Audio Engineering Society

Convention Paper

Presented at the 145th Convention
2018 October 17–20, New York, NY, USA

The impact of compressor ballistics on the perceived style of music

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ABSTRACT

Dynamic range compressors (DRC) are one of the most commonly used audio effect in music production. The timing settings are particularly important for controlling the manner in which they will shape an audio signal. We present a subjective user study of DRC, where a series of different compressor attack and release setting are varied and applied to a set of 30 sec audio tracks. Participants are then asked to rate which ballistic settings are most appropriate for the style of music in their judgement and asked to select one of a series of tag words, to describe the style or setting of the song. Results show that the attack parameter influences perceived style, more than the release parameter. From the study this is seen more evidently in the case of Jazz and Rock styles than in EDM or Hip-Hop. The area of intelligent Music production systems might benefit from this study in the future as it may help to inform appropriateness for certain DRC settings in varying styles.

1 Introduction

1.1 Overview

The history of the dynamic range compressor is inextricably linked to changes in trends and styles in popular music production. The sonic signatures of certain well known Vari-Mu, VCA, FET and Opto models have had a huge impact on shaping the inherent sound of sound recordings in the last 50 years. This has been discussed previously in several related works including [1, 2, 3]. These works however focus on the impact of compressor design and the effect of various electronic components, rather than the applications and implications of the use of the compressor.

1.2 The Task

What has less often been discussed is the impact of changes in compressor ballistics on perceived style in music [4, 5]. Hilsamer and Herzog define compressor ballistics as "a gain smoothing stage with different time constants for rising and falling edges to reduce non-linear distortion on transient signals" [6]. Adjustments to attack and release settings in a DRC can vastly alter not only the timing of the program material but also make significant changes to timbre and tonal quality. This has been discussed by Barthet et al [7] and later by Wilmering, Fazekas and Sandler [8] Indeed '*groove*' and '*feel*' may be affected greatly by micro-timing changes instigated by differences in attack and release settings when applied to similar

styles of music. In this paper, we investigate the impact of compressor attack and release times on the perception of style across several genres. We conduct a listening experiment in which trained participants will select the track with compressor ballistics deemed most appropriate according to their judgement. We also investigate whether the intention of music composed in one genre or style might be interpreted as closer to another purely by altering the envelope shape of a DRC. Terms such as nostalgia, vintage or retro are sometimes used and ascribed to such phenomena.

1.3 Study

The purpose of the study is to measure the perceived effect of making changes to attack and release settings in a DRC on four separate drum tracks created in four different styles. A secondary task in our study is to choose appropriate tag words to describe the sound. This may help to ascertain whether participant describe the perceived effect consistently.

The rest of this paper is organized as follows. In Section 2 we discuss relevant works on compressor evaluation with a particular emphasis on ballistics. In Section 3 outline or research methodology, including the experiment design, audio material and participant data. In Section 4 we present our results while we discuss the main observations in Section 5. Section 6 presents our conclusions and finally we outline our future work in Section 7.

2 Background

2.1 Compressor Evaluation Studies

A wide range of published studies were considered in our research when designing the experiments discussed in Section 3. Regardless of make or model, certain types of DRC may be viewed as more suited to processing one instrument or sound, than another. There has been thorough discussion about the sonic signature exhibited by three well known studio compressors in a previous study by Moore, Till and Wakefield [1]. The authors pointed out that the timing response was altered significantly at the attack stage of gain reduction. The choice, and subsequent selection of certain well known vintage compressors will be influenced by the program material being processed. This may be dependent upon exhibited characteristics of the unit, specifically, attack and release settings. One may be viewed as being more appropriate than another in this context. For instance, the design and appropriateness of the Urei 1176 compressor for rhythmic material has been discussed by Moore in the Art of Record Production article, ‘All Buttons In’ [2].

2.2 Previous work on Compressor Ballistics

The impact of ballistics in DRC’s has been discussed by Wagenaars et. al. [4] and Neuman et. al. [5]. Previous works in this area have indicated that ballistics in a DRC do have a noticeable effect on both loudness and timing.

2.3 Semantic Descriptors

The language used to describe compression characteristics has also been discussed in by Pearce, Brookes and Mason in the Audio Commons Hierarchical ontology of timbral semantic descriptors [9, 10], as well as Stables et al. [11, 12]. These studies identify timbral attributes that have the potential to describe audio.

3 Compressor Setting Evaluation

To ascertain how people perceive different compressor settings, we conducted a listening experiment. In this section we discuss the creation of the program material and provide relevant details about the participants and experimental conditions.

3.1 Material

Four music excerpts were created using Apple Loops as well as written parts created by virtual instruments in Logic Pro X. The examples were based on four styles: Rock, Jazz, HipHop and Electronic Dance Music (EDM). The audio was bounced out of Logic Pro X as a 24-bit WAV file at a sample frequency of 44.1 KHz. All files were loudness matched and normalised to -26dB LUFS. A software emulation

plugin of the ubiquitous Solid State Logic (SSL) Bus compressor made by Universal Audio was used to process drum and percussion material. This choice of compressor was influenced by its inherent characteristic fast response to transients due to its Voltage Controlled Amplifier (VCA) design. Attack and Release settings were varied in the compressor and applied separately to the rhythmic or percussive elements of the four different styles. The SSL compressor has a gentler release time than attack. Two Attack times were chosen, alternating between 0.1 ms (fast) and 30 ms (slow) and Release time varied from 0.1 sec (fast) and 1.6 secs (slow). The Ratio parameter was set at 4:1 for all tests and a consistent amount of gain reduction (6-8 dB) was maintained.

3.2 Participants

Twenty six participants completed the listening test using the Web Audio Evaluation Tool [13, 14]. These consisted predominantly of male Music Production students (24 males, 2 females) with at least two years of recording and mix engineering experience. Among the test participants, there were two award-winning mix engineers who reported themselves as experts. Only two of the students were female which reflects the unfortunate but typical gender imbalance in music technology. The age range was between 20 and 59 years of age.

3.3 Procedure and Methodology

We created a Web-based listening experiment and conducted the test in a lab environment. Participants were asked to answer a short questionnaire to ascertain age, gender and experience before a series of 40 questions were presented sequentially. Listeners were encouraged to set a comfortable playback level and then told not to alter this during the experiment. Finally, a pop-up box for feedback was provided for comments about how they rated the test. The first 24 questions were simple AB forced choice selections where participants were asked to choose the most appropriate music excerpt for a given musical style, followed by 16 further questions asking the participant to select an appropriate descriptor from a choice of 6 tags. (Hard, Pillowy, Punchy, Smooth, Soft, Staccato) These tags were chosen from [10], proposing a hierarchical ontology of timbral semantic descriptors.

3.4 Experimental Setup

Listening conditions were the same for each participant. The user interface was implemented using the Web Audio Evaluation Tool [14]. The test was conducted using a Universal Audio Apollo Twin Audio Interface with AKG K812 Open backed headphones used for sound reproduction.

4 Results

The data was analysed using Chi Squared test with a binomial distribution [15] to determine statistical significance between appropriateness ratings. Matlab was used for processing the data and for creating plots used in the analysis. Results indicate that the effect of changes in attack and release settings are more significant for both Rock and Jazz and to a lesser extent, EDM. In all three cases a fast attack and slow release consistently show a greater perceived difference than all other permutations, but there is a preference for fast release in EDM. Fig. 1 illustrates this clearly.

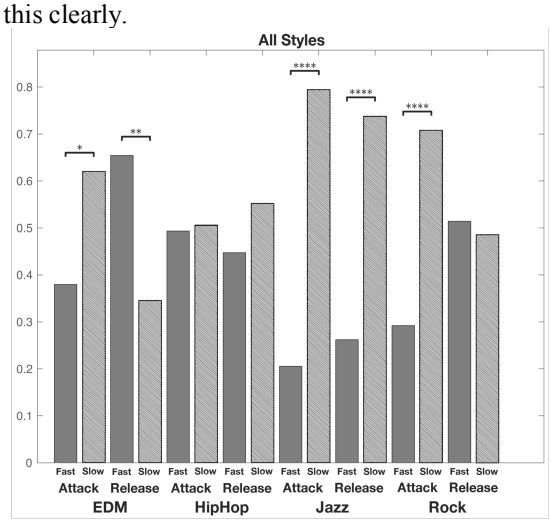

Fig. 1. Attack and Release preferences for individual styles of music indicating significant differences at certain settings (* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, **** = $p < 0.0001$).

This is represented also in Table 1.

Comp	Fast Attack	Slow Attack	Fast Release	Slow Release
EDM	0.38	0.62	0.65	0.35
Hip-hop	0.48	0.52	0.46	0.55
Rock	0.29	0.71	0.51	0.54
Jazz	0.25	0.78	0.25	0.77

Table 1. Significance of Compressor ballistics settings over 4 styles of music.

Across all styles, we can observe that Attack has more pronounced perceived effect on appropriateness than Release.

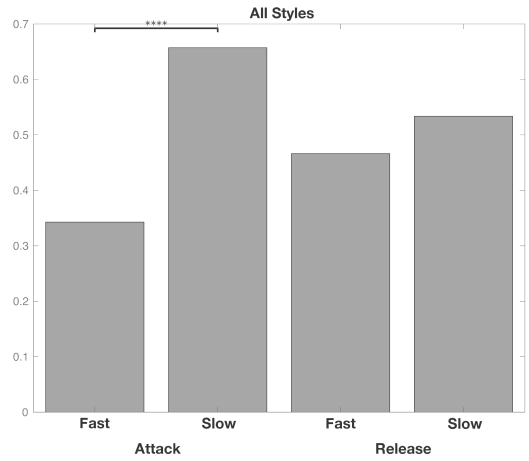

Fig. 2. Attack and Release preferences for all four styles of music (* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$, **** = $p < 0.0001$).

When using tags to describe what the listener perceived at different compressor settings the following 4 plots that reflect responses in each style indicate that EDM, regardless of settings, is heard as predominantly hard, punchy or staccato. In summary, more aggressive. This contrasts with Jazz and Rock which were perceived as being predominantly pillowy, soft or smooth. As an aside, it is notable how often 'pillowy' is used when describing Rock.

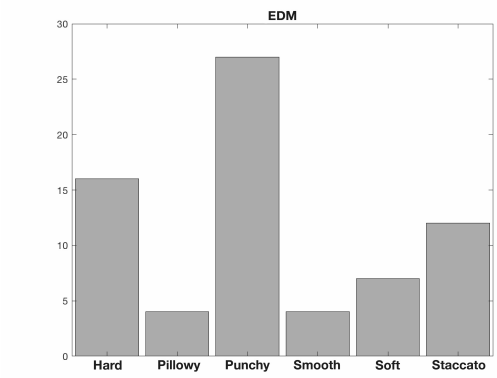

Fig. 3. Descriptors used for compression ballistics settings in EDM.

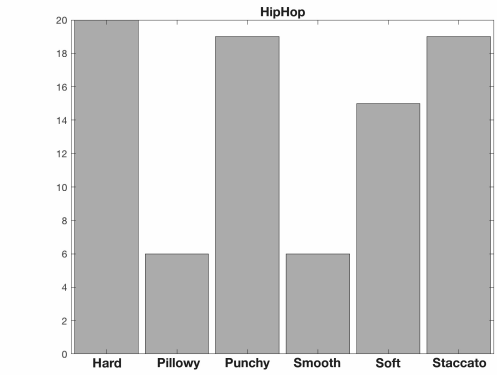

Fig. 4. Descriptors used for compression ballistics settings in Hip-Hop.

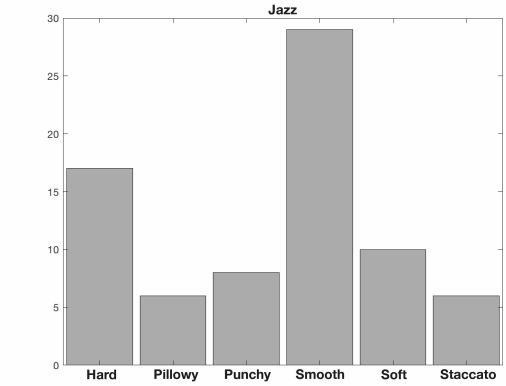

Fig. 5. Descriptors used for compression ballistics settings in Jazz.

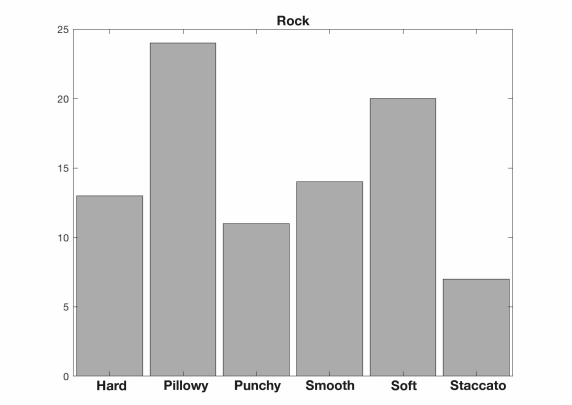

Fig. 6. Descriptors used for compression ballistics settings in Rock

It is reasonably clear from the results that Attack has more of a significant effect on the perception of the appropriateness of style compared to Release. It can also be shown that this applies most strongly in the cases of Jazz and Rock.

5 Evaluation and Discussion

To some degree the results support the hypothesis that the intention of music in one style might be perceived as more appropriate to another by altering the envelope shape in a DRC. A fast attack in combination with a slow release will often yield a smoother, softer of more pillowy effect. The opposite is found to be true when the two settings are inverted with attack slow and release set to fast. It is significant that the Rock and Jazz genres show this more clearly. Both attack and release were shown to be far less significant in the case of EDM and almost insignificant in the case of the Hip-Hop style. Regardless of style, attack has been shown to make a bigger difference than release.

The results are impactful because they show that amongst a group of amateur music producers, there is a consensus of opinion, when describing the audible effects of varying attack and release settings. There is also some consistency when describing what they are hearing. It is not uncommon for software plugins to offer appropriate generic settings as suggestions for different styles and it is hoped that this research might help to inform these assumptions in the future.

6 Conclusions

The aim of this paper was to assess the perceived differences of changes in DRC ballistics settings on the style of music. It was specifically concerned with assessing the appropriateness of these settings for a given genre or style of music and whether there was any agreement as to how these changes were perceived and described. It has been shown that the attack stage of gain reduction has more significant effect on the perception of style than the release stage. This is seen more strongly in the style of jazz and rock.

Our study identifies a link between ballistics settings made in a DRC and their appropriateness for different program material. The impact on how style is interpreted is greatly dependent upon timing differences. There are established practices amongst recording and mix engineers [16, 17] which influence the choice of DRC. For instance, it is often assumed that a Universal Audio LA2A is better suited to processing bass and vocals, while an SSL 4000 bus compressor is better suited to treating rhythmic material or stereo bus processing. Compression type based upon inherent and characteristic, timing differences [2] has been investigated and discussed already, but appropriateness to style has less so. Our results help in understanding how the use of tools in music production may evolve with style as well as how their effect may result in different perceptions of style. Finally, our results may also facilitate the development of intelligent compressor control applications. See work by Ma [18] and more recent studies by Sheng and Fazekas for further discussion [19, 20, 21].

7 Further Work

There are several areas where this study could be improved. For example, perceived differences between hardware and software has yet to be examined in this context. Introducing a hardware based model into the listening test may have altered

the results significantly. A systematic dissemination of compression types is also necessary for future study as timing characteristics are often dictated by, and dependent upon, Opto, FET, Vari-Mu and VCA. Many well-known, iconic, compressors mentioned in the paper by Moore, Till and Wakefield [2] will also impart a sonic signature of their own, particularly in terms of Total Harmonic Distortion (THD). This will almost certainly influence the sound and behavior of the DRC. The final consideration here, though arguably more subjective, is the influence of retro aesthetics in the sound that people hear when evaluating sound recordings. When softening transients or slewing time constants this can sometimes be perceived as sounding more retro. Softening or smoothing by altering attack settings in a DRC may hold some clues when considering this phenomenon [1, 8].

Acknowledgements

This work was supported by the EPSRC Grant "Fusing Audio and Semantic Technologies for Intelligent Music Production and Consumption" (FAST-IMPACt) EP/L019981/1 and the European Commission H2020 research and innovation grant AudioCommons (Grant n. 688382).

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