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AUDIO MASTERING: EXPERIMENTING ON THE CREATIVE SYSTEM OF MUSIC PRODUCTION

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ABSTRACT

If creative productivity emerges from human interactions and these interactions are increasingly mediated by technologies it should be possible to seek empirical confirmation that specific technologies contribute, in whatever degree, to the creative output of particular forms of cultural productions. To test this idea the contention of this paper is that one should be able to detect a differential response to a recorded piece of music that has been mastered, from a piece of music that is un-mastered, at the point of audience reception. Audience response was measured on three emotion scales and it was confirmed that responses did change dependent on whether participants were listening to un-mastered or mastered versions of the same recorded piece.

1. BACKGROUND

To gain an insight into the relationship between technological manipulation and creative output an understanding of what has already been learned about creativity itself at the rational or theoretical level and an application of these ideas to a specific circumstance of technological contribution at the empirical level would need to be considered.

The current academic research into creativity has moved a great distance beyond the Romantic conception implicit in most common understandings of the way creative works come into being (Boden, 2004; Negus & Pickering 2004, Pope, 2005; Sawyer, 2006). The discipline of psychology has recently produced a number of confluence models of creativity that suggest creative activity comes about through a multifactorial process (Sternberg, 1999). One of these confluence models, produced in the discipline of psychology i.e. the systems model of creativity (Csikszentmihaly, 1988), asserts that rather than creativity being the result of the work of a single individual genius it arises out of the complex conjunction of a number of psychological, social and cultural factors that operate in a systemic way to produce creative works.

It can be seen that the process used to create, in this case, recorded musical works is most often a collaborative and systemic one with each step in the recording process adding something of creative value to the final work the audience hears. In this regard, Peter Wicke has argued that: "music as the individual expression of an outstanding artistic personality is *de facto* impossible. [Music has become] a collective means of expression, to which the individual musician can only contribute in a collective activity with others" (Wicke, 1990) and this is intimately connected to the recording process. The community of personnel involved in this collaborative process includes not only the musicians and producers but also the technicians who control and manipulate the studio technology in the process of record making (McIntyre & Paton, 2008). Those technicians who work with the technological dimensions of the recording process are called engineers. Their roles have become so important to the creative process that record engineers can now be distinguished from mix engineers and mastering engineers all of whom perform different functions in the recording process. From pre-production to production to post-production each step in the recording chain changes the final product slightly. It follows that the creative work each of these engineers are involved in should therefore have an impact on the reaction the audience has to that piece of music and be discernible in some way by that audience. The claim here is that not only will the captured or constructed performance by the musicians influence audience reaction but so too will how the recording is mixed and, for the purposes of this paper, the manner in which it is mastered.

The Mastering Process.

Mastering, according to Bob Katz, is the 'last creative step in the audio production process, the bridge between mixing and replication (Katz, 2002). As outlined in McIntyre & Paton (2008) the mastering process is 'the stage of post-production where the overall final product is adjusted so that it is intelligible, in audio terms, across all playback systems and, in this case, may be compared to the colour grading process undertaken in film work' (2008). This process involves not only track assembly and editing, but also equalisation, a variety of dynamics processing, level matching and track coding. These processes offer the 'last chance to enhance sound or repair problems in an acoustically-designed room – an audio microscope' (Katz, 2002) prior to the tracks being manufactured for delivery to an audience. As Don Bartley one of Australia's leading mastering engineers claims 'definitely, you can make a difference (Bartley quoted in McIntyre & Paton, 2008).

The Relationship Between Music and Emotion

There is considerable evidence to support a strong link between music and emotion (Rawlings & Leow, 2008; Juslin & Sloboda, 2001; Sloboda, 1991). We can already distinguish a large number of frequencies at birth (Lecanuet, 1996) and we quickly learn to localise sound sources based on auditory cues. The sense of hearing

rapidly begins to advance and the response to music in particular, develops further, demonstrating a number of "music processing" skills that underlie our later perception of music (Hodges, 2006). Development of these faculties forms the basis of the link between emotion and music perception in later life.

Humans are emotionally sensitive to the parameters of music including variations in the pitch, tempo, amplitude, and timbre (McDermott, 2008; Goldstein, 1980). We even associate specific levels of these qualities with specific emotional states (Husain, Thompson & Schellenberg, 2002; Hevner, 1937). Behavioural and physiological measures (Peretz & Zatorre, 2005) have all been used to demonstrate changes in mood and arousal that occur when listening to particular forms of music (Luck et al., 2008). Not only can music pieces induce a particular mood or emotion, the converse is also true and often people use music to induce or diminish particular moods (Kreutz et al., 2008; Saarikallio & Erkkila, 2007). Evidence from brain injury and split brain patients show that there is a hemispherical bias towards processing music in the right hemisphere (Joseph, 1988). This is the same hemisphere, which is also strongly linked to emotion processing in language and speech (Limb, 2006) and other stimuli. Further, neural projections from these higher cortical areas are known to feed into the limbic system, specifically the amygdala, a brain structure implicated in the processing and expression of emotion. There are additional projections from here to the hippocampus (long-term memory) as well as the hypothalamus (regulating body temperature, blood pressure and other autonomic functions). Although the debate continues as to the exact relationship between emotion and music perception, there is an undeniable link.

Proposal

If mastering is indeed implicated in the creative process, in that it has a measurable effect on the recorded piece, the contention of this paper is that one should then be able to detect a differential response to a recorded piece that has been mastered, from a piece that is un-mastered, at the point of audience reception. In this case, an audience response (as measured on three emotion scales) should necessarily change dependent on whether participants in an experimental process, of the type outlined here, are listening to un-mastered or mastered versions of the same recorded piece. Additionally the type of music piece may differentially change the way the mastering process affects reception of the mastered and un-mastered pieces.

2. METHOD

Participants

Eighteen (eight male) people from the University of Newcastle general population served as volunteers after inspecting the experimental setup and giving full written, informed consent. The age range of participants was 22 - 46 years, $M = 26.5$ years, *Median* = 24 years. Participants received no monetary compensation for time associated with participation. All participants had normal or corrected to normal vision, there was no self-reported history of any mental illness. All participants underwent tone based audiometric hearing tests before participating and had normal hearing thresholds (< - 20 dB HL for each octave frequency between 500 Hz and 4000 Hz inclusive).

Apparatus & Stimuli: Musical Excerpts

Four different music pieces each rated by the experimenters as broadly representative of four different emotional conditions (intense, negative, positive, calm) were used in the experiment. Each music piece was approximately 60 seconds in duration and consisted of the first verse and chorus of four different songs composed by one of the experimenters. The music pieces could be broadly classified as from the Rock genre. Two different versions of each musical work were employed, an *un-mastered* piece and a *mastered* version of the same musical piece. The *mastered* and *un-mastered* music pieces were set to be energy level equivalent, 70 dB SPL.

The un-mastered music pieces were the final stereo mixes made from the original multi-track tapes. Each performance and technical aspect of the recorded work added its nuanced effect to the final musical product to that point and the producer engaged the musicians in a number of takes on each track until he was satisfied that a spirited and musical performance was achieved. The mix process followed and was completed by a separate mix engineer, not the record engineer.

The mastered musical pieces, on the other hand, were the same pieces of music as the mixed and un-mastered pieces but they had been moved along the production chain and had undergone the mastering process. The studio mastering desk, signal path and outboard processors added to the particular audio qualities the process added to the final mastered versions.

Measurement Scales

The measurement scales used in the experiment were based on those used by Illie and Thompson (2006). Specifically they were three polar emotion scales: Valence, Negative-Positive; Tension, Tense-Calm; Energy, Boring-Exciting. The scales were as displayed in figure 1. The polar terms were placed at each end of an unbroken line. Participants were instructed to indicate their preference on the polar scale by placing a mouse cursor over the line and clicking the mouse button. There were no indicators or tick marks on the scale or any visual, numerical reference. We felt that the ordinal scales used by Illie and Thompson (2006) did not afford the same data richness nor participant response freedom as the unmarked scales used in the current experiment. Additonally instead of using ordinal data as a dependent variable we chose a continuous dependent variable.

Internally the experimental software scaled responses from zero (the leftmost position of the scale) to 100 (the rightmost position of the scale). The order of presentation of the scales was randomised on a per trial basis.

Procedure

Experimental trials were participant initiated, music pieces were delivered via a set of headphones (Sennheiser HD-280) connected to the experimental computer at 70 dB SPL in a quiet room. After the music piece had finished the three measurement scales were

presented on screen, once a participant was satisfied with their responses a mouse click started the next trial. This procedure was repeated three times for each music piece (mastered/un-mastered) for a total of 24 trials. The order of presentation of trials was randomised for each participant.

Design & Analysis

The experimental design was a 4 (Music: Intense, Negative, Positive, Slow) x 2 (Mastering: Mastered, Un-Mastered) repeated measures factorial design. There were three different DVs, Valence, Energy and Tension corresponding to the three different response scales. Participants' final DV responses were taken as the average of the three relevant experimental trials. A 4 x 2 repeated measures factorial ANOVA was performed on each of the three DVs, with Bonferroni corrected pair-wise comparison.

3. RESULTS

Valence

Repeated measures ANOVA of the Valence scale data revealed a significant main effect of Music condition, F (3, 51) = 10.33, p < .01; both the Negative and Slow music pieces were rated as more negative than the Intense or Positive music pieces irrespective of the Mastering condition, all ps < .05. There was also a significant main effect of Mastering condition, F (1, 17) = 8.28, p = 0.1, with the mastered music pieces producing more positive valence ratings than the un-mastered music pieces.

Finally, there was a significant interaction between the two conditions, F (3, 51) = 3.77, p = .02. In the Mastered condition, the Negative music pieces and Slow music pieces were rated consistently more negative as compared to Intense or Positive music pieces, all ps < .05. Further, the Intense music pieces were rated significantly more negative than the Positive music pieces, p < .01. In the Un-Mastered condition, the Negative music pieces were rated consistently more negative as compared as to Intense or Positive (M = 54.32, SE = 4.16) music pieces, all ps < .05. Conversely Positive music pieces were rated more positively than Negative or Slow music pieces, all ps < .05.

Energy

Repeated measures ANOVA of the Energy scale data revealed a significant main effect of Music condition, F (3, 51) = 14.76, p < .01; the Slow music pieces were consistently rated as more boring as compared to the Intense, Negative, and Positive music pieces, all ps < .01. There was also a significant main effect of Mastering condition, F (1, 17) = 12.06, p < .01; with the mastered music pieces, eliciting more exciting Energy scale ratings from participants as compared to un-mastered music pieces.

The ANOVA also revealed a significant interaction between the Music and Mastering conditions, F (3, 51) = 7.54, p < .01; In the Mastered condition the results reflect those of the main effects, participants consistently rated only the Slow music pieces as being more boring as compared to any of the other music pieces, all ps < .01. The same pattern was revealed, in the Un-Mastered condition, all ps < .01.

Tension

Repeated measures ANOVA of the Tension scale data revealed a significant main effect of Music condition, F (3, 51) = 36.57, p < .01; Participants rated Slow music pieces as significantly more calm than Intense, Negative and Positive music pieces, all ps < .01. Conversely, participants rated Intense music pieces as more tense as compared all other music pieces, all ps < .05.

There was also a significant main effect of Mastered condition, F (1, 17) = 5.49, p = .03; irrespective of music condition participants rated Mastered music pieces as consistently lower than Un-Mastered music pieces, in direct contrast to the results of the other two rating scales. There was no significant interaction between the Music and Mastered conditions.

4. ANALYSIS/DISCUSSION

Across all three emotion scales participants consistently rated *mastered* music pieces differently to *un-mastered* music pieces indicating that the mastering process was able to produce a notable and consistent change in emotion ratings. Specifically participant ratings of the four different music pieces were increased relative to the emotional music type, That is Intense music was rated as more tense, Positive music as more positive and so on. Participant ratings were, in effect, amplified. Previous research has demonstrated that we respond differentially in terms of emotion in reference to changes in the parameters of music pieces and these results accord with those findings.

Quite apart from these results, this research has shown that the modified emotion scales used in this experiment can be used to help quantify an otherwise difficult problem, the relative emotional impact of music. This type of technique complements an ethnographic approach, such as that taken in McIntyre & Paton (2008), helping to provide a richer set of data on the mastering process.

There are however, some limitations with the approach described in this paper. Firstly, ratings given by participants were by their very nature, subjective, and secondly, the three scales used do not necessarily capture all of the emotion content provoked by listening to the specific music pieces used. The subjective nature of the self-report emotion scales can be viewed as both a potential problem and aid in that the emotional reaction to music is often personal and can only truly be captured by taking into account a person's unique developmental, cultural and emotional trajectories. Whilst this is true, it is still possible to derive commonalities in participant responses across a particular sample. Thus, the kinds of measures employed in this research can be used to take into account some measure of the specific, and the general, nature of the emotional impact of music. Two future directions are suggested, first increase the number of emotion scales used to help narrow the specific involvement of particular emotions and second complement the emotion self report measures with more general physiological measures that are not influenced by self-report.

A logical extension of this work therefore would be to employ psychophysical measures of emotion, such as skin conductance

response (SCR), electrocardiogram (ECG), and blood pressure measurements in addition to the emotion scales used here as well as potentially including further emotional scales in order to reinforce the results gained. Further applying the emotion scale technique used here to different steps or aspects of the music recording process may also help tease apart the complex interplay between the many players and components of the recording process.

5. CONCLUSION

This research has focused on a single aspect of a complex process of music production that is operative within the larger systemic recording process. This research helps to quantify what many in the music industry consider as given, that is, that mastering engineers have a quantifiable and consistent affect on the creative process of recording of musical works. The research verifies, at an empirical level, the anecdotal claims made by mastering engineers themselves and those that use their services. The techniques applied in this study, along with complementary ethnographic methods, should also provide those concerned with studying the creation of music and how music-makers go about their business a set of research focused tools to aid in understanding that phenomenon. Finally, this research establishes, at the empirical level, a verifiable connection between creative output and technologies used in that output.

6. REFERENCES

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