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## Contrasts of Register Underlie the Perception of Musical Humor

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## Abstract

In the psychological literature on musical humor, the emphasis on laughter-inducing music has naturally led researchers to focus on quite uncommon devices, such as stylistic deviations or formal incongruities that strongly violate listeners' expectations, as the privileged basis for musical humor. But musical humor extends well beyond laughter-inducing music. It is also a kind of semantic content frequently ascribed to music, as attested by the long list of musical genres that are more or less explicitly associated with humor, wit, or comedy. As such, the communication of musical humor should be able to also rely on non-deviant compositional techniques; that is, compositional techniques that conform to the standard syntax in which the musical output is generated. In this paper, we show that selectively augmenting or inhibiting contrasts of register found in passages of Cécile Chaminade's humorous piano music impacted the extent to which both expert and non-expert listeners rated such passages as expressing something humorous. We then analyze the effects of contrasts of register in light of incongruity and play theories of humor, and further discuss the relevance of our results for the semantics and pragmatics of music.

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**Key words:** humor, music, expressivity, pragmatics, Chaminade

Both humor and music lie at the cornerstone of our human lives: they are two cultural practices and two means of communication universally shared by humans (Fry, 1994; Mehr et al., 2019), to the point that they are sometimes taken as defining ingredients of what makes us human. While there is now a very large body of empirical psychological research on each of these two phenomena taken separately, there are comparatively few studies on their intersection (for bibliographic and meta-analytic data, see Arias, 2001; Haire & MacDonald, 2019; Kokkidou, 2012; Lowry, 1974; Nissan, 2012).

Most of the empirical research on musical humor focuses on what might be called *laughter-inducing (or evoking) music*; that is, music that causes in the listener an emotional and behavioral reaction such as laughter, smiling, or feeling of amusement. The first experimental observations on laughter-inducing music took place in fact within more general studies on emotions and meaning in music (Campbell, 1942; Hevner, 1935, 1936, 1937; Schoen, 1927). Mull's (1949) pioneering study was the first to focus solely on the issue of laughter-inducing music. The aim of her study was to demonstrate correlations between certain formal and acoustic musical features and the listener's sense of amusement. Mull asked the participants to identify the passages they considered amusing within three works of program music, first by hiding the program from them and then by providing it to them. She found that, whatever the formal or acoustic parameter considered (register, tempo, duration, timbre, etc.), contrasts in the values taken by a given parameter were the feature most often present in passages judged humorous.

Subsequent studies have extended the research path opened by Mull (1949) in three directions: first, by attempting to further identify the formal and acoustic parameters that elicit laughter, smiling, or amusement (Huron 2004, 2006; Nagy et al., 2022; Rozin et al., 2006); second, by investigating how such laughter, smiling, or amusement responses varied as a function of personal variables such as age (LeBlanc et al., 1992; Smith, 1994), nervousness

(Lassauzet, 2020), and musical expertise (Moore & Johnson, 2001); third, by studying the effects of laughter-inducing music—or, more broadly, of music combined with non-musical humorous stimuli—in education (Freeman, 1952; Streat, 2011) and art therapy (Haire & MacDonald, 2019, 2021; Haire & Oldfield, 2009; Szabo et al, 2005), particularly in relation to improvisation and ludic activity (Amir, 2005; Stensaeth, 2017).

While musical humor remains a relatively marginal topic within the psychology of music, research on musical humor in musicology, ethnomusicology, and more generally, the humanities and social sciences, is a striving field. Arias (2001) counted 832 publications on musical humor in the humanities and social sciences. In addition, since 2001, numerous large-scale publications have appeared, from individual publications and dissertations (Blanchet, 2010; Bourne, 2016; Brown, 2007; Cherlin, 2017; Cummins, 2017; Ellis, 2012; Eriksen, 2016; Goeth, 2016; Krol, 2021; Lassauzet, 2019; Honrubia Martinez, 2017; Palmer, 2015; Zank, 2009) to ambitious edited collections (Guillebaud & Stoichita, 2013; Joubert & Le Touzé, 2017; Jung-Kaiser & Diedrich, 2015; Kippelen, 2017; Kitts & Baxter-Moore, 2019; Lorient, 2015; Lorient & Roubet, 2010; Turner, 2015).

A striking aspect of this literature is the variety of the repertoires addressed, which venture far beyond the few canonical examples of the Western classical repertoire usually considered in the studies on musical humor mentioned earlier (e.g., Haydn, Mozart's *A Musical Joke*, K. 522, Beethoven, Saint-Saëns's *The Carnival of the Animals*, Richard Strauss's *Till Eulenspiegel*, Satie, or Peter Schickele, aka P. D. Q. Bach). It includes music composed or performed in war contexts (Benoit-Otis et al., 2016; Despoix et al., 2018; Ellis, 2010; Korczynski, 2011; Turner, 2015), sacred and ritual music (Goldberg, 1993; Guillebaud & Stoichita, 2013; Jung-Kaiser & Diedrich, 2015), film music (Biancorosso, 2009; Mera, 2002) and other video-accompanying music (Dinnen, 2016; Liikkanen & Salovaara, 2015), jazz, rock, and popular song (Ellis, 2012; Guerpin, 2010; Kitts & Baxter-Moore, 2019; Wise,

2012), Javanese gamelan (Benamou, 2013; Sutton, 1997), South Indian music (Guillebaud, 2013), Romani music (Stoichita, 2008), Turkish and Arabic music, (Cler, 2010, Lambert, 2013), South African music (Martin, 2013, Pietilä, 2019), French rural music (Etay, 2013, Nyawalo, 2019), various genres of comic opera (Cailliez, 2014; Hawig & Riemer, 2018; Lorient, 2015; Vendrix, 1992), European medieval and Renaissance music (Canguilhem, 2015; Minamino, 2001; Singer, 2016), Western composers whose humor has been overlooked such as Lully (Arnason, 2011), Debussy (Lassauzet, 2019; Wong, 2016), Ravel (Zank, 2009), Rachmaninoff (Eriksen, 2016), and Bartok (Brown, 2007), and post-war Western avant-garde music (Boura, 2008; Kippelen, 2017).

The sheer length of this list clearly reflects that within the musicological literature, musical humor is taken to extend well beyond music that elicits laughter, which, as David Huron himself plainly admits, “is not a common response in music” (Huron, 2006, p. 287). Here, musical humor is not only envisioned as a type of experience and reaction, but also as a semantic and communicative phenomenon—as a type of content of the musical stimulus communicated by the composer and the musicians. To draw on a distinction that is often made in the field of musical emotion studies, the focus within the musicological literature seems to be more on humor-as-musically-expressed (or communicated) than on humor-as-musically-aroused (or caused) (Davies, 2010; see also Walton, 1993, and London, 2002, for an application of this distinction to the phenomenon of musical humor).

Such a focus on the semantic aspects of musical humor has the benefit of bringing musical humor closer to humor in general (Crépiat, 2021; Houseman, 2013; Kitts & Baxter-Moore, 2019). It also frames musical humor as a communicational phenomenon, precisely relying on the listeners’ ability to recognize that the music is produced with the intent to elicit comical amusement, beyond the mere monitoring of one’s own laughter reaction—which is not always a reliable indicator (see London, 2021, for a discussion of musical performances

that unintentionally elicit laughter). But more importantly, it forces us to consider musical humor as a somewhat banal phenomenon, which is much more frequent and important in music in general than the arguably more exceptional cases of laughter-inducing music. In the psychological literature on musical humor, the emphasis on laughter-inducing music, such as Mozart's *Musical Joke* or Peter Schikele's musical parodies, has naturally led researchers to focus on quite uncommon devices, such as stylistic deviations or formal incongruities that strongly violate listeners' expectations (in the sense of Meyer, 1956), as the privileged basis for musical humor. But one might wonder how musicians and composers actually proceed in the much more frequent cases in which they simply want to musically express or represent something humorous, and not necessarily elicit laughter among their audience. Given how common it is for musicians to attempt at creating music that has some humorous content, it would seem reasonable to assume that such attempts do not require the introduction of the same kind of strongly incongruous or unexpected musical elements but rather rely on non-deviant compositional techniques; that is, compositional techniques that conform to the standard syntax in which the musical output is generated.

In the present paper, we report on a study that precisely aimed at showing in a systematic way that such non-deviant compositional techniques can underlie the communication of musical humor. To make our case, we chose to focus here on how the manipulation of contrasts of register (i.e., the presence of a clear difference in pitch register between two adjacent musical elements) might contribute to our perception of musical humor. Two main reasons guided this choice.

First, contrasts of register seem to be frequently used by composers wishing to communicate humorous content, as evidenced by many musicological analytical insights and case studies on this subject (Brown, 2007; Casablanca, 2000; Cherlin, 2017; Dalmonte, 1995; Gooley, 2005; Kidd, 1976; Krol, 2021; Lassauzet, 2019; Palmer, 2015; Perry-Camp,

1979; Ravas, 2005; Rosen, 1997; Sheinberg, 2000; Wise, 2012), as well as some writings coming directly from composers, musicians, and critics (Briard, 1884; Goeth, 2016; Russell, 1985). This is also consistent with the results of Mull's (1949) pioneering study, which concluded that contrast (of register or any other formal parameter) were a key compositional strategy in eliciting amusement.

Second, register is a parameter that can be easily manipulated experimentally: a given configuration of register (e.g., a contrast between two registers) can be inhibited or increased with fine-grained variations but without having to modify other parameters, thus without altering the syntactical content of the musical stimulus.<sup>1</sup> This is an important methodological advantage compared to contrasts involving other parameters that might induce a significant syntactical alteration of the musical stimulus when manipulated (e.g., the contrast between two chords, between major and minor modes, or between two durations).

The goal of our study was thus to selectively manipulate contrasts of register in passages of music explicitly composed to express a humorous content, in order to see whether such contrasts impacted the perception of the music's humorous content. Our pre-registered hypothesis (<https://osf.io/39xtp>) was that increased contrasts would lead to a higher tendency to judge a musical excerpt as expressing a humorous content, whereas inhibited contrasts would lead to a lower tendency to judge the same musical excerpt as expressing a humorous content. Moreover, we also pre-registered the hypothesis that contrasts of register would only influence the ratings of humorous content, but not the ratings of basic emotional expressivity. In other words, and based on the literature reviewed above, our hypothesis here was that contrasts of register were not acting as a mere intensifier, indiscriminately making more salient whatever semantic or expressive properties ascribed to the music, but rather played a causal role in the communication of the music's humorous content. To put this hypothesis to a stringent test, our study thus also assessed the impact of contrasts of register on the perception



of the music's joyful content, given how close joy and humor are generally taken to be, through mirth or exhilaration; that is, the kind of joy and pleasure aroused by humor (Amir et al, 2015; Martin, 2006; Panksepp, 2000).

## **Method**

### **Participants**

We recruited two groups of participants for this study, one group of nonmusicians (musical practice < 2 years,  $N = 34$ , age = 24.7, max = 35, min = 19, female = 15, male = 19) and one group of musicians (musical practice > 8 years of musical practice,  $N = 33$ , age = 24.5, max = 38, min = 18, female = 27, male = 6). Group size was determined based on a power analysis relying on a pilot experiment (using a similar design, albeit with partly different stimuli), which indicated that we should test 30 participants to have a power of 80% at the .05 alpha level. Both groups of participants were recruited through the INSEAD-Sorbonne Université Behavioural Lab recruitment procedure.<sup>2</sup> Each participant received 10 euros as compensation. Data for both groups were collected in October 2021 and November 2021 in Paris. We excluded two participants from the nonmusician group—one because of data collection problems and another one because of difficulties in understanding and performing the task.

### **Stimuli**

To assess whether contrasts of register favor the identification of the music's humorous content, we needed to find pieces that were: 1) overtly composed with a humorous intention in mind; 2) relatively unknown, as to avoid recognition or contextual associations; 3) not obviously laughter-inducing as our goal was to focus on the ability to identify a humorous intention, over and beyond the monitoring of one's own laughter reaction. A

potential difficulty was to end up cherry-picking such pieces. Our strategy was thus to focus on one composer, whose output would satisfy all three constraints, and then to select our excerpts from that composer's output in a very systematic fashion. Of course, focusing on only one composer might run the risk to make any generalization more difficult. But the introduction of contrasts of register does not seem to be an idiosyncratic strategy, only used by a few composers. On the contrary, it seems to be a relatively widespread strategy to convey musical humor (see e.g., Briard, 1884; Dalmonte, 1995; Goeth, 2016; Lassauzet, 2019; Russell, 1985). As such, we believed that, if a causal relationship between contrasts of register and the perception of musical humor were to be found based on the output of a single composer, it could reasonably extend more broadly to the many composers that rely on similar strategies.

For this first study, we chose to focus on French composer Cécile Chaminade (1857-1944), who wrote a series of humorous pieces that are typical of the early 20th century salon music. We considered only her piano pieces, as our study would involve using a sound synthesis software and as piano typically gives better sounding results than, say, string or wind instruments. We first identified all the piano pieces that contained in their title words or names with humorous or comical undertones. We found eight such pieces: *Humoresque*, *Étude humoristique*, *Caprice humoristique*, *Valse humoristique*, *Scaramouche*, *Pierrette*, *Arlequine*, *Caprice-impromptu*.

We then looked within each of those pieces for contrasts of register. In this regard, in order to select the excerpts in a systematic way, and in the absence of a formal definition of what counts as a contrast of register in the previous literature, we defined contrasts of register as a particular type of change of register specified by three minimal conditions: 1) the change of register concerns at least two successive and distinct musical segments; that is, musical units larger than one single note such as a motive or phrase (Lerdahl & Jackendoff, 1983); 2)

the direction of the change of register between the two segments can indifferently be ascendant or descendant (Narmour, 1990, 1992); 3) the intervallic distance between the first note of the first segment and the first note of the second segment must be at least one octave (Deliège, 1987; Schellenberg, 1997).

Following those guidelines, we found ten musical excerpts (of roughly 10-second length) built around a contrast in register (i.e., containing a “lower” segment and a “higher” segment). Those ten musical excerpts belonged to five different pieces.

Two factors were then considered in manipulating those excerpts. First, whether the contrast contained in the excerpt would be augmented or inhibited. In the following, we will refer to this factor as CONTRAST. Second, whether such manipulation of contrast will be obtained through an upward transposition (i.e., transposing a contrasting segment upwards) or through a downward transposition (i.e., transposing a contrasting segment downwards). In the following, we will refer to this factor as TRANSPOSITION. Each original excerpt was thus modified in four different ways according to the two factors considered:

- *Contrast inhibited by an upward transposition:* The contrast of register within the excerpt is eliminated by transposing one or two octaves higher (depending on the range of the original contrast) the lower segment.
- *Contrast inhibited by a downward transposition:* The contrast of register within the excerpt is eliminated by transposing one or two octaves (depending on the range of the original contrast) lower the higher segment.
- *Contrast augmented by an upward transposition:* The contrast of register within the excerpt is increased by transposing one octave higher the higher segment.
- *Contrast augmented by a downward transposition:* The contrast of register within the excerpt is increased by transposing one octave lower the lower segment.

These four types of manipulation were created following a precise procedure: the basic rule was to transpose only the melodic part of our segments, unless, and only unless, transposing the melody created an overlap with the accompaniment (with the melody being no longer in the *superius* position), in which case selected parts of the accompaniment were also transposed to avoid such overlap.

All the modifications were implemented using the MuseScore software. Sound files corresponding to each excerpt were then exported using the same software. This yielded a total of 50 sound excerpts: one original version and four modified versions for each of our initial musical passages. Figure 1 shows the score for one of the original excerpts by Cécile Chaminade (an excerpt from the *Étude humoristique*), together with its four modified versions (all the scores for the original excerpts and their modifications are provided in the Supplementary Material accompanying this article at [mp.ucpress.edu](http://mp.ucpress.edu)).

We also selected 15 additional excerpts, taken from the same corpus of “humorous” pieces, to act as distractors for our experiment (the scores for these distractors are also provided in the online Supplementary Material).

# Étude humoristique op. 138

Cécile Chaminade (1857-1944)

Original version (b. 17-24)

Vivo  $\text{♩} = 96$   
*f pesante molto sostenuto*  
*f*  
*p leggero*

Contrast inhibited by an upward transposition

Vivo  $\text{♩} = 96$   
*f pesante molto sostenuto*  
*f*  
*p leggero*

Contrast inhibited by a downward transposition

Vivo  $\text{♩} = 96$   
*f pesante molto sostenuto*  
*f*  
*p leggero*

Contrast augmented by an upward transposition

Vivo  $\text{♩} = 96$   
*f pesante molto sostenuto*  
*f*  
*p leggero*

Contrast augmented by a downward transposition

Vivo  $\text{♩} = 96$   
*f pesante molto sostenuto*  
*f*  
*p leggero*

Figure 1. Cécile Chaminade, *Étude Humoristique*, b. 17–24: original version and the four modified versions.

## Procedure

We presented twice the 50 excerpts and the 15 additional distractors to participants, in two successive blocks, so that each participant listened to a total of 130 excerpts divided in two blocks of 65 excerpts. In the “joy block,” participants had to listen to each excerpt and rate, on a continuous scale, the extent to which they found the music expressed something joyful (from “Not at all” to “Very much”). In the “humor block,” participants had to listen to each excerpt and rate, on a continuous scale, the extent to which they felt the music expressed something humorous (from “Not at all” to “Very much”). The order of the two blocks was counterbalanced between participants so as to ensure having an equal number of participants doing the two block orders. In each block, the order of the stimuli was pseudorandomized by maximizing the distance between the different versions of the same musical passage (i.e., original, contrast inhibited by a transposition upwards, contrast inhibited by a transposition downwards, contrast augmented by a transposition upwards, contrast augmented by a transposition downwards). The 15 distractor excerpts were randomly inserted within each block of stimuli to control for demand effects.

Finally, at the end of the experiment, participants had to answer the following four questions (presented in randomized order) on a continuous scale:

- To which extent did you imagine a scene (a movie scene, a theater scene, a scene from everyday life, etc.) to evaluate the comical content of musical excerpts? (from “Never” to “Always”)
- To which extent did you imagine a scene (a movie scene, a theater scene, a scene from everyday life, etc.) to evaluate the joyful content of musical excerpts? (from “Never” to “Always”)
- To which extent did you rely on your felt emotion while listening to evaluate the humorous content of musical excerpts? (from “Never” to “Always”)

- To which extent did you rely on your felt emotion while listening to evaluate the joyful content of musical excerpts? (from “Never” to “Always”)

Note that our experiment was conducted with French-speaking participants. In our task related to the perception of the music’s joyful content, we used the expression *musique joyeuse* which, in French, refers to both “joyful music” and “happy music” (*musique heureuse* is almost never used). Similarly, in our task related to the perception of the music’s humorous content, we used the term *comique* (“comical”) rather than the word *humour* (“humorous”) for two reasons. First, in folk terminologies as well as in humor research, the terms commonly used to describe humorous phenomena are notoriously numerous, ambiguous, mutually exclusive and even varying across languages and historical contexts (Attardo, 2020). In order to target as precisely as possible the idea of humor-as-content, we thus needed a term as unambiguous as possible. In French, the word “comical” is less ambiguous than the word “humor.” The latter is an umbrella term (see Attardo, 2020, pp. 7–10) used to denote any phenomenon related to the general category of humor. As such, it can be used to denote either a content with humorous properties or a stimulus that provokes laughter. On the opposite, “comical” is most often used to denote contents with humorous properties. Second, the word “comical” in French is more often associated with works of art (e.g., comedy in theatre, comedy movies, etc.) than the word “humorous,” making the question asked in our task more intuitive for the participants.

### **Statistical Analysis**

We analyzed participants’ ratings using GLMMs (generalized linear mixed models) in R with *RStudio* (1.4.1106) and using the *lmerTest* 3.1-3 package. We report *p* values, estimated from hierarchical model comparisons using likelihood ratio tests and only present models that satisfy the assumption of normality, and statistical validation (significant

difference with the nested null model; Gelman & Hill, 2006). To test for main effects, we compared models with and without the fixed effect of interest. To test for interactions, we compared models including fixed effects versus models including fixed effects and their interaction. We used participant's identification number as random factor. For post hoc analysis we used paired *t*-tests corrected for multiple comparisons using Bonferroni correction.

Moreover, to investigate the effects of contrast manipulations on ratings, while controlling for possible confounding factors, we performed a causal based mediation analyses using the *mediation* package in R (Tingley et al., 2014). In a nutshell, causal mediation analysis allows us to distinguish how two predictor variables A and B influence an outcome variable C, by quantifying two types of effects: Average Direct Effects (ADE)—how factor A directly influences C— and Average Causal Mediation Effects (ACME)—how B mediates the effect of A on C. With this method, we investigated whether the effect of Contrast on humor and joy ratings was mediated by the overall pitch height of the musical excerpts. To compute the mean pitch of each excerpt we exported the MIDI files using MuseScore and computed the mean MIDI-note of each excerpt by averaging the MIDI note numbers across all the notes of the excerpt.

Using these methods, we performed three complementary analyses investigating how the joy and humor ratings of the manipulated excerpts varied depending on the different manipulations, as well as an analysis investigating participants' listening strategies.

## **Results**

### **First Analysis: Comparing the Experimental Manipulations With the Original Excerpts**



We first investigated how the joy and humor ratings of our experimental manipulations differed from the original excerpts composed by Cécile Chaminade. To do this we analyzed our data with a 5 x 2 x 2 factorial analysis, using “Condition” (Inhibition Downward, Inhibition Upward, Original, Augmentation Downward, Augmentation Upward), “Task” (Joy, Humor), and “Musicianship” (Musicians, Nonmusicians) as predictors and Participant\_ID as random factor.

We found a main effect of Condition,  $\chi^2(4) = 73.0, p = 3.9e-15$ , a main effect of Task,  $\chi^2(1) = 8.0, p = .004$ , no effect of Group,  $\chi^2(1) = 2.3, p = .12$ , and a marginally significant interaction between Condition and Task,  $\chi^2(4) = 9.4, p = .05$  (Figure 2).

Post hoc analysis (Bonferroni- $\alpha = .0125$ ) revealed that humor ratings were significantly higher for excerpts where contrast had been augmented by an upward transposition compared to the original version,  $t(64) = 3.19, p = .002$ . Conversely, humor ratings were significantly lower for excerpts in which contrast had been inhibited by a downward transposition as compared to the original version,  $t(64) = -3.40, p = .001$ . However, we found no significant difference when comparing to the original versions augmented versions through a downward transposition,  $t(64) = 0.08, p = .93$ , nor inhibited versions through an upward transposition,  $t(64) = 2.22, p = .02$  (see the Supplementary Material online for detailed results of the post hoc tests).

This suggests that there might be an interaction between the presence of a contrast and pitch height in listeners’ perception of musical humor. Indeed, our manipulations affected listeners’ ratings on musical humor only when they were congruent, so to speak: more contrasts *and* higher pitches made the music more humorous; less contrast *and* lower pitches made the music less humorous. But the effect of contrast alone was not strong enough to counterbalance the effects of a pitch transposition that would go in the opposite direction (but note that, symmetrically, the effects of such pitch transpositions alone were not strong enough

to counterbalance the effects of a contrast manipulation that would go in the opposite direction: inhibited contrasts through an upward transposition are not judged more humorous than the originals, despite the presence of higher pitches).

In the Joy task, we found that joy ratings were significantly higher for versions of the excerpts in which contrast had been inhibited by an upward transposition as compared to the original version,  $t(64) = 4.6$ ,  $p = .00002$ , and conversely, significantly lower for versions of the excerpts whose contrast had been inhibited,  $t(64) = -6.01$ ,  $p = 9.6e-8$ , or augmented,  $t(64) = -3.73$ ,  $p = .0004$ , by a downward transposition as compared to the original version. This is in line with many findings from music emotion studies, which have shown a consistent link between pitch frequency and emotional valence (for a recent overview, see Juslin, 2019), and suggests that listeners' ratings on joy are mainly driven by absolute pitch height rather than the presence (or absence) of relative contrasts of register between adjacent segments. The results we found for the Humor task suggest that our manipulation of the excerpts' contrasts of register somehow interacted with the direction of the transposition involved in the manipulation (i.e., whether one of the segments was transposed upwards or downwards). We investigated in more details this possibility in our second and third analyses.

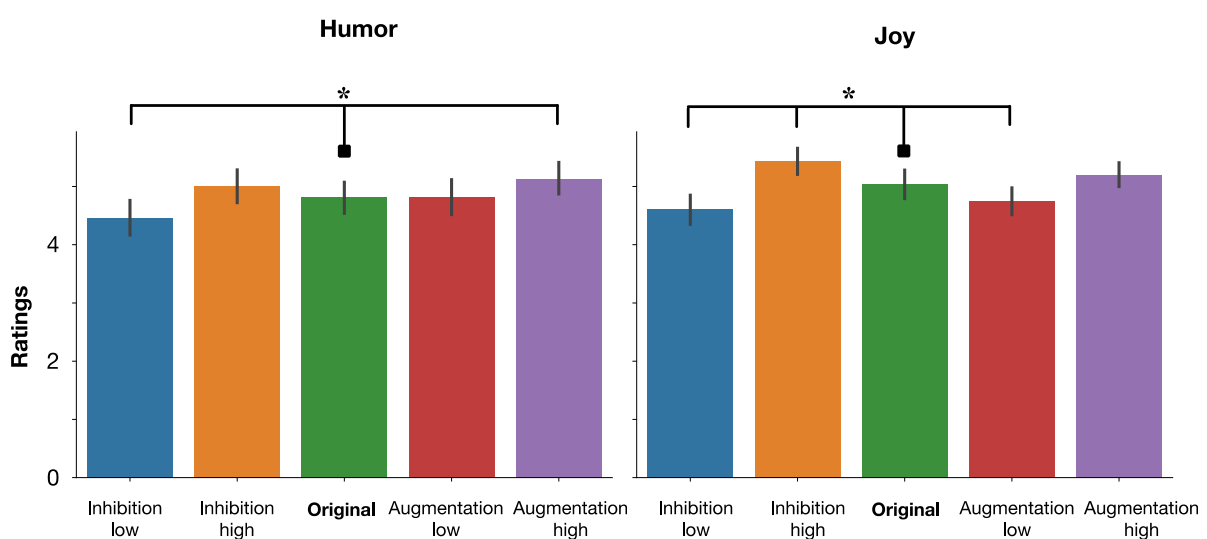


Figure 2. Impact of the four experimental manipulations on the original ratings.

## Second Analysis: Impact of Contrast and Transposition on Listeners' Ratings

To gain more insight on how Contrast and Transposition respectively impacted listeners' perception of humor and joy, we ran a complementary analysis, but considering only the manipulated excerpts. Specifically, we did a 2 x 2 x 2 factorial analysis for each task, using "Contrast" (Inhibition, Augmentation), "Transposition" (Upwards, Downwards), and "Musicianship" (Musicians, Nonmusicians) as predictors and Participant ID as a random factor for each task.

For the Joy task, we found no main effect of Contrast,  $\chi^2(1) = 0.7, p = 0.4$ , but a main effect of Transposition,  $\chi^2(1) = 75.8, p = 2.2e-16$ . Excerpts with a segment transposed upwards were judged as 0.64 ( $\pm 0.06$  standard errors) more joyous than excerpts with a segment transposed downwards, which is in line with the aforementioned studies on musical emotions showing that musical joy is more likely to be associated with higher pitch frequency. Finally, we found a significant interaction between Contrast and Transposition,  $\chi^2(1) = 8.2, p = .004$ . Again, these results are not surprising in light of music emotion studies: excerpts that had been deprived of their lower frequencies through an upward inhibition were judged as more joyful than the excerpts that had been deprived of their higher frequencies through a downward inhibition. We found no significant main effect or interaction of Group with any other factor (see SM for in depth statistical analyses including results of hierarchical model comparisons and post hoc tests).

For the Humor task, we found a main effect of Contrast on ratings,  $\chi^2(1) = 10.0, p = .001$  (Figure 3). As predicted, ratings of excerpts with an augmented contrast were significantly higher by 0.24 ( $\pm 0.07$  standard errors) as compared to excerpts with inhibited contrasts. We also found a main effect of transposition,  $\chi^2(1) = 28.9, p = 7.3e-8$ . Excerpts transposed upwards were judged as 0.42 ( $\pm 0.07$  standard errors) more humorous than

excerpts with a segment transposed downwards. We found no significant interaction between Contrast and Transposition,  $\chi^2(1) = 2.4, p = .12$ . We found no significant main effect or interaction of Group with any other factor (see SM for in depth statistical analyses including results of hierarchical model comparisons and post hoc tests).

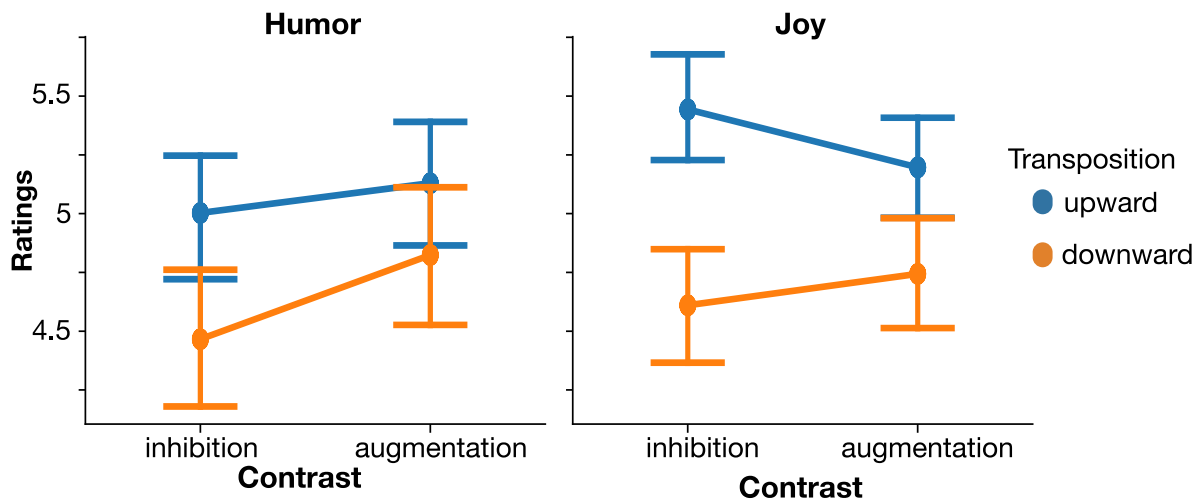


Figure 3. Factorial analysis of the effects of Contrast and Transposition on listeners' ratings.

The fact that Contrast had an effect on humor ratings but not on joy ratings is in line with our hypothesis of contrasts of register as playing a privileged role in the identification of music's humorous content. Note that, in the same perspective, we also found that listeners' ratings of the music's humorous content and of its joyful content were only marginally significantly correlated, and that the strength of this correlation was quite weak ( $r = .27, p = .05$ ; Figure 4). This is consistent with the fact that listeners' ratings for humor and joy were differently affected by our manipulation of contrasts of register.

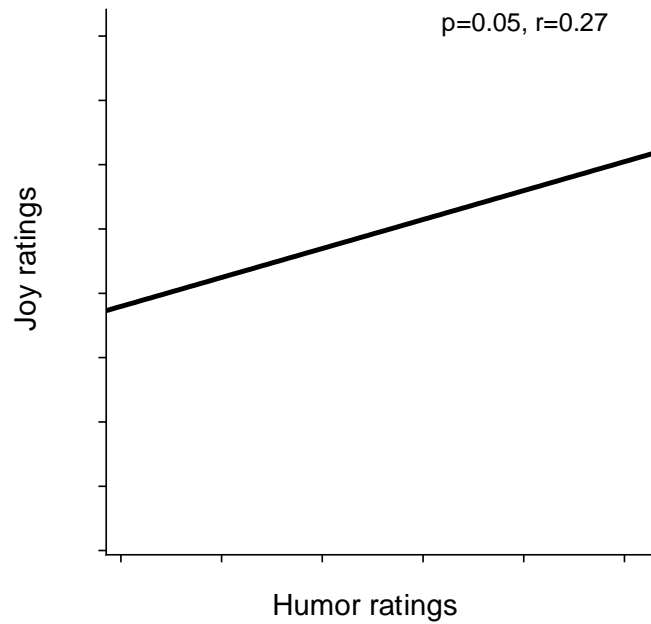


Figure 4. Correlation between humor ratings and joy ratings (each dot represents the mean humor (x-axis) and joy (y-axis) ratings for a musical excerpt).

However, the main effect of Transposition in the Humor task suggests that pitch height is also relevant in the evaluation of the music’s humorous content, and that musical passages displaying higher frequencies are more likely to be assessed as expressing humor. Our third analysis investigated this possible confound in more detail.

### **Third Analysis: Impact of Contrast on Listeners’ Ratings When Controlling for Register**

To investigate possible confounding factors of the effect of contrast on the listener’s ratings—presented in the second analysis above—we investigated whether the perception of musical humor was mediated by the overall register of the excerpts. To do this, we ran a model-based causal mediation analysis, where we investigated whether Contrast (i.e., augmented vs. inhibited) had a direct effect on ratings and/or whether the effect of contrast on

ratings was mediated by the excerpts' overall register (which we estimated as the mean MIDI-note).

We first studied how our experimental measure of overall register height (mean MIDI-note) varied for the different conditions. We confirmed that excerpts transformed through an upward transposition indeed tended to have a higher mean MIDI-note than their original counterparts, whereas the excerpts transformed through a downward transposition tended to have a lower mean MIDI-note than their original counterpart (Figure 5a). Moreover, we found that the mean MIDI-note of the 50 musical excerpts was strongly correlated to joy ratings ( $r = .76, p = 8.9e-11$ ), and to humor ratings ( $r = .52, p = 9.1e-6$ ) (see Figure 5b)—although the correlation was weaker for humor ratings (which is in line with the second analysis).

We then performed a causal mediation analysis investigating whether the effect of Contrast on joy and humor ratings was mediated by mean MIDI-note. This analysis revealed that there was no significant average direct effect from Contrast to joy ratings (Estimate = -0.05, CI: [-0.21, 0.09],  $p = .53$ ; Figure 5c), and that the effect of Contrast on joy ratings was significantly mediated by mean MIDI-note (Estimate = 0.11, CI = [0.05, 0.18],  $p = 2e-16$ ). In contrast, for humor ratings, the effect of Contrast on humor ratings was significantly mediated by mean MIDI-note (Estimate = 0.05, CI = [0.02, 0.08],  $p = 2e-16$ ). However, we also found a significant average direct effect from Contrast to humor ratings (Estimate = -0.28, CI = [-4.5, -0.11],  $p = .002$ ). This suggests that contrasts of register had a specific impact on listeners' perception of musical humor, even when considering the variance in the ratings explained by the excerpts' overall register.

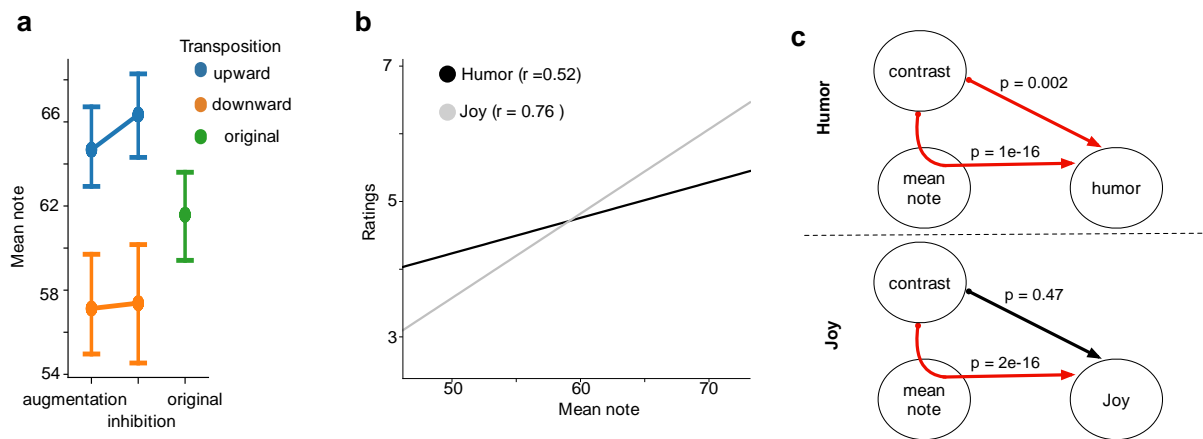


Figure 5. (A) Mean MIDI-note for all the excerpts depending on contrast and transposition conditions. (B) Correlation between excerpts' mean MIDI-note and listeners' ratings for Joy and Humor tasks. (C) Causal mediation Analysis results for both the Humor (up) and Joy tasks (down). Predictors are Contrast and mean MIDI-note. Outcomes are either humor ratings (top) or joy ratings (down). Red arrows indicate significant pathways ( $p < .05$ ).

### Listening Strategies in Joy and Humor Tasks

Finally, we analyzed the rating differences for the four debriefing questions with paired  $t$ -tests. As shown in Figure 6, we found that participants were more likely to imagine a fictional scene while listening to music when they had to assess the music's humorous content, as compared as to when they had to assess the music's joyful content; musicians:  $t(30) = 2.63, p = .01, d = 0.54$ ; nonmusicians:  $t(28) = 2.24, p = .03, d = 0.4$ . However, no difference between the tasks was observed with respect to the extent to which the listeners relied on their felt emotions; musicians:  $t(30) = -0.32, p = .74, d = 0.05$ ; nonmusicians:  $t(28) = -1.48, p = .14, d = 0.38$ .

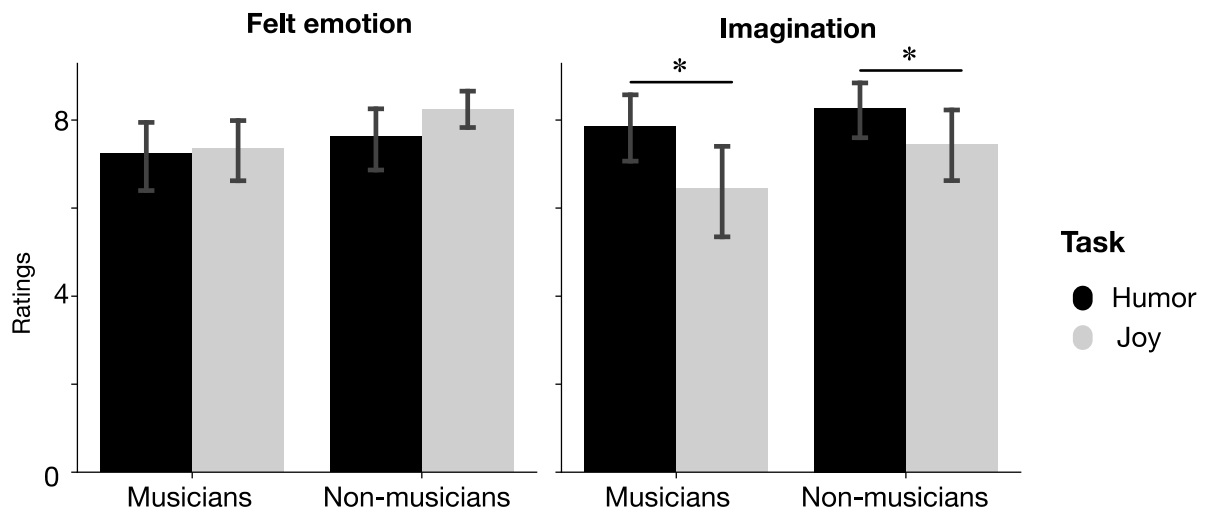


Figure 6. Reported listening strategies for the two rating tasks.

Here, it might be that the style of the musical excerpts we selected shares many features with the style of the music stereotypically associated with silent movies, or even comical movies in general (however, see Altman, 2004, for a discussion on how this stereotype does not match the actual musical practices). Indeed, during our debriefing sessions, several listeners spontaneously associated our stimuli with silent movies such as Chaplin's, and this association was probably made even more salient when we asked them to evaluate the music's humorous content. It might also be that types of musical contents in fact differ in their immediacy—with basic emotions, such as joy, more immediately available to the listener's perception and more complex, layered contents, such as humor, requiring an additional act of imagination (Levinson, 1996). Lastly, this result could also be tied to the social nature of comedy—assessing the humorous content of a musical passage implicitly triggering the need to imagine a social scene between interacting agents. We come back to this possibility in the discussion below.

## Discussion



Humor is present within all types of cultural and artistic mediums, and music is of course no exception. Even when music has no accompanying vocals, musicians sometimes aim at giving some humorous undertones to their sonic output—as attested by the long list of musical genres that are more or less explicitly associated with humor, wit, or comedy. We believe that such musical presentations “under the humorous mode”—which are likely to be much more common than music aiming at eliciting full-fledge laughter—have not received the attention they deserve in empirical studies on musical humor. Despite being limited to the compositional output of one single composer, our study provides a first step in showing how simple, standard musical resources—such as contrasts of register—might underpin the expression of musical humor. Here, we showed that directly manipulating contrasts of register found in passages of Cécile Chaminade’s piano music impacted the extent to which listeners rated such passages as expressing something humorous. In particular, we showed that excerpts with an augmented contrast were judged as expressing significantly more humorous content than excerpts with an inhibited contrast, and that such effect was still present when considering the impact that higher pitch frequency had on the perception of musical humor.

### **Contrasts of Register and the Mechanisms Behind the Perception of Musical Humor**

A striking result of our study is that there was no significant effect of musical expertise on listeners’ ratings. Musicians and nonmusicians were impacted in the same way by our manipulations of contrasts of register. It could be that all listeners are in fact similarly “experienced” when it comes to identify music’s expressive properties, as long as such listeners are sufficiently attuned, through mere cultural exposure, to the broad sonic and syntactical properties of the musical culture under consideration (Bigand & Poulin-Charronnat, 2006). In this perspective, our results go against the idea that hearing humor in music is inherently referential, being strongly dependent on the expert knowledge of the

musical practices from a specific cultural context (Attardo, 2020; Crépiat, 2021; Dalmonte, 1995; Eriksen, 2016; Houseman, 2013; Kitts & Baxter-Moore, 2019; Lassauzet, 2019). On the contrary, our results suggest that this kind of expressive or semantic property of musical excerpts might be readily accessible to a wide range of listeners. Another plausible explanation might be that the perception of musical humor taps in more general cognitive processes, independent of the musical medium. In particular, it might be that, because of the discontinuity introduced in the melodic flux, heightened contrasts of register were simply treated as the kind of benign violation that is typically associated with humor (Warren & MacGraw, 2015). We come back to this possibility below.

Four other aspects of our results related to the perception of musical humor deserve further discussion. First, our results show that the manipulation of the sole contrasts of register only had a moderate impact on participants' ratings. The musical expression of humor is indeed likely to be associated with the combination of different kinds of contrasts. For example, in the excerpt of the *Étude Humoristique* given above (see Figure 1), Chaminade doubles the contrast of register with a contrast of density (two or three parallel lines vs one single line) and a contrast of articulation (*marcato* vs. *ordinario*), thus reinforcing the impression of hearing two different musical sources or persona, differing in size or weight, following one another on the auditory stage, or interacting in some way with one another (Bregman, 1990; Schlenker, 2017). In other words, contrasts of register tend not to be used in isolation but most often together with contrasts happening at some other levels, in order to achieve a clearer contrast in the overall gestalt of the musical piece. As such, it is not surprising that manipulating independently one specific kind of contrast only resulted in a somewhat small effect size. Further studies could explore more systematically the role of other types of contrasts and of their interactions in the expression of musical humor.

Second, the limited impact of contrasts of register in the perception of musical humor also points towards the idea that contrasts of register do not by themselves ground the music's humorous content but rather function as a basic inferential parameter, making the inference of a compositional humorous intent more relevant only when some other sonic conditions are met. Our original excerpts were indeed different in terms of modes, tempo, articulation, etc. As such, and independently of our manipulation, they presented some variability in how listeners found them expressing something humorous (see Figure 7). It is thus possible that contrasts of register were treated as cues (in the sense of Deliège, 1987, and Temperley, 2001) that made the humorous intent more salient only in the appropriate sonic context; that is, in the kind of context in which the interpretation of the music as expressing something humorous already made sense. In that perspective, contrasts of register would have a primarily pragmatic role, helping listeners to disambiguate between the various possible semantic interpretations afforded by the present musical context.



Figure 7. Listeners' ratings of Joy and Humor for Chaminade's original excerpts.

Third, and obviously, our results should not be interpreted as showing that contrasts of register invariably cause the music to be perceived as expressing something humorous. It would indeed be quite easy to exhibit a piece of music that displays swift contrasts of register that are put to use for widely different expressive means than expressing humor. However, we saw that heightened contrasts of register did not lead listeners to rate musical excerpts as more joyful. In other words, if a passage of music expresses something joyful, augmenting the contrasts of register it contains does not seem to make it sound more joyful. This rules out the possibility that contrasts of register act as a mere expressive intensifier, making more salient any basic expressive property of a given musical passage. Here, it might be useful to distinguish between basic expressive properties (such as sadness, joy, or anger), which are directly perceived within the music on the basis of some resemblance with the vocal expression of the corresponding emotion (Bedoya et al., 2021; Juslin, 2019) and more complex expressive properties, which require from the listener to engage in an additional act of imagination—imagining for example that a persona within the music is expressing such or such emotion or mental state (Hatten, 2018; Levinson, 1996). A possible explanation of our pattern of results would be that contrasts of register only make more salient this later kind of expressive properties, by making it easier for the listeners to hear the music as expressing some kind of abstract narrative or dramatic content (Almén, 2008). This is consistent with the fact that listeners tended to engage significantly more in acts of imagination when they had to assess the music’s humorous content, as compared to its joyful content (see Figure 6 above). But again, this picture may need to be refined. Recent studies on narrative engagement with music (McAuley et al., 2021) showed that inhibiting contrasts did not in fact reduce the ability of listeners to engage in narratives when listening to music. So it cannot be that contrasts of register just make it generally easier for listeners to engage in acts of imagination when listening to music. Rather, it might be that contrasts of register are specifically important

when some kind of *social* imagination is required—when the perception of the music’s expressive content relies on the listener’s ability to hear at least two different musical personae, or to hear a social interaction within the music (Aucouturier & Canonne, 2017). This is clearly not the case for every narrative one might imagine when hearing music; but this is likely to be a crucial aspect of being able to hear the humorous content of a piece of music, given the often-social nature of comedy. Such perspective would explain why contrasts of register impacted the perception of the music’s humorous content in such a clear way. In that sense, the presence of augmented contrasts made it easier for our participants to imagine two different agents interacting in a fictional scene, akin to prototypical scenes of comedy duo, which are precisely build around uneven relationships between two characters (Roberts, 2018).

Fourth, our results also show an impact of register on the perception of the music’s humorous content. Here we found that listeners were less likely to rate the excerpts as expressing something humorous when parts of the excerpts had been transposed downwards, resulting in the elimination of the excerpt’s higher frequencies. Such result suggests that iconic or imitative resources might play a role in the perception of musical humor. In particular, a musical piece could convey a humorous content because it imitates laughter, or because the listener recognizes in it a musical representation of the sonic phenomenon of laughter. For example, previous work by Trevor and Huron (2018) investigated whether isochronous staccato rhythmic patterns are more likely to be found in instrumental music associated with humor, but provided only mixed evidence that such compositions actually emulated the prototypical rhythmic pattern of laughter. But besides its rhythmic structure, laughter is also distinctive in terms of fundamental frequency, which is routinely much higher than in speech (Bachorowski et al., 2001). Moreover, the fundamental frequency of laughter is also more likely to change swiftly over time, often from one extreme to the other. And it is

precisely the excerpts in which the contrast had been augmented through an upward transposition that were judged as most humorous. As such, our results are compatible with the idea that musical humor is more likely to be perceived when the music is heard as presenting some broad iconic resemblance with the sonic manifestation of laughter.

### **Contrasts of Register, Musical Humour, and Musical Pragmatics**

One way to systematize the four above interpretations of our results in a coherent way is to consider them as a set of hypotheses about the semantic and pragmatic functions of contrasts of register in the perception of the music's humorous content. The central point is that these possible functions of contrast of register in humorous music are not necessarily mutually exclusive, similarly to what can be observed in other aspects of music cognition like narrativity, in which contrasts of register have both semantic and pragmatic functions (MacAuley et al., 2021). Further comparative studies, including cross-cultural and cross-historical perspectives, should be conducted to refine our understanding of these semantic and pragmatic functions.

That being said, as fruitful as these four interpretations of our results are, they still leave open one important question: what are the underlying cognitive mechanisms enabling contrasts of register to have such semantic or pragmatic effects on the perception of the music's humorous content? Our results do not provide an answer to such question, but the very nature of the parameter we have chosen may provide one. Contrasts of register are indeed closely related to two of the main theories of humor, namely the incongruity theory and the play theory (Attardo, 2020; Carroll, 2014). They are likely to induce, on the one hand, surprise (i.e., incongruity) within the listener's expectations of the musical form, and, on the other hand, a sense of playfulness, given their tendency to activate the perception of a social interaction of humorous nature within the music (e.g., the two personae of a comical duo).

To draw on a now classic distinction in joke studies (Attardo et al., 2002), contrasts of register could be considered as “background incongruities”—i.e., an incongruous content that is part of the fictional situation depicted by the joke rather than of the punchline of the joke. In other words, background incongruities can be seen as a kind of incongruous content that is not addressed or resolved but rather explicitly presented as a normal aspect of the scene. For example, in the joke “How does an elephant hide in a cherry tree? It paints its toenails red” (Hempelmann & Attardo, 2011, p. 132), the representation of an elephant hiding in a cherry tree is a background incongruity because it is presented as a presupposition of the question; that is, as a (falsely) noncontroversial matter of fact. Conversely, the representation of the same elephant painting its toenails in red is a “foreground incongruity,” because it is presented as a surprising answer to the question; that is, an incongruous content that plays the role of the punchline of the joke. Empirical studies have shown that background incongruities increase the processing and evaluation of the humorous content of jokes compared to jokes without background incongruities (Attardo, 2020; Samson & Hempelmann, 2011). Here, contrasts of register in music, as a normal syntactic parameter, could clearly be seen as playing the role of background incongruities when they are conveying a humorous content. As for the link between contrasts of register and play theory, contrasts of register could here have the meta-communicative role of “keying” (Hymes, 1972) or “framing” (Goffman, 1974) the humorous nature of the musical content. In that perspective, contrasts of register are perceived as a signal indicating a playful situation and/or context of interpretation; that is, communicating a meta-message such as “this is play” or “activate a playful mindset” (Bateson, 1972). This potentially leads to a humorous interpretation of the musical content, given the correlation often observed between humor and playfulness, especially in music (Hevner, 1936; Moseley, 2016).

This functionalist description of both background incongruities (as a semantic type of incongruities within a fictional situation) and framing of a playful mode of interpretation (as a pragmatic function of the message communicating something about the message itself) offers a coherent explanation of the cognitive mechanisms which might underlie the role of contrasts of register in the perception of musical humor:

- Contrasts of register, considered as a specific kind of contrast to be combined with other kinds of contrasts, play the semantic role of background incongruities, enhancing the processing and evaluation of the humorous nature of the musical content. For example, in the excerpt 10 (see online Supplementary Material), the contrast of register is combined with a contrast of dynamics (switch from forte to mezzo piano) and a contrast of harmony (switch from minor to major mode).
- Contrasts of register, considered as a basic inferential parameter, have the pragmatic function of framing a supposedly intended playful mode of interpretation of the musical content. For example, again in the excerpt 10 (see Supplementary Material), the contrast of register is perceptually very salient and at the same time highly unexpected. It can thus easily be interpreted as having the function of framing a playful mode of listening.
- Contrasts of register, considered as an expressive intensifier of social-imaginative expressive properties, also play the semantic role of background incongruities, but in a more indirect way: complex expressive properties that are intensified and, at the same time, that involve social imagination, are more likely to be interpreted as exaggerated and/or stereotypical behaviors between at least two agents/personae, which is a typical background situation of a humorous content. For example, in the excerpt 1 (see Supplementary Material), the short motives in the first four bars are quickly contrasting in register. They are, at the same time, very similar (albeit not identical).



The combination of the quickly-changing registers with the strong salient melodic similarity intensifies the expressive properties of this passage, fostering the social-imaginative interpretation of exaggerated behaviors, typical of humorous situations.

- Contrasts of register, considered as presenting some broad iconic resemblance with the sonic manifestation of laughter, also have a pragmatic function of framing a playful mode of interpretation of the musical content: iconic imitation of laughter within a non-obvious joking context, such as listening to classical music, are likely to be perceived as incongruous at a semantic level and, then, re-interpreted at a pragmatic level as signaling “This is play / This is humor.” For example, again in the excerpt 1 (see Supplementary Material), the same short motives quickly contrasting in register in the first four bars share some broad resemblance with the sonic manifestation of laughter. The semantic incongruence of such an unexpected expressive property in the context of a classical piece of music could plausibly be interpreted as a signal of a playful or humorous communicative intention.

Ultimately, such an interpretation of contrasts of register as being at the interface between semantics and pragmatics invites us to reconsider the very divide between humor-as-experience and humor-as-content. Indeed, it remains a possibility that the music’s humorous content is in fact inferred by listeners on the basis of their felt experience; and conversely, it could be that some humorous experience is aroused in the listeners once they identify the music’s humorous content, through emotional contagion or empathy (for a similar discussion on the case of musical emotions, see Levinson, 1996; Song et al., 2016). These possibilities could be empirically investigated, for example by comparing participants’ zygomatic activity (the muscle used to smile) before and after the introduction of a contrast of register in a musical stimulus—as done for the study of vocal emotions (Arias et al., 2018). If bursting into laughter is an uncommon reaction to music, as David Huron (2006) once claimed, we would

argue that smiling is not. Such a move from laughter to smiling would allow to study in a more fine-grained fashion the relation between the semantics of musical humor and listeners' physiological and psychological experience, thus helping to bridge the gap between two lines of research that has remained separated for too long.

#### Footnote

<sup>1</sup> Note that non-syntactical aspects might be altered. For example, timbre, being a complex, multi-dimensional musical parameter, is almost necessarily impacted by any lower-level acoustic modification.

<sup>2</sup> The recruitment was done among the INSEAD large pool of participants and on the basis of an eligibility questionnaire. This eligibility questionnaire aimed to verify the level of musical practice of the volunteers in order to constitute the test groups.

### Author Note

Authors H. R. and P. A. S. contributed equally to the work. C. C., H. R., and P. A. S. designed the experiment. H. R. and C. C. selected and produced the musical stimuli. P. A. S. programmed the interface used in the experiment. C. C. and P. A. S. collected the data. P. A. S. analyzed the data. C. C. and P. A. S. interpreted the results. C. C. and H. R. wrote the paper.

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