Emptying rooms: When the inverted-U model of preference fails—An investigation using music with collative extremes

Anthony Chmiel and Emery Schubert

Empirical Musicology Laboratory, School of the Arts and Media,
The University of New South Wales, Sydney, New South Wales 2052, Australia
Correspondence: e.schubert@unsw.edu.au

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Abstract

Daniel Berlyne's inverted-U model remains a simple, well-supported explanation of music preference as a function of collative variables. However, after reviewing the literature, we identified a gap in studies examining preference for music exhibiting collative variable levels that were classified as extreme. A small number of studies using examples of extreme music suggested a floor-effect for preference, where preference ratings remained at or near the minimum for subsequent exposures. To further investigate this, we tracked preference ratings for two music stimuli over three weekly exposures: one stimulus deemed as an example of extreme music, and a second stimulus deemed as moderately unusual. The moderately unusual stimulus produced results compatible with the inverted-U model, whereas the extreme stimulus did not. In addition, a substantial percentage (32%) of individual preference trajectories for the extreme stimulus outlined a floor-effect. We conclude that the inverted-U might break down for extreme music.

Keywords: music, preference, extreme, inverted-U, Daniel Berlyne, collative variables, unusual, complexity, familiarity

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Introduction

Daniel Berlyne's inverted-U model is one of the most cited and broadly supported models of music preference in the past 50 years (Chmiel & Schubert, 2017; Finnäs, 1989; Hargreaves & North, 2010). The model has been tested using abstract auditory stimuli (e.g., tone and rhythm sequences) and realistic music experiences (e.g., pieces from a range of styles, time periods, and cultures). Berlyne (1960, 1971) proposed that aesthetic preference is primarily related to the amount of arousal produced by collative variables, such as complexity or familiarity. He additionally proposed that this relationship is parabolic in nature, with particularly moderate arousal producing an optimal point of preference, and an increase or decrease in arousal from this point corresponding with a decrease in preference. As a function of variables such as complexity and familiarity, the inverted-U is robust under many circumstances. However, we noticed one exception that forms the basis of the present investigation. In brief, it appears that the inverted-U might not hold when the stimulus exhibits an extreme level (i.e., extremely unfamiliar, extremely complex, or extremely unusual). The aim of the present study is to further investigate preference ratings for stimuli of this nature.

Explanation of the inverted-U model

Berlyne published his psychobiological theory in 1960 and proceeded to empirically test it, primarily with visual stimuli, over the next 15 years (Berlyne, 1967, 1970, 1971, 1974). The theory posits that arousal is a determinant of aesthetic preference, and that the level of arousal produced by a stimulus (known as *arousal potential*) is controlled by three types of variables. These are (a) *psychophysical variables* (perceivable differences in the stimuli, such as signal intensity), (b) *ecological variables* (cognitive associations and meanings relating to a stimulus), and (c) *collative variables*. Collative variables refer to the evaluative properties of a stimulus, which are collated by a respondent. These include complexity, novelty or familiarity (measured either through self-reported ratings or assumed through controlled exposures to a stimulus), change, conflict, surprisingness, uncertainty, interestingness, and ambiguity (Berlyne, 1960, p. 44; 1971, p. 69). Berlyne (1971, p. 69) proposed that the collative variables are the most significant determinants of preference, and it is for this contribution that he is most remembered.

The inverted-U relationship proposed by Berlyne is outlined in Figure 1. While the model can be described as a quadratic function, it can also be seen as consisting of three segments (Berlyne, 1971, p. 194; 1974, p. 176; Heyduk, 1975, p. 84; Walker, 1973, p. 69). These segments are (a) an increase in preference (the left segment of the curve), (b) a decrease in preference (the right segment), and (c) a complete inverted-U segment; the first two segments are outlined in Figure 1 with dashed lines. The segment of the curve that is encountered depends largely on the context of the stimulus. As an example, a handful of exposures to

an unfamiliar stimulus might be expected to produce the initial increasing segment, whereas repeated exposure to a stimulus that is already highly familiar might be expected to produce the second decreasing segment. With this in mind, a complete inverted-U curve might only be encountered in specific circumstances. Furthermore, multiple variables may interact with another and together influence the overall level of arousal potential, while the inverted-U relationship remains hidden among individual collative variables.

Literature review

Our review of the literature found a significant number of studies reporting either inverted-U results for music preference in relation to one or more collative variables (e.g., Bragg & Crozier, 1974; Burke & Gridley, 1990; Crozier, 1974; Getz, 1966; Gordon & Gridley, 2013; Hunter & Schellenberg, 2011; Orr & Ohlsson, 2001; Vitz, 1966), or results reporting one or more segments of the model (Bartlett, 1973; Eerola & North, 2000; Heyduk, 1975; McMullen, 1974; North & Hargreaves, 1995, 1996; Nunes, Ordanini, & Valsesia, 2015; Smith & Cuddy, 1986; Steck & Machotka, 1975). Regardless of these consistent and replicable results, one study (Hargreaves, 1984) reported a statistically flat result between preference and familiarity, which cannot be explained by the model. In his first experiment, Hargreaves investigated preference and familiarity responses of 59 participants for two short music excerpts over three exposures in a single, 3-hour session. Preference results for one excerpt produced an inverted-U trajectory, while results for the other excerpt steadily increased. Hargreaves' second experiment investigated preference and familiarity ratings of 40 participants for three short music excerpts (popular

music, classical music, and an avant-garde jazz excerpt) and contained 12 exposures (three weekly sessions, with four exposures per session). Preference ratings for the popular music and classical music excerpts produced an inverted-U relationship over subsequent exposures; however, the avant-garde jazz stimulus produced a statistically static result, remaining at a mean rating of 2 on a 5-point scale (ranging from 1 to 5) for all 12 exposures. There is no segment of the inverted-U curve that could explain this result.

The avant-garde excerpt was an unspecified selection of approximately 1 minute in duration taken from *Milk Teeth* by the group "A Touch of the Sun" (Mayo & Cusack, 1975), a spontaneous improvisation duo consisting of clarinet and guitar. What is of particular note for this excerpt, in addition to the unchanging preference rating, is that the style of music can be regarded as highly unusual and complex. We could not find a copy of this particular album to analyze the music, however we were able to talk to Simon Mayo (clarinettist of A Touch of the Sun) via personal correspondence and ask him to rate the two variables complexity and unusualness for the music on 11-point scales (0 to 10) for a general audience:

> The music was a chaotic combination of influences from jazz and avant-garde classical areas…we were good at emptying rooms very quickly. The people who liked our stuff were few…[o]ur music, to me at least, was all about an attempt at communication with the other musicians by using whatever sounds came to our hands or minds, mostly avoiding conventional tonal sequences. There was no composition on

> paper…[o]ften it rambled. Sometimes we just stopped for a while…I guess for the man in the street, the album would have been considered at the time maximum extremeness (10,10) for both features (complexity and unusualness).
>
> (S. J. Mayo, personal communication, April 2016)

With this maximum rating of complexity and unusualness in mind, we wondered whether there might be something special about extreme music that can violate its membership of the inverted-U. In other words, while highly complex, initially disliked music should become more liked with repeated exposures, perhaps when that music exhibits an extreme level of the collative variable the inverted-U relationship breaks down. Our initial investigation involved an examination of the music psychology literature in which preference and one or more collative variables were examined for stimuli of a highly unusual or extreme nature. The studies identified are listed in Table 1 and can be divided into two broad groups according to the kinds of stimuli used: Western and non-Western music.

Western stimuli

Our review of the literature only identified three studies (Margulis, 2013; Mull, 1957; Tan, Spackman, & Peaslee, 2006) using realistic Western music that could be deemed as highly unusual or highly complex. The studies by Mull (1957), and by Tan, Spackman, and Peaslee (2006) reported results outlining one or more segments of the inverted-U. Mull (1957) examined preference responses of 16 highly trained undergraduate music students to Schoenberg's String Quartet No.

3, Op. 31, first movement, and Hindemith's String Quartet No. 4, Op. 32, second movement[1]. The pieces are described as follows:

> Schoenberg in this excerpt uses a tone-row based on the 12-tone scale, with strikingly unmelodic, a-tonal, and dissonant effect. Hindemith, using his unique system of changing tonality based on the roots of the tone combinations, also produces an effect quite different from that of classical tonality as well as one of considerable dissonance.
> (Mull, 1957, p. 155)

These excerpts are therefore highly complex and push the boundaries of the classical idiom as might be understood by a general, non-specialist audience at the time of Mull's publication. However, the participants of this study were specifically chosen for their musicality (p. 156). Musicians are generally regarded as holding a higher tolerance for musical complexity and unconventionality (Orr & Ohlsson, 2005), and the concepts described by Mull such as atonality and dissonance would not be considered particularly unusual to students in a conservatorium. As such, it should come as little surprise that preference results for this study increased with subsequent exposures. The stimuli and audience of this study do not present a legitimate parallel with the extreme avant-garde stimulus and general audience of Hargreaves' study, and so a similar anomalous result can hardly be expected.

[1] The pieces are listed here as they are reported by Mull, although in the original publication both stimuli appear to contain misspellings of the work numbers. The Schoenberg stimulus most likely refers to the String Quartet No. 3, Op. 30. The Hindemith stimulus may refer to either the String Quartet No. 4, Op. 22 or the String Quartet No. 5, Op. 32.

Tan et al. (2006) used two distinct types of stimuli. The first type consisted of a number of unaltered classical piano solos, approximately 1 minute in duration. As these stimuli were unaltered, Tan et al. referred to them as "intact" stimuli. The second type of stimuli were created by linking together three or four 20-s excerpts of different pieces, also of classical piano solos. These stimuli were referred to as "patchwork" stimuli and are assumed by Tan et al. to hold a higher level of complexity than the intact stimuli. The authors noted (p. 411) that no effort was made to provide continuity between the linked adjoining excerpts, and so they were not matched in terms of thematic or harmonic material, key, tempo, mood, or style. In this way, the patchwork compositions could be considered highly unusual. The results for this study resembled segments one and two of the inverted-U model, with the intact stimuli producing a decreasing relationship with preference and exposure, and patchwork composition producing an increasing relationship.

However, like the Mull study, the unusualness and complexity of the patchwork compositions are not entirely comparable to the unusualness of Hargreaves' avant-garde stimulus. The reason for this lies in the linking of adjoining excerpts. While Hargreaves' stimulus was an atypical piece of music at all points in its duration, the atypicality of these patchwork stimuli is not explicitly measured. We can, however, make an assumption that the patchwork stimuli might sound unusual for only several seconds at the brief linking periods, before returning to a generally familiar format. In other words, the real question is whether the entire listening experience for this group of participants was truly extreme in the way that Simon Mayo described A Touch of the Sun as "emptying rooms". In this

light, we believe, again, that the stimuli between the two studies are not comparable and that the result in Hargreaves' article remains anomalous because of the extreme properties of the music.

Margulis (2013) examined preference for short excerpts of modernist music by Luciano Berio and Elliott Carter. Margulis described these specific excerpts as "atonal, rhythmically complex, and challenging, yet many committed and sophisticated listeners find them deeply rewarding aesthetically" (p. 49). Three types of stimuli were used: 1) unaltered excerpts; 2) excerpts with short sections (2–12 seconds in duration) repeated immediately after they occurred in the excerpt ("immediate repetition" condition); 3) excerpts in which the repeated section was inserted later, after more music had occurred ("delayed repetition" condition). Both repetition conditions received significantly higher ratings of preference than the unaltered condition, although there was no significant difference between the two conditions. The stimuli in this study can be seen as examples of highly unusual and complex, or even extreme music, and the observed result fits the first segment of the inverted-U model. However, the focus of Margulis' investigation was on the effect of intraopus (internal) repetition, rather than the influence of repeated exposures of an entire stimulus. For this reason, the data could not be used for comparison with any certainty for the purpose of our study.

Non-Western music

As unusual music could also be used to describe certain situations in which a person is exposed to music from a culture different to their own, we also

investigated studies using stimuli of this nature. Generally speaking, we would assume this term to refer to circumstances where the respondent has little or no cultural and musical understanding of the situation, little or no previous exposure to this music type, and when the music consists of elements that are foreign to the culture and musical tendencies that the respondent is familiar with. As a non-exhaustive list, examples of unfamiliar elements may be (a) melodic and harmonic in nature, such as with quarter-tonality or uncommon intervals, (b) concerned with unfamiliar timbre and instrumentation (such as large portamento and wider vibrato than the participant is accustomed to), and (c) language specific, in the case where the language is foreign to the languages with which the listener is familiar.

We identified seven studies (Brittin, 1996; Downey & Knapp, 1927; Erdmonston, 1969; Flowers, 1980; Heingartner & Hall, 1974; Shehan, 1985; Teo, Hargreaves, & Lee, 2008) investigating preference for non-Western music while manipulating at least one collative variable. In addition, we identified one study (Meyer, 1903) that used a microtonal composition (composed by the experimenter) created specifically for the study, performed on a reed organ, and another (Johnson, Kim, & Risse, 1985) in which melodies of Korean pieces were appropriated as solo piano performances. These two studies have been listed in Table 1 as “non-Western appropriations”. All nine of these non-Western studies produced results that could be explained by a segment of the inverted-U curve. Regardless, we performed aural examination on the stimuli used in four non-Western studies (Brittin, 1996; Erdmonston, 1969; Heingartner & Hall, 1974; Teo et al., 2008) for which the tested stimuli were easily accessible to see if the

stimuli used were extreme in nature, or not. Our examination concluded that none of the stimuli qualified as extreme music. Aural examination was not possible on the remaining five studies for varying reasons: The stimuli used by Meyer (1903) and Johnson et al. (1985) could not be recreated; the excerpts used by Shehan (1985) and the Cantonese excerpt used by Downey and Knapp (1927) were unidentified; we were unable to locate the excerpts referred to by Flowers (1980).

As noted in Table 1, the mean preference ratings for Downey and Knapp's unidentified excerpt of Chinese voice and orchestra increased with subsequent exposures. However, when these results are plotted (see Figure 2, recreated from the data reported in Downey & Knapp, 1927, p. 229), they are visually similar to the results of Hargreaves' avant-garde stimulus. That is, preference ratings for the non-Western stimulus (the dark line) occur much lower than the other tested stimuli, and any increase appears marginal. Furthermore, the results reported by Downey and Knapp are purely descriptive, based on means alone, with no *SD* or raw data values reported to allow additional inferential analysis. With this in mind, it is possible that the difference in mean preference ratings over subsequent exposures were not statistically significant, in which case these results could also be interpreted as remaining flat over the four exposures. While the piece is unidentified, Downey and Knapp describe it at several points. Specifically, they note that the piece contained "dissonance and irregular timing, in strong contrast to the melodious and orderly selections" (p. 225), and that "The Cantonese song was felt to be definitely unpleasant. A few

persons complained that an anticipation of hearing it operated to reduce their enjoyment of the programme as a whole" (p. 228).

Abstract stimuli

As noted earlier, Table 1 is composed of studies on realistic (i.e., ecologically valid) music stimuli. Additionally, a number of studies have investigated preference for abstract stimuli such as short sequences of random tones or rhythmic patterns, and these could be viewed as containing a high level of unusualness in that they do not resemble typical Western music. However, the ecological validity and complexity level of these stimuli can be assumed to be different to those in Table 1 (specifically, we regard the complexity levels of these stimuli as being relatively simple). Regardless, in this section, we review studies examining abstract auditory stimuli. A substantial number of previous studies of this nature have reported inverted-U results (Bragg & Crozier, 1974; Crozier, 1974; Martindale & Moore, 1989; McMullen & Arnold, 1976; Vitz, 1966), or results exclusively containing segments of the inverted-U (McMullen, 1974; Smith & Cuddy, 1986; Steck & Machotka, 1975). In addition to these studies, Szpunar, Schellenberg, and Pliner (2004) examined liking responses for abstract stimuli (short monophonic tone sequences, used in one experiment) and realistic music stimuli (excerpts of orchestral music, used in two experiments). Participants were given varying levels of subsequent exposures, ranging from 2 to 64. Further, this article split participants into an incidental listening condition and a focused listening condition. Our analysis of this study does not focus on this final aspect, and is limited to investigation of collative variables only.

With exposures acting as the independent variable, five of the six experiments reported results compatible with the segmented inverted-U curve, although the reported results of the remaining experiment cannot be fit to the model. The incidental listening groups reported monotonic increasing relationships between liking and exposure over three experiments, regardless of the stimulus type. Such a result is to be expected, as incidental listening has been previously linked with Zajonc's (1968) *mere exposure* effect; for a detailed review on this, albeit mainly in terms of visual stimuli, see Bornstein (1989). The focused listening conditions reported inverted-U results for both experiments using realistic stimuli, yet non-significant results when abstract stimuli were used. The mean preference ratings of this group remained at approximately 4 on a 7-point scale, up to the maximum 64 exposures. However, these short tone sequences do not meet our inclusion criteria of extreme, realistic music.

In summary, with the exception of Hargreaves (1984) we have not been able to identify any studies examining the relationship between preference and one or more collative variables for extreme music stimuli. From Downey and Knapp's description of the Chinese stimulus, and their description of the aversion their participants held for it (see Section *Non-Western music*), it is possible that this was also an example of an extreme collative variable of the kind found on *Milk teeth*. However, we were unable to specifically identify this Chinese stimulus. We propose that it may be possible that music of this nature, which we refer to henceforth as containing collative extremes, is not responded to in the standard, inverted-U manner compared with music exhibiting non-extreme collative levels, and therefore such music is not compatible with the overarching inverted-U

model. In response to this lacuna, we decided to perform an empirical investigation. Specifically, we wanted to test the null hypotheses that preference for extreme music would fit the inverted-U trajectory for familiarity and for complexity.

Method

Design

This study analyzed interactions and patterns between ratings of preference (dependent variable) and two collative variables: complexity and familiarity. This way we could falsify the model; if it could not fit any segment of the inverted-U, it could be because of some special characteristic of the extreme collative variable.

Materials

Two music excerpts were used, and these were intentionally chosen from styles thought to be unfamiliar to Western listeners. For our first excerpt we used a piece of Beijing opera, as this style matched the description provided by Downey and Knapp. We selected the piece *The drunken concubine* (see Table 2 for details), which we deemed an example of music containing collative extremes, from the perspective of a "general Western" audience. For our second excerpt, we selected *The most unwanted song* (see Table 2 for details), a pastiche composition designed, according to the authors, from the results of a survey asking what musical and lyrical elements people found most undesirable (Soldier, n.d.). We justified this piece as containing a moderate to high level of unusualness due to the atypical arrangement, although we judged the complexity

level of the individual sections as lower than in *The drunken concubine*. Specifically, some sections of the excerpt were moderately complex, and some sections were not complex at all. We therefore propose that this stimulus is moderately unusual, yet not extreme in nature.

Participants

Ninety-two participants took part in this study, split into four approximately even-numbered groups. Two groups were exposed to *The drunken concubine*, and the remaining two groups were exposed to *The most unwanted song*. Two groups were used per stimulus to minimize the influence any systematic external artefacts could have on a single group. However, one of the groups exposed to *The drunken concubine* was not able to record their data due to a technical fault. This left the final participant pool as 25 participants (19 female, 6 male, mean age of 20.6 years) exposed to *The drunken concubine*, and 46 participants (25 female, 21 male, mean age of 20.7 years) exposed to *The most unwanted song*. All participants were undergraduate students enrolled in an elective course that included full-time music students, part-time music students, and non-music students. Participants were asked how many years of formal music training they had received, and also for how many years they had practiced on an instrument or vocally. The participants exposed to *The drunken concubine* ranged from 0 to 16 years of formal training (M = 5.1 years) and 0 to 18 years of practice (M = 5.3 years). The participants exposed to *The most unwanted song* ranged from 0 to 20 years of formal training (M = 8.6 years) and 0 to 20 years of practice (M = 3.4 years). Participants from each group were a reasonable balance of non-musicians, musicians, and casual musicians.

Procedures

Participants were exposed to the excerpts in three weekly sessions. Each group received one exposure of their selected excerpt in each session, creating a total of three exposures to a single stimulus per group. Several additional repeated stimuli of popular and classical music were included in these sessions to divert attention from the stimuli to be examined. Participants were seated in a room and listened to the excerpt through a common sound system. Preference ratings ("I like this piece") were recorded using an 11-point rating scale (Strongly Agree [10]; Strongly Disagree [0]; Neither Agree nor Disagree [5]). Participants logged all data into an online survey created with *Key Survey* (WorldAPP, Braintree, MA). Responses were made on supplied desktop computers or personal devices consisting of either a laptop or a tablet. Statistical analyses were performed using *SPSS Version 24* (IBM, Armonk, NY).

Ethics

Potential participants were informed about the nature of the study, and all who agreed to participate completed a written consent form. The study received ethics approval (UNSW Human Ethics Approval HC13015).

Results

Analyses used

Descriptive statistics of preference for each stimulus are reported in Table 3. Both stimuli were subjected to separate repeated measures ANOVAs, with preference as the dependent variable and exposure as a within-subjects independent variable. In addition, linear and quadratic regression analyses

assessed the relationship between preference and complexity, and between preference and familiarity. Individual preference trajectories for each participant were also examined and designated into one of two categories: (a) a trajectory compatible with the segmented inverted-U model (i.e., a trajectory following one of the three segments outlined in Section *Explanation of the inverted-U model*) or (b) a trajectory incompatible with the inverted-U model.

The drunken concubine

A repeated measures ANOVA did not produce a significant main effect of exposure for *The drunken concubine* ($F(2, 48) = 1.10$, $p = .34$, $\eta^2 = .044$). Thus, a flat result was observed, appearing close to the minimum preference rating (see Table 3). Regression analysis results are reported in Table 4. The linear regression explained a significant portion of the variance between preference and complexity, and the linear term coefficient can be interpreted as the initial rising slope of the inverted-U curve. The quadratic (curvilinear) regression also explained a significant portion of the variance between preference and complexity, with a slightly larger R^2 value; however, the quadratic term coefficient was not significant at the p =.05 level. In contrast to the linear regression observed between preference and complexity, the variables preference and familiarity did not produce a significant linear or quadratic component. Together, these data do not support the null hypothesis that preference for an extreme stimulus fits the inverted-U as a function of complexity or as a function of familiarity. As a follow up, preference trajectories were examined on an individual basis. Fifteen (60%) of the participants produced a trajectory congruent with the inverted-U model, while the remaining

10 (40%) participants produced incompatible results. Of these 10 responses, two produced a *standard-U* trajectory (i.e., preference decreased, then increased). The remaining eight responses (32% of the total *N*) produced a floor-effect across exposures, with consistent preference ratings of 0 in each case. Importantly, these floor-effect responses cannot be explained by the inverted-U model.

The most unwanted song

A repeated measures ANOVA produced a significant main effect of exposure for *The most unwanted song* ($F(2, 90) = 4.18$, $p = .018$, $\eta^2 = .085$). Additionally, a Tukey post hoc test measuring the difference in preference ratings from exposure 1 to exposure 3 was significant ($p = .005$)[2]. Thus, preference ratings produced a significant decreasing trajectory from the first to the third exposure, supporting the null hypothesis that a non-extreme stimulus fits the inverted-U as a function of preference. Both the linear and quadratic regression analyses explained a significant portion of the variance between preference and complexity. The linear term coefficient could be interpreted as the initial rising slope of the inverted-U, although the quadratic term coefficient produced an inverted-U curve and explained a greater portion of the variance. This can be observed in Figure 3 alongside the linear regression line. As with *The drunken concubine*, the variables preference and familiarity did not produce a significant linear or quadratic component. When preference trajectories were examined on an individual basis, 33 (72%) of the participants produced a trajectory

[2] Although for Tukey post hoc tests measuring differences in preference between exposure 1 and exposure 2, and exposure 2 and exposure 3 $p > .05$.

compatible with the model, while the remaining 13 (28%) participants produced incompatible results. Of these 13 participants, eight (17% of the total *N*) produced standard-U trajectories, one participant produced a flat trajectory at a preference rating of 6, and another participant produced a flat trajectory at a preference rating of 5. The remaining three (6% of the total *N*) participants produced floor-effect trajectories remaining at 0. This is a substantially smaller percentage of floor-effect trajectories than observed for *The drunken concubine*.

Discussion and conclusion

This study identified a gap in investigations of music preference for extreme music stimuli, proposing that certain kinds of music might not follow an inverted-U relationship with preference as a function of a collative variable. However, we only found a very small number of studies that tested what we refer to as extreme music. In line with our hypothesis, the unusual yet not extreme stimulus (*The most unwanted song*) produced results compatible with a segmented inverted-U model: a significant decrease in mean preference ratings and upon individual investigation the preference trajectories for 72% of participants fit one of three segments of the model. In contrast, preference responses for the extreme stimulus (*The drunken concubine*) did not produce a significant overall relationship with preference, and upon individual investigation a lower percentage (60%) of participants produced trajectories that were compatible with the inverted-U. In addition, a substantial number of participants (32%) produced floor-effect results for *The drunken concubine*, which is reminiscent of the preference results of the extreme avant-garde stimulus reported by Hargreaves (1984) and the unidentified, possibly extreme

Cantonese stimulus reported by Downey and Knapp (1927). In contrast to this, only three participants (6% of the total *N*) produced a flat response of 0 over the three exposures for *The most unwanted song*.

It is therefore possible that extreme music is not responded to in the standard manner, and that preference for music of this type cannot be predicted with the usual models. One possibility is that there exists a level of unusualness at which the inverted-U model might completely break down, as seen with Hargreaves' (1984) stimulus. Presumably, as unusualness or complexity increases the inverted-U model might progressively become less and less accurate at predicting preference, up to a point where it no longer becomes a viable explanation. Interestingly, no significant relationship was observed between preference and familiarity. This runs counter to the general findings that preference follows the segments of the inverted-U as a function of familiarity (e.g., Bartlett, 1973; Bradley, 1971; Getz, 1966; Hargreaves, 1987; Hunter & Schellenberg, 2011; Johnston, 2016; North & Hargreaves, 1995, 1997; Schellenberg, Peretz, & Vieillard, 2008; Verveer, Barry, & Bousfield, 1933; Washburn, Child, & Abel, 1927). Similarly, this floor-effect result cannot be explained by the *mere exposure* effect (Zajonc, 1968), being an important alternative model to the inverted-U (Hargreaves & North, 2010). However, as we previously noted in our review of abstract stimuli, the mere exposure effect has primarily been linked to incidental exposures (Szpunar et al., 2004; Zajonc, 2001) , and therefore can be argued to hold limited relevance to the focused listening examples used in this study.

The main implication of the study is that while the inverted-U has produced robust relationships between preference and collative variables, the relationship may break down for certain kinds of stimuli. Our hypothesis of the extreme music breakdown opens new questions about the otherwise parsimonious predictions of the inverted-U model. We acknowledge that much of the focus of aesthetic research has moved on from Berlyne's psychobiological model, for example towards more ecologically rich areas (see, e.g. Bullot & Reber, 2013; Hargreaves, 2012; Hargreaves, Miell, & MacDonald, 2012; Konečni, 1982; Leder, Belke, Oeberst, & Augustin, 2004; Martindale & Moore, 1989; North & Hargreaves, 2000; Schubert, Hargreaves, & North, 2014). Indeed, the extreme characteristics we examined here could be explained in a number of ways, including ecological factors such as the lack of meaning such music may have for the individual (Kersten, 2015; Martindale, Moore, & Borkum, 1990; North, Krause, Sheridan, & Ritchie, 2017). Yet, in terms of music preference, the results of the inverted-U model continue to be replicated. In brief, the majority of studies explicitly testing the inverted-U while holding other variables constant—such as ecological and psychophysical variables—have produced little direct evidence to question the inverted-U model (but see, also Nadal, Munar, Marty, & Cela-Conde, 2010). The present study brings light to one such possible area that may prove fruitful in this regard. However, further investigation is required, specifically including additional exposures and a broader sample of unusual and extreme music.

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Table 1.
List of studies investigating preference and one or more collative variables for stimuli that were classified as potentially unusual or extreme.

Author(s) and year	**Unusual Stimuli**	**Stimulus culture**	**Preference result(s)** [1 2 3 4]	**Manipulated variable(s)**	**Exposures** [5]	**Participants** [5]	**Comments**[5]
Brittin (1996)	Excerpts of Caribbean, African, Asian Indian, and Papua New Guinean music	Non-Western	∩	Complexity (rated)	1	225	
Downey & Knapp (1927)	Unidentified Chinese piece consisting of voice and Chinese orchestra, described as dissonant and with irregular time	Non-Western	—	Familiarity (exposures, and rated on a binary scale)	4	33	This study also investigated preference for 9 Western stimuli. The results for the Chinese piece appear to slightly increase over exposures, however as only descriptive statistics were used, we are unable to determine whether this slight increase was statistically significant. As such, it is also possible that preference remained flat over subsequent exposures, as we have coded it

Author(s) and year	Unusual Stimuli	Stimulus culture	Preference result(s) [1 2 3 4]	Manipulated variable(s)	Exposures [5]	Participants [5]	Comments[5]
Erdmonston (1969)	Asian Indian music	Non-Western	↗	Musical awareness (training and knowledge in the style of the stimuli, or a lack of it)	1	21	
Flowers (1980)	Top 40 popular music, and African music	Non-Western	↗	Familiarity (assumed by style)	1	64	
Hargreaves (1984)	Avant-garde jazz	Western	↗ —	Familiarity (rated)	3; 12	59; 40	This study also investigated popular music, classical music, and easy-listening music. The Avant-garde stimulus produced an increasing result in Exp. 1, and a flat result in Exp. 2

Author(s) and year	Unusual Stimuli	Stimulus culture	Preference result(s) [1 2 3 4]	Manipulated variable(s)	Exposures [5]	Participants [5]	Comments[5]
Heingartner & Hall (1974)	Pakistani folk music	Non-Western	↗	Familiarity (exposures)	1- 8	96; 54	Exp. 2: As the ANOVA analysis only reports significance between extreme points of ratings, it is not possible to determine whether the initial decrease in preference was significant. This code is not definitive
Johnson, Kim, & Risse (1985)	48 melodies from Korean pieces, performed in single notes on the piano	Non-Western appropriation	↗	Familiarity (exposures)	2, 6, or 11	24	Participants were either 1) alcoholic Korsakoff Syndrome patients; 2) alcoholic patients; 3) non-alcoholic patients
Margulis (2013)	Excerpts of modernist pieces by Luciano Berio and Elliott Carter	Western	↗	Intraopus repetition	1	33	Intraopus repetition was manipulated by editing some excerpts, which had several short sections repeated. Repeated excerpts received a significant increase in preference compared to non-manipulated excerpts

Author(s) and year	Unusual Stimuli	Stimulus culture	Preference result(s) [1 2 3 4]	Manipulated variable(s)	Exposures [5]	Participants [5]	Comments[5]
Meyer (1903)	A self-composed, micro-tonal instrumental piece performed on a reed organ	Non-Western appropriation	↗ ↘	Familiarity (exposures)	12 - 15	14	This result is based on descriptive statistics only
Mull (1957)	Classical music (works of Schoenberg and Hindemith)	Western	↗	Familiarity (exposures)	5	16	Participants all held a high level of musical training, so these stimuli have not been classed as extreme. This result is based on descriptive statistics only
Shehan (1985)	Asian Indian, African, Hispanic, and Japanese music	Non-Western	↗	Familiarity (exposures)	1 or 5	26	Western popular and classical music was also investigated. These styles decreased in liking over exposures

Author(s) and year	Unusual Stimuli	Stimulus culture	Preference result(s) [1 2 3 4]	Manipulated variable(s)	Exposures [5]	Participants [5]	Comments[5]
Tan, Spackman, & Peaslee (2006)	Excerpts of classical piano solos. Some were unaltered, and some created by linking unrelated excerpts together	Western	↗ ↘	Familiarity (exposures)	4	74	Overall results showed a linear increase in preference. When observed via stimulus group, patchwork stimuli ↗, intact stimuli ↘
Teo, Hargreaves, and Lee (2008)	Excerpts of Malay, Chinese, and Asian Indian music	Non-Western	↗	Familiarity (rated)	1	89	

Note.

[1] ↗ Preference increases.

[2] ↘ Preference decreases.

[3] ∩ Inverted-U result.

[4] ─ Flat result.

[5] Experiments (Exp.) separated by semicolon.

Table 2.
Details of stimuli used in MS3.

Stimulus	Abbreviated title	Excerpt duration
Komar, V., Melamid, A., and Soldier, D. (1997). "The most unwanted song", on *The people's choice: music* [CD]. New York: Mulatta Records.	*The most unwanted song*	2:48
Lanfang, M. (1930). "The drunken concubine", on *Famous arias from Peking Opera, Vol. 1* [CD]. Beijing: China Record Corporation	*The drunken concubine*	2:37

Table 3.
Descriptive statistics of preference by stimulus and exposure, listed as M (SD).

	The drunken concubine	*The most unwanted song*
Exposure 1	1.84 (2.04)	4.30 (3.09)
Exposure 2	1.84 (2.23)	3.78 (2.76)
Exposure 3	1.36 (1.99)	3.37 (3.15)

Table 4.
Results of regression analysis for each stimulus.

The drunken concubine

Variables	*F*	r^2	*β*	*t*	*df*
Preference and complexity					
Linear	15.612 ***	.176	.42***	3.951	1,73
Quadratic	8.491 ***	.191	.401	1.142	2,72
Preference and familiarity					
Linear	.079	.002	.033	.280	1,73
Quadratic	.472	.021	-.552	.234	2,72

The most unwanted song

Variables	*F*	r^2	*β*	*t*	*df*
Preference and complexity					
Linear	10.385 **	.071	.266 **	3.223	1,136
Quadratic	8.634 ***	.113	-.665 *	-2.543	2,135
Preference and familiarity					
Linear	1.163	.008	.092	1.078	1,136
Quadratic	2.252	.032	-.619	-1.822	2,135

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

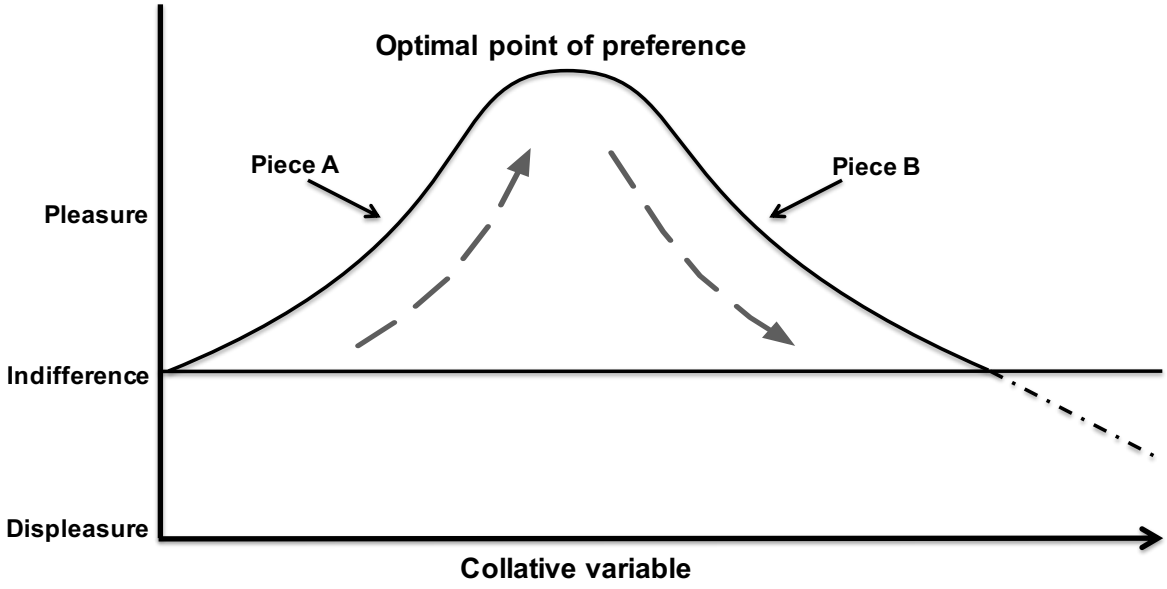

Figure 1. The Wundt curve. The first two segments of the curve are depicted with dashed arrows.

Note. This figure is adapted from one published by Berlyne (1971, p. 89). A similar adaption appears in Chmiel and Schubert (2017).

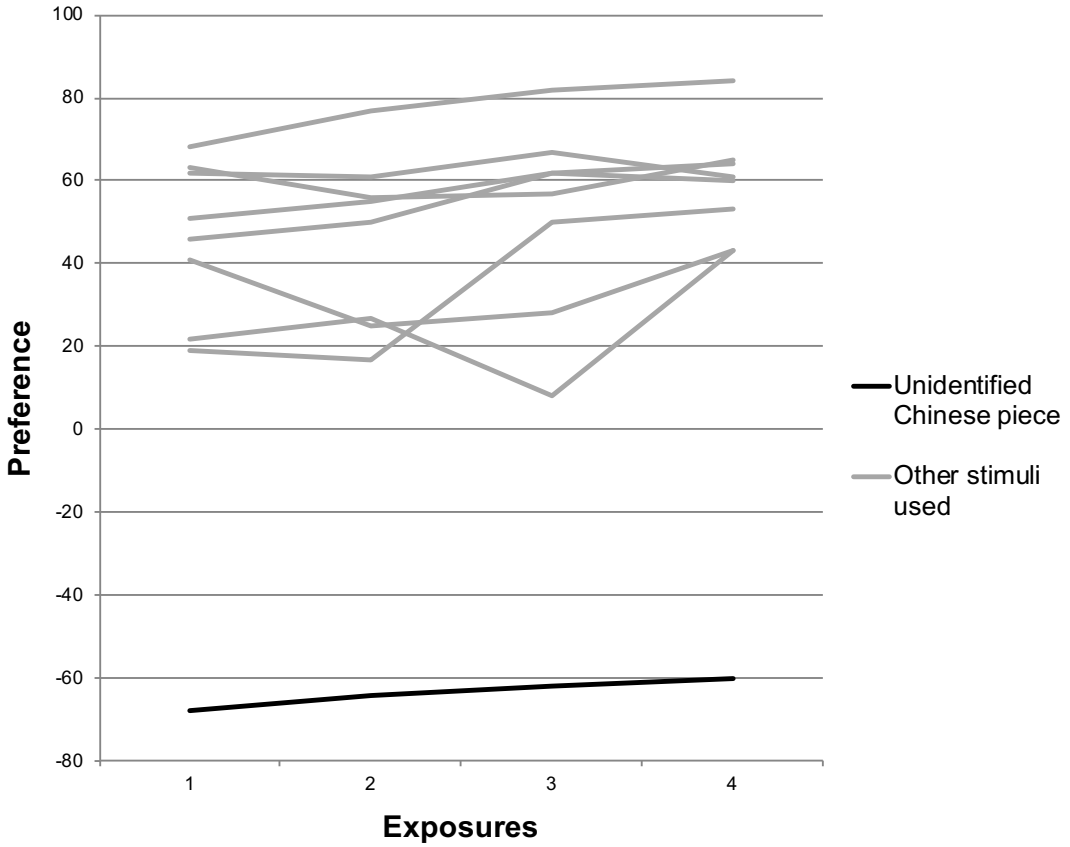

Figure 2. Mean preference ratings by exposure, created from descriptive statistics reported in Downey and Knapp (1927).

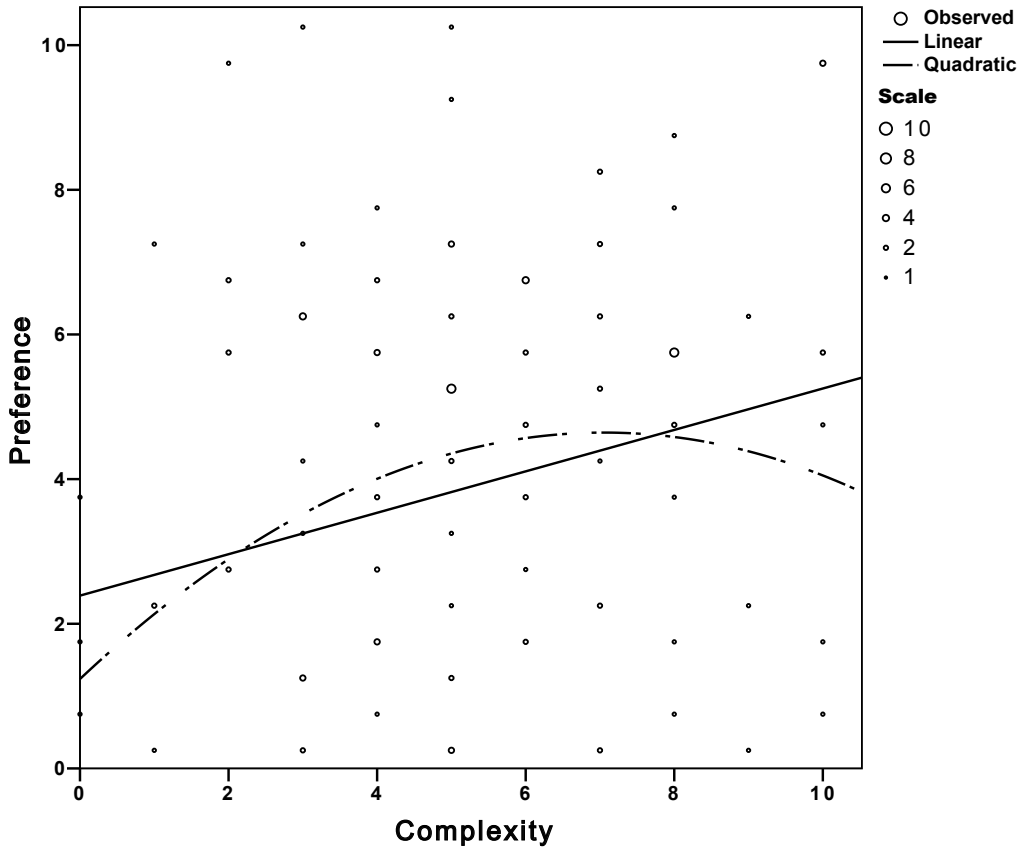

Figure 3. Linear and quadratic curve fitting of the variables preference and complexity for *The most unwanted song*.