according to the condition.

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