AN ANALYSIS OF AFFECTIVE CONTENT IN THE SECOND MOVEMENT OF BEETHOVEN'S PATHÉTIQUE USING AN ACOUSTIC ETHOLOGICAL MODEL

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ABSTRACT

Two studies were carried out regarding the perceived expressive content for the second movement of Beethoven's *Pathétique* sonata (No. 8, Opus 13). In the first open-ended study, listeners provided descriptive terms for 5-second recorded excerpts. A content analysis was carried out on the terms resulting in 15 affective dimensions. In the second study 19 listeners judged the affective content for 5-second excerpts from the same work for all 15 dimensions. The amalgamated data provide a diachronic portrait of how the music changes over time. The relationship of the affective content to objective features of the music are discussed and interpreted using concepts from an ethological model of communication.

1. INTRODUCTION

A number of studies have been carried out tracing changes in reported musical affect over the course of a listening experience (Heinlein 1928; Hevner 1935; Nielzén and Cesarec 1981; Tagg 2006). In many studies, listeners hear a complete musical work or passage and are asked post-stimulus to report their perceived or felt emotion. Several researchers have aimed to collect more continuous data over the course of a listening experience (e.g., Nielsen 1987; Krumhansl 1996; Schubert 2010). This continuous data-collection approach has the potential for better tracing the dynamic changes experienced by listeners in typical listening situations. However, the demands of continuous response may overwhelm listeners: there may be insufficient time for the listener to introspect and respond before a change in the musical character renders the response no longer appropriate. Inspired by the goals of continuous data collection, and at the same time wary of placing excessive task demands on listeners, in this study we explore an intermediate approach between fully continuous data collection and post-stimulus data collection. We employ what we have called a "progressive exposure method" in which listeners are exposed to brief sequential excerpts of the music one at a time, but with some musical context surrounding each excerpt. This allows the listener to focus on his or her experience of relatively short passages, and so better allows us to trace changes in affect as the music unfolds.

An important issue is the duration of the excerpts used in the progressive exposure method. A handful of studies have examined the temporal processing involved in music listening. Gjerdingen and Perrott (2008) studied the duration of musical excerpts required for style identification. Gjerdingen and Perrott likened the task of style identification to "scanning the radio dial" where a listener decides whether to remain at the current station or move to the next station in a very short period of time. In a formal study, they found that listeners begin processing information pertaining to musical style within 250ms from stimulus onset. Likewise, a study by Plazak and Huron (this volume) suggests that listeners are well able to characterize the affective mood or content of excerpts as short as 1000 milliseconds. In light of this research, sound excerpts on the order of 1-5 seconds might be considered suitable for the progressive exposure method. Shorter time periods would lead to a practical constraint. For example, a five-minute work would require 300 1-second excerpts, potentially requiring over 2 hours to complete.

After listening to the work in question, we found that 2-3 seconds seemed too short, while 6-second excerpts seemed too long. That is, 6-second excerpts were more likely to span passages exhibiting more than one affective character. Accordingly, we chose to employ 5-second excerpts. This duration may not be appropriate for other works. For example, works with faster tempos may very well exhibit a faster "affective flux."

In order to avoid abrupt onsets and offsets, each excerpt was edited so as to begin with a 500 ms fade-in and end with a 500 ms fade-out. The beginning and end-points for the excerpts were musically arbitrary and so there is a danger that some of the affective responses may be artifacts of the position of the excerpt due to the editing. In order to minimize this possible artifact, we elected to make two complete sets of edited excerpts that were offset by 2.5 seconds. In short, one set of excerpts spanned the time sequence, 0-5, 5-10, 10-15, etc.; a second set of excerpts spanned the time sequence 2.5-7.5, 7.5-12.5, 12.5-17.5, etc. Each listener heard one of the two complete sets. Using this method, we created 112 sound excerpts in two sets of 56 each. This enabled us to attain a 2.5-second temporal resolution.

In brief, we carried out two studies of a single musical work, namely, Beethoven's *Pathétique* sonata (No. 8, Opus 13), second movement. In the first study we collected open-ended responses from listeners; these responses were used to establish a set of affect-related scales that were then used by an independent group of listeners to characterize the same musical work.

2. INITIAL STUDY

The goal of our initial study was to identify a set of pertinent affective categories or dimensions that could be used in the main

study to characterize different musical moments. Rather than simply imposing our own affective categories, we proposed to employ a bottom-up method in which listeners themselves would provide musically appropriate categories, at least appropriate for the 2nd movement of the *Pathétique*.

PARTICIPANTS

Five experienced listeners were recruited from the Ohio State University School of Music. Specifically, four graduate students and one professor participated. The study took place in an Industrial Acoustics Corporation sound isolation room. Listening was done in open-field conditions rather than via headphones.

The experimenter read the directions aloud while the participant read along.

INSTRUCTIONS:

The purpose of this experiment is to gather information about music and emotion. At the end of the experiment I'll say more about our specific goals.

In this study you will be listening to brief excerpts from a slow movement from a piano sonata by Beethoven. After each excerpt, I'll ask you to describe your feelings, and what emotions or moods you think the passage expresses or conveys. I'll prompt you with a few questions to try to get you to say as much as you can about the music. I will be transcribing your remarks on a lap-top computer so I might ask you to slow down or repeat what you said. There will be fifteen brief excerpts, and the whole procedure shouldn't take any more than about 30 minutes.

I may ask you some questions, but the purpose of the questions is simply to get you to talk about what you hear. Ideally, I wouldn't ask you any questions at all.

You can talk about any aspect of the sound – whatever catches your attention, whatever you think, whatever it reminds you of. Once again, I want you to describe your feelings, and what emotions or moods you think the passage expresses or conveys. My preference is for you to simply talk about what you are feeling or what you think the passage conveys without my prompting.

Do you have any questions about this?

Participants were also told they could listen to each passage as often as desired.

Participants heard 15 five-second excerpts of music, and their task was to talk about the emotional aspects (i.e., open subjective report). In order to encourage the participants to speak at length about their perceptions, the experimenter transcribed their remarks using a laptop computer. After each remark, the experimenter prompted the participant for further observations. That is, there was constant pressure on participants to come up with additional thoughts or observations pertaining to a given five-second excerpt. Our goal was to solicit the widest range of responses. We elected not to have participants type their responses into a computer, since the work involved in typing might discourage lengthy commentaries or reduce the number of observations. Similarly, we elected not to simply record participant monologues. By having the experimenter persistently prompt the participant, we assumed that participants would be more likely to think about the excerpt and to continue speaking until they found an apt characterization of the passage. The experimenter typed the responses, sometimes asking the participant to slow down in order to ensure proper transcription. In total, the participants provided 592 discrete comments describing the fifteen musical excerpts.

CONTENT ANALYSIS

Following the data collection, an informal content analysis was carried out on the 592 comments provided by the five participants. All of the comments were printed on individual slips of paper, and the paper slips were then manually sorted according to whatever categories seemed appropriate for the analyst. This categorization procedure was done twice, once by the first author, and a second time by an independent researcher not involved with the project. After sorting, both analysts provided descriptive labels for each of their categories.

One of the analysts divided the comments into 22 categories whereas the second analyst divided the same 592 comments into 32 categories. Recall that our aim is to identify a set of pertinent affective categories or dimensions that can be used in the main study to characterize different musical moments. Our aim is to use these analyses to find a common semantic core pertinent to the specific musical work. One approach would simply amalgamate the two analyses to form 54 categories. However, there were several categories that appeared to be synonymous in the two lists. The content categories for both analysts are shown in Table 1.

In the process of reconciling the two content analyses our principal goal was to identify the shared or common categories, and to reduce the total number of categories into a more manageable set, suitable for the second study. Accordingly, in reconciling the two content analyses, three criteria shaped our choice of categories: (1) Some categories appeared to describe structural aspects of the music rather than the affective content. For example, a category labeled "intrinsic musical qualities" was discarded. These categories have an asterisk (*) in Table 1. (2) Ten categories between analysts appeared to be similar or synonymous, and so were combined. These categories are in italics in Table 1. In five cases, both analysts had assembled nearly identical comments for a given category, although the category labels provided by the two analysts were not identical. An example of such a category was "suspense" and "anticipation," which were simply combined together. These categories are in bold in Table 1. (3) Finally, some of the categories were small, representing or containing a small number of participant comments. These were simply eliminated, and are marked with a dash.

Following this process, a final list of 15 affective categories was established. Table 1 shows the complete set of categories identified by the two analysts and the 15 combined categories.

Combined categories are horizontally aligned with the final amalgamated label indicated in the "combined" column. These combined categories were then used in the main study.

Analyst 1	Analyst 2	Combined
Moodiness	**Emotional**	Emotional/Moody
Sincerity	**True/Truthful**	Sincerity/Truthful
-Insincerity		
Positive/Happy	**Positive-feelings (Happy/Joy/ Glee/ Celebration/ Goodwill)**	
Dark	*Dark*	Dark
-Obnoxious		
Calm/Serene	**Pastoral/ Peaceful/ Relieved**	Calm/Serene
	-Picturesque-in-a-calming way	
Cheeky/ Impudent/Sassy	*Humorous/ Cheeky*	Cheeky/Sassy
Lonely/Isolated	*Isolated/Alone*	Lonely
-Intimate		
-Buoyant/Bouncy		
Contentment/ Settled/Resolved	*Contentment/ Complacent*	Contentment
Carefree/ Lighthearted	*Carefree*	Carefree
Weighty/Heavy	*Grounded/ Weighty*	Weighty
Internal-struggle/ Stiving/Yearning	*Striving/ Yearning*	Striving/Yearning

Analyst 1	Analyst 2	Combined
-Triumphant/ Emerging-from-difficulty		
Unsettled/ Anxious	*Threatening/ Unsettling*	Unsettled/ Anxious
Sad/Tragic/ Depressed	*Sad/Depressed/ Desperate/ Depression/*	Sad/ Depressed/ Tragic
*Lumbering		
Important/ Majestic/Serious	*Importance/Graceful/ Majestic/Royal*	Important/ Serious
Anticipation/ Building-to-something	**Tenseness/Suspense**	Suspense/ Anticipation
*Accomplish-ment/Arrival/ Closure		
	-Moving	
	*Intrinsic Musical Qualities	
	*Puzzling	
	-Cartoonish	
	-Nostalgia	
	*Realization	
	*Uncertainty	
	-Epic	
	*Superficial/ Meaningless	
	-Unpleasing	
	-Unnerving	

Table 1: The results of the content analysis. The far-right column includes the labels used in the main study. Labels in *italics* were deemed synonymous categories and so were combined. Labels in **bold** had similar content, though the label was different. A label capturing both affective terms was created for the main study. Labels with asterisks (*) described categories related to musical structures instead of affect, and so were discarded. Labels with a dash (-) had small representations and so were discarded.

3. MAIN STUDY

For the main study, nineteen listeners were recruited from the Ohio State University School of Music. Participants heard 56 five-second excerpts in random order spanning the entire duration of 4'40" from the John O'Conor recording of the 2nd movement from Beethoven's *Pathétique* sonata. In addition, they heard five repeated excerpts to test intra-subjective reliability. For each excerpt, our goal was to collect ratings for all 15 affective scales – as determined in the initial study. However, it was deemed impractical to ask individual subjects to make 15 judgments for each of the 61 musical excerpts. Listeners are apt to forget how the passage sounded, and may become confused about the different assessment categories. Accordingly, we spread the 15 judgments across five participants so that each participant made only 3 judgments for each sound stimulus. In effect, a single task was divided among five participants.

The study took place in an Industrial Acoustics Corporation sound isolation room. The experimenter read the directions aloud while the participant followed along with the printed instructions.

INSTRUCTIONS:

The purpose of this study is to gather information about music and emotion. At the end of the experiment I'll say more about our specific goals.

In this study, you will hear a series of 61 5-second excerpts from a slow piano piece. You will be asked to rate each excerpt on 3 emotional scales.

Although the excerpts are 5 seconds long please concentrate on only evaluating the middle portion of each sound excerpt: the fade-in and fade-out are present only to help you hear the context. So if there is a difference between the beginning, middle, or end portions, please just rate the middle.

Use the linear scale to indicate your judgments for each of the 3 categories. Please do not evaluate your own emotional response to the music, but simply what you think the music is trying to convey.

Each emotional scale is represented by a line, with one end of the scale representing the maximum amount of that emotion and the other end representing the minimum amount of the emotion.

You can listen to an excerpt as often as you like by clicking on the PLAY button. For each excerpt, each scale will appear one at a time. You must adjust each scale before moving on to the next. Once the scale is adjusted, click NEXT EMOTION and the next rating scale will appear. If you need to move back, click the PREVIOUS EMOTION button.

For the last rating scale of the excerpt, you must click NEXT EMOTION and then NEXT EXCERPT to move on to the next sound excerpt. Once you move on to the next excerpt, you cannot move back to a previous excerpt.

The experiment will take roughly 30 minutes to complete.

Do you have any questions?

RESULTS

Results are preliminary; data collection, data analysis and hypothesis-testing are ongoing. Figure 1 provides an illustration of the data for a 37.5-second passage from the second movement of the *Pathétique*. Specifically, Figure 1 plots six of the 15 dimensions: lonely, dark, unsettled/anxious, happy/joyful, carefree, and calm/serene. The data from both stimulus sets have been combined into a single graph.. In order to better amalgamate the data across subjects, the data for each participant was first normalized by subtracting the average across the sample for that participant and dividing by the standard deviation. Since the stimulus sets were offset by 2.5, the interleaved data similarly provides data-points every 2.5 seconds. The dotted lines show the music presented in the stimulus judged by each participant. The points between the dotted lines represent the averages of the evaluations for the music between the dotted lines judged by the 0-second offset group. The points on the dotted lines represent the averages of the evaluations of the music of the 5-second excerpt centered on the line, judged by the 2.5-second offset group. In other words, there was a 1.25-second overlap with the other offset-group at the beginning and end of every stimulus.

From the affects plotted, a few informal observations may be pertinent. At measure 37 a significant change of texture occurs. Here Beethoven moves to the minor mode with a triplet figuration. The change in texture is clearly reflected in many of the affective scales. For example, judgments of dark and unsettled/anxious increase, while happy/joyful and calm/serene judgments plummet. Note that the bass staccato lines that appear in measures 38 and 40 cause a noticeable lightening of affective judgments. Specifically, the staccato lines cause dips in the unsettled/anxious judgments, and even cause judgments of loneliness to decline (one might even speculate that the entry of a new melodic line with a highly contrasting character amounts to the entry of a new "persona" into the texture and so makes the texture more "populous" rather than lonely).

Another significant change occurs at measure 42. Here the texture increases in density, there is increasing loudness, increasing pitch height, increasing overall distance between voices, and a change from minor chords to predominantly major chords, including arpeggiations of major triads in the right hand. Notice that the happy/joyful and carefree judgments increase dramatically at this point. Although judgments of darkness are often correlated with judgments of unsettled/anxious, here we see an instance of these two affective judgments moving in opposite directions. Calm/serene judgments are low, while unsettled/anxious judgments are high, leading to a musical moment with high valence and high arousal – at once both happy/joyful and unsettled/anxious. In a sense, the "happiness" of this moment is colored a sense of agitation or edginess.

REFERENCES

Gjerdingen, R., & Perrott D. (2008). Scanning the dial: The rapid recognition of music genres. *Journal of New Music Research*. *37:2*, 93-100.

Heinlein, C.P. (1928). The affective character of the major and minor modes in music. *Journal of Comparative Psychology*, *47*, 103-18.

Hevner, K. (1935). The affective character of the major and minor modes in music. *American Journal of Psychology*, *48*, 246-68.

Krumhansl, C. L. (1997). An exploratory study of musial emotions and psychophysiology. *Canadian Journal of Experimental Psychology*, *51*, 336-52.

Nielsen, F.V. (1987). Musical 'tension' and related concepts. In T.A. Sebeok & J. Umiker-Sebeok (eds), *The semiotic web '86. An international yearbook* (pp. 491-513). Berlin, Germany: Mouton de Gruyter.

Nielzén, S., & Cesarec, Z. (1981). On the perception of emotional meaning in music. *Psychology of Music*, *9*, 7-17.

Schubert, E. (2010). Continuous self-report methods. In P.N. Juslin & J.A. Sloboda (eds), *Handbook of Music and Emotion: Theory, Research, Applications* (223-53). New York: Oxford UP.

Tagg, P. (2006). Music, moving images, semiotics, and the democratic right to know. In S. Brown & U. Volgsten (eds), *Music and manipulation. On the social uses and social control of music* (pp. 163-86). New York: Berghahn Books.

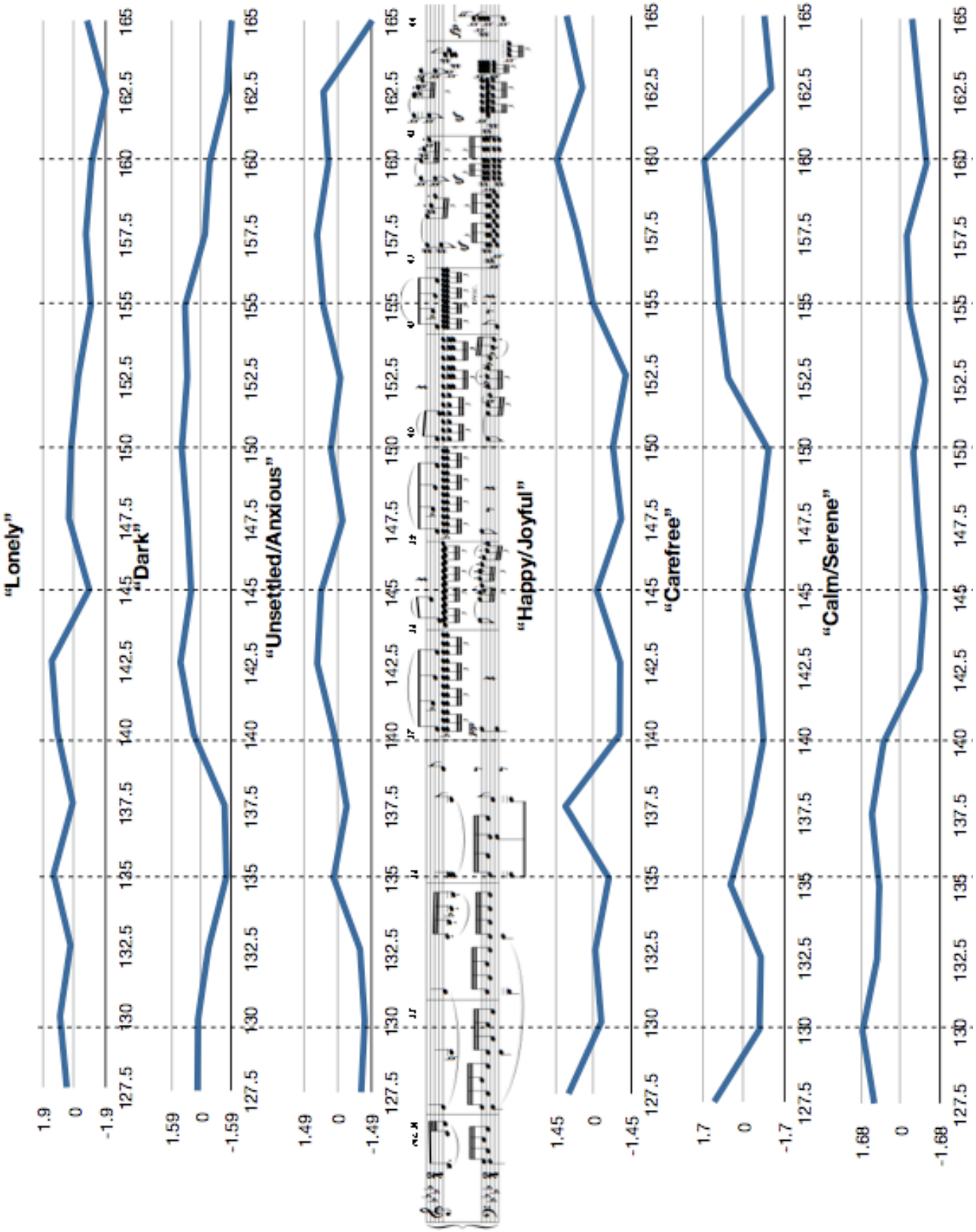

Figure 1: Measures 34-44 of Beethoven's *Pathétique* Sonata (No. 8, Op. 13) with an analysis of affect by participants using the "progressive exposure" method. Measurements are normalized, and so are measured in standard deviations away from the mean across the excerpt. Dotted lines demarcate the 5-second stimuli judged by participants. Data points between the lines are judgments of the excerpt between lines. Data points on the lines are judgments of the 5-second excerpt centered on the line.