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The impact of subgrouping practices on the perception of multitrack mixes

David M. Ronan¹, Brecht De Man², Hatice Gunes¹, and Joshua D. Reiss²

¹*Centre for Intelligent Sensing, Queen Mary University of London, Mile End Road, London E1 4NS, United Kingdom*

²*Centre for Digital Music, Queen Mary University of London, Mile End Road, London E1 4NS, United Kingdom*

Correspondence should be addressed to David M. Ronan (d.m.ronan@qmul.ac.uk)

ABSTRACT

Subgrouping is an important part of the mix engineering workflow that facilitates the process of manipulating a number of audio tracks simultaneously. We statistically analyse the subgrouping practices of mix engineers in order to establish the relationship between subgrouping and mix preference. We investigate the number of subgroups (relative and absolute), the type of audio processing and the subgrouping strategy in 72 mixes of nine songs, by 16 mix engineers. We analyse the subgrouping setup for each mix of a particular song and also each mix by a particular mixing engineer. We show that subjective preference for a mix strongly correlates with the number of subgroups, and to a lesser extent which types of audio processing are applied to the subgroups.

1. INTRODUCTION

At the early stages of the mixing and editing process of a multitrack mix, the mix engineer will typically group instrument tracks into subgroups [1]. An example of this would be grouping guitar tracks with other guitar tracks or vocal tracks with other vocal tracks. Subgrouping can speed up the mix workflow by allowing the mix engineer to manipulate a number of tracks at once, for example by changing the level of all drums with one fader movement, instead

of changing the level of each drum track individually [1]. Note that this can also be achieved by a Voltage Controlled Amplifier (VCA) group - a concept similar to a subgroup where a specified set of faders are moved in unison by one 'master fader', without first summing each of these channels into one bus. However, subgrouping also allows for processing that cannot be achieved by manipulation of individual tracks. For instance, when nonlinear processing such as dynamic range compression or har-

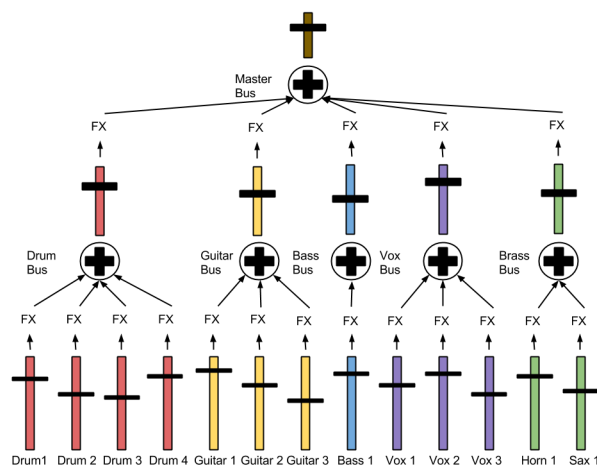


Fig. 1: Typical subgrouping setup.

monic distortion is applied to a subgroup, the processor will affect the sum of the sources differently than when it would be applied to every track individually. An example of a typical subgrouping setup can be seen in Figure 1.

Very little is known about how mix engineers choose to apply audio processing techniques to a mix. There have been few studies looking at this problem and none of them specifically looked at subgrouping [2–4]. Subgrouping was touched on briefly in [2] when the authors tested the assumption “*Gentle bus/mix compression helps blend things better*” and found this to be true, but it did not give much insight into how subgrouping is generally used. In [5], the authors explored the potential of a hierarchical approach to multitrack mixing using instrument class as a guide to processing techniques. However, providing a deeper understanding of subgrouping was not the aim of the paper. Subgrouping was also used in [6], but similarly to [5] this was only applied to drums and no other instrument types were explored. The technique of subgrouping is to the best of our knowledge a poorly documented mix technique in audio engineering literature [1, 7, 8].

Although subgrouping is not well documented, it is used extensively in all areas of audio engineering and production. This would imply that there are basic unwritten rules that are carried out when a mix engineer makes use of subgrouping. These rules can be

as simple as putting similar instruments together in the one subgroup [5, 6]. By investigating these practices we hope to develop these rules and generate constraints that may someday be used in intelligent mixing systems such as those described in [5, 9–12].

The aim of this paper is to see the extent to which different mix engineers perform subgrouping, and what kind of subgroup processing they use. Furthermore, we quantify what effect subgrouping has on the subjective quality of the mix, if any. The next section provides details of a mix experiment from which we gathered the subgrouping data. Section 3 provides the results obtained from the mix session files, which are analysed and discussed in Section 4. In Section 5, we summarise our findings and outline future work.

2. DATA

2.1. Experiment

A dataset of mix projects was examined to see how many subgroups were created by mix engineers, what kind of subgroup processing they used and how the mix engineers created the subgroups. An experiment had been previously conducted where different mixes of different songs, obtained with a representative set of audio engineering tools, were rated by experienced subjects [4].

The mix engineers in this experiment were students of the MMus in Sound Recording at the Schulich School of Music, McGill University. Each song was mixed by one of the two classes of eight students each, such that one group of students mixed five songs in total (over three semesters - four as first years and one more as second years), and one group mixed four songs in total (over two semesters) [4]. A breakdown of which songs were mixed by which group can be seen in Table 1.

Five out of nine songs are available on the Open Multitrack Testbed¹ [13] including raw tracks, the rendered mixes and the complete Pro Tools project files, allowing others to reproduce or extend the research. The authors welcome all appropriately licensed contributions consisting of shareable raw, multitrack audio, DAW project files, rendered mixes, or a subset thereof. Due to copyright restrictions, the other songs could not be shared.

¹multitrack.eecs.qmul.ac.uk

| Song name | Mix engineers |
|--------------------------------|---------------|
| Red To Blue (S1) | A - H |
| Not Alone (S2) | A - H |
| <i>My Funny Valentine</i> (S3) | A - H |
| Lead Me (S4) | A - H |
| In The Meantime (S5) | A - H |
| - (S6) | I - P |
| <i>No Prize</i> (S7) | I - P |
| - (S8) | I - P |
| Under A Covered Sky (S9) | I - P |

Table 1: Mix groups and song titles. Songs in italics are not available online due to copyright restrictions.

2.2. Data Extraction

The data for each mix engineer’s subgrouping setup was extracted manually from each of their Pro Tools session files. Information extracted from each session file includes how many subgroups there were, if any subgroup processing such as equalisation (EQ), dynamic range processing (DRC) and reverb were used, and if subgroup send processing was used. Subgroup send processing is when the audio from a subgroup is sent to an auxiliary track or outboard device for audio processing.

We also logged the instruments in each subgroup, to determine on what basis different tracks are subgrouped, and whether the subgroups were hierarchical. We define a hierarchical subgroup as a type of subgroup that groups two or more subgroups together. An example would be a guitar subgroup that contains a rhythm guitar subgroup and a lead guitar subgroup.

The overall preference score for each mix engineer on each mix was calculated by taking the median rating value given by the mix engineers and the mix professionals from the other group participating in the experiment. We used the median value as the mix preference ratings are not all normally distributed. However, we found that the difference between the median and mean mix preference ratings were not large enough to report separately. The distributions of the mix preference ratings for each mix engineer are presented in the results section.

3. RESULTS

Table 2 shows a breakdown of the most commonly

| Subgroup type | # subgroups | # tracks |
|------------------|-------------|----------|
| Vocals | 90 | 324 |
| Drums | 78 | 680 |
| Guitars | 69 | 371 |
| Keys | 56 | 164 |
| Bass | 47 | 88 |
| Other percussion | 17 | 43 |
| Brass | 12 | 33 |
| Strings | 10 | 24 |

Table 2: The number of different individual subgroup types and how many audio tracks of that type occurred in all the mixes.

created individual subgroup types. The subgroup type indicates the main instrument type in that subgroup. We found there to be eight individual subgroup types and drums was the most common instrument type in all of the mix projects. Table 3 shows that a number of subgroups contained combinations of instruments. We also found that almost all mix engineers subgrouped audio tracks based on instrumentation and only four out of the 72 mixes had no subgroups at all, in which three out of the four mixes were of the same song.

| Subgroup type | # subgroups |
|--------------------------------|-------------|
| Bass + Guitars + Keys + Vocals | 4 |
| Drums + Bass + Guitars + Keys | 4 |
| Bass + Guitars + Keys | 3 |
| Drums + Percussion | 3 |
| Guitars + Keys | 3 |
| Drums + Bass + Vocals | 1 |
| Drums + Bass | 1 |
| Bass + Guitars | 1 |
| Drums + Bass + Keys + Vocals | 1 |

Table 3: The number of different multi-instrument subgroup types that occurred in all the mixes.

Table 4 shows how many hierarchical subgroups we had in the mixes we examined. Drums and vocals were the only single instrument types that were hierarchically grouped and the rest were combinations of instrument types. The most hierarchically subgrouped instrument was drums. Furthermore, we

| Hierarchical subgroup type | No. of hierarchical subgroups |
|-------------------------------|-------------------------------|
| Drums | 10 |
| Vocals | 3 |
| Bass + Guitar + Keys + Vocals | 2 |
| Drums + Bass + Guitars + Keys | 2 |
| Drums + Bass + Vocals | 1 |
| Bass + Guitar + Keys | 1 |
| Drums + Vocals | 1 |
| Drums + Bass + Keys + Vocals | 1 |
| Bass + Guitars | 1 |

Table 4: The number of different hierarchical subgroup types that occurred in all the mixes.

| | S1 | S2 | S3 | S4 | S5 |
|----------|---------|---------|--------|---------|--------|
| A | 10 (44) | 10 (25) | 9 (17) | 9 (23) | 3 (26) |
| B | 2 (45) | 5 (28) | 8 (17) | 7 (22) | 6 (25) |
| C | 13 (42) | 8 (25) | 9 (17) | 6 (25) | 8 (25) |
| D | 4 (43) | 3 (25) | 0 (19) | 4 (23) | 3 (25) |
| E | 10 (45) | 7 (25) | 9 (19) | 10 (23) | 8 (25) |
| F | 2 (44) | 3 (25) | 0 (19) | 7 (23) | 4 (25) |
| G | 8 (43) | 8 (25) | 0 (19) | 6 (23) | 6 (25) |
| H | 6 (43) | 3 (25) | 9 (19) | 8 (23) | 6 (25) |

Table 5: The number of subgroups created for each song by each mix engineer in mix group A - H. The number of audio tracks used in each mixing project is in parentheses.

found that hierarchical subgroups were present in 19 of the 72 mixes examined.

In Tables 5 and 6 we present the absolute amount of subgroups created by each mix engineer for each of the songs they mixed. The number in the parentheses is the number of audio tracks that each mix engineer used for each mix. The reason there is a variation in the audio track number for each mix is because some mix engineers duplicated audio tracks or else completely left them out of the mix.

Table 7 shows the different amount of track types available to each mix engineer before they began to mix. The subgroup types used in Table 2 are based on the different audio track types we found for each

| | S6 | S7 | S8 | S9 |
|----------|---------|--------|--------|--------|
| I | 7 (18) | 3 (12) | 3 (16) | 5 (28) |
| J | 7 (25) | 4 (17) | 4 (25) | 7 (28) |
| K | 7 (26) | 0 (17) | 1 (28) | 5 (28) |
| L | 6 (25) | 6 (17) | 4 (20) | 3 (30) |
| M | 10 (25) | 7 (17) | 4 (25) | 3 (22) |
| N | 8 (25) | 3 (17) | 6 (25) | 4 (29) |
| O | 9 (25) | 5 (18) | 8 (26) | 8 (29) |
| P | 6 (14) | 6 (20) | 5 (29) | 6 (22) |

Table 6: The number of subgroups created for each song by each mix engineer in mix group I - P. The number of audio tracks used in each mixing project is in parentheses.

| Ratio type | ρ |
|--|---------------------|
| <i>Subgroup - Audio Track Ratio</i> | 0.62 ($p < 0.01$) |
| <i>Subgroup EQ - Audio Track Ratio</i> | 0.67 ($p < 0.01$) |
| <i>Subgroup DRC - Audio Track Ratio</i> | 0.45 ($p < 0.05$) |
| <i>Subgroup EQ + DRC - Audio Track Ratio</i> | 0.59 ($p < 0.01$) |

Table 8: Average amount of subgroups, EQ subgroups, DRC subgroups and EQ + DRC subgroups created per mix engineer and its correlation (Spearman's rank correlation coefficient) with median mix preference.

song.

In Tables 8 and 9 we present the correlations (Spearman's rank correlation coefficient) of the average amount of subgroups, EQ subgroups, DRC subgroups and EQ + DRC subgroups created per mix engineer with median mix preference as well as the correlation (Spearman's rank correlation coefficient) of the amount of subgroups, EQ subgroups, DRC subgroups and EQ + DRC subgroups created per mix with median mix preference. The number of subgroups in the correlation scores is presented as the number of created subgroups relative to how many audio tracks the mix engineer used to create the final mix. We call this the *Subgroup - Audio Track Ratio*. This also applies to the different types

| Track type | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|------------------|----|----|----|----|----|----|----|----|----|
| Vocals | 17 | 9 | 1 | 6 | 9 | 4 | 1 | 4 | 10 |
| Drums | 11 | 10 | 9 | 9 | 10 | 10 | 8 | 10 | 9 |
| Guitars | 12 | 2 | 0 | 6 | 2 | 2 | 5 | 7 | 15 |
| Keys | 1 | 4 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Bass | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| Other percussion | 1 | 0 | 4 | 1 | 0 | 1 | 0 | 0 | 0 |
| Brass | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 |
| Strings | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 7: The number of different audio track types in each song before they were mixed.

| Ratio type | ρ |
|--|---------------------|
| <i>Subgroup - Audio Track Ratio</i> | 0.32 ($p < 0.01$) |
| <i>Subgroup EQ - Audio Track Ratio</i> | 0.4 ($p < 0.01$) |
| <i>Subgroup DRC - Audio Track Ratio</i> | 0.35 ($p < 0.01$) |
| <i>Subgroup EQ + DRC - Audio Track Ratio</i> | 0.38 ($p < 0.01$) |

Table 9: Amount of subgroups, EQ subgroups, DRC subgroups and EQ + DRC subgroups created per mix and its correlation (Spearman’s rank correlation coefficient) with median mix preference.

of processing applied to each subgroup, so we have the *EQ Subgroup - Audio Track Ratio*, the *DRC Subgroup - Audio Track Ratio* and the *EQ + DRC Subgroup - Audio Track Ratio*. The *EQ + DRC Subgroup - Audio Track Ratio* is a measure of when a subgroup was created and both EQ and DRC processing are applied. Ratios were used because larger mixes with more instrumentation are likely to have more subgroups. This allowed us to compare the amount of subgroups created and the types of subgroup processing used on a mix by mix basis. This linear relationship is evident in Table 2 where we see that when more audio tracks are available there tends to be more subgroups created. In fact, the Spearman rank correlation coefficient for this relationship is very strong and significant with a value of 0.93 ($p < 0.01$).

4. ANALYSIS AND DISCUSSION

In Tables 2-4 we summarised the different subgroup types that were created in all the mixes examined. We looked at standard subgroups and hierarchical subgroups. Table 2 shows that the top three standard subgroups were vocals, drums and guitars. In a mix there can be many different vocalist types. There may be a lead vocalist, a secondary vocalist and background vocalists. This would explain why it is the most subgrouped instrument type. The mix engineers may have wanted to control and process different subgroups of singers that are singing in different styles or singing different parts of each song. The song Red to Blue (S1) is a perfect example of when this occurs. Three of the eight mix engineers have split the vocal tracks into separate subgroups for processing. One of the mix engineers was doing this for simple gain processing, but the other two mix engineers were doing it for gain processing as well as applying EQ and DRC processing. Also, vocals tend to be the most important instrument type in a mix. In [14] it was shown that most of the listener’s attention and about a third of the critical comments on the same mixes used in this paper were about vocals. It has also been shown that the vocals are consistently the loudest instrument type in the same mixes we examined [3].

The second most subgrouped instrument type was drums. Drums are an important part of a mix as they are the rhythm section that keeps the rest of the song in time, so it would be important to be able to control how loud they are in a mix. It is also worth mentioning that in [2], under testing the assumption “*Gentle bus/mix compression compression helps blend things better*”, it was found that

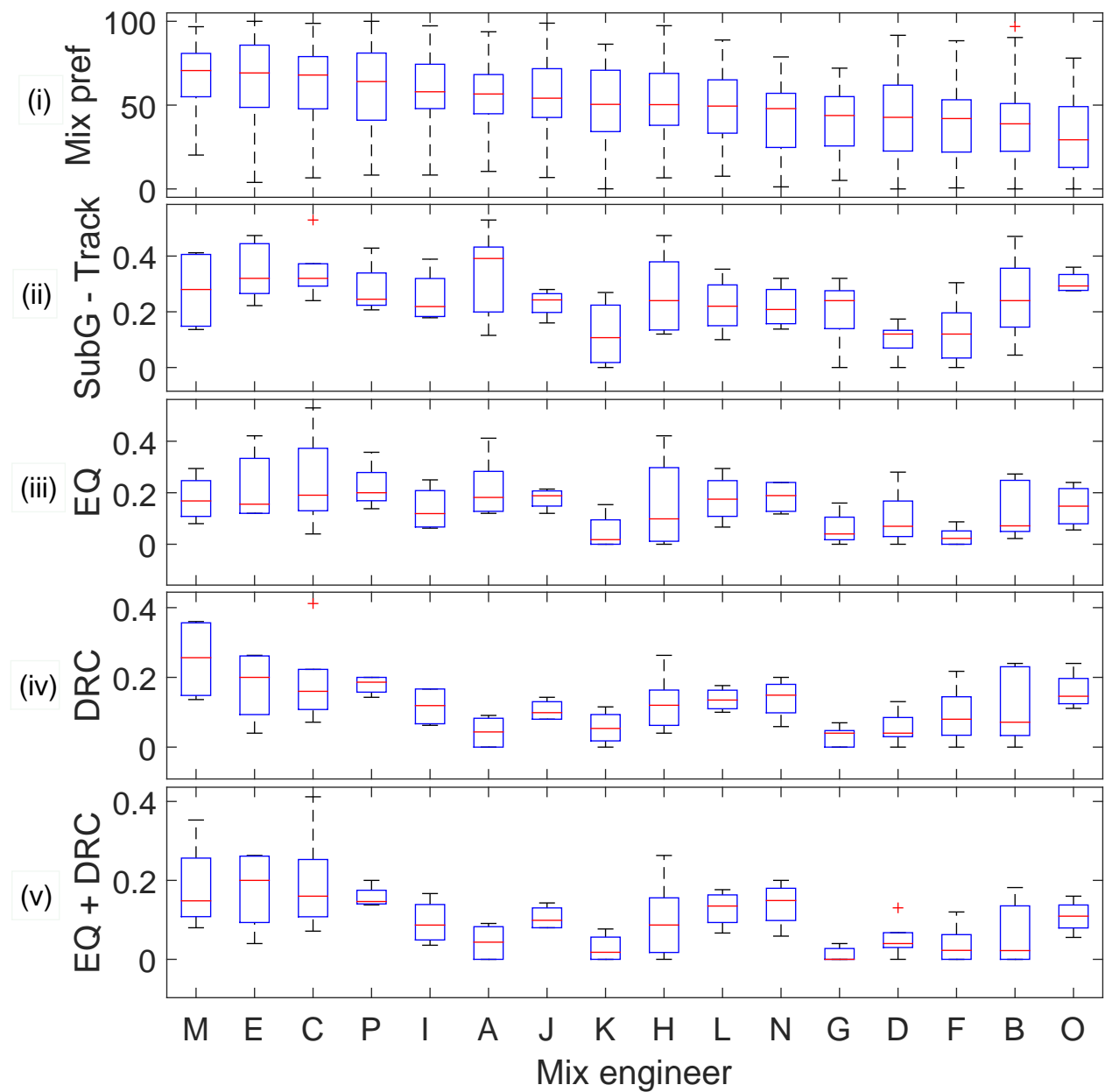


Fig. 2: (i) shows each mix engineer’s mix preference ratings ranked from highest to lowest median value. (ii - v) show the *Subgroup - Audio Track Ratio*’s, the *EQ Subgroup - Audio Track Ratio*’s, the *DRC Subgroup - Audio Track Ratio*’s and the *EQ + DRC Subgroup - Audio Track Ratio*’s for all the mixes created by each mix engineer.

some professional mix engineers like to apply DRC to the drums as a subgroup. Drums also have the most amount of instrument tracks in all of the mix projects, see Table 2.

The third most frequently subgrouped instrument type was the guitars. Guitars are similar to vocals because it is possible to have different styles of guitar playing in a single mix. An arrangement might contain lead guitars and rhythm guitars, distorted and clean guitars, and electric and acoustic guitars. All of these guitar types serve a different purpose in a mix, so it is easy to see how a mix engineer might want to control them or process them individually. An example might be that a mix engineer wants to apply more EQ to a particular group of guitars. Something like this occurred in two separate mixes for the song Red to Blue (S1). One mix engineer had a subgroup for ‘Heavy’ guitars which used EQ processing, while another mix engineer had a subgroup for ‘Lead’ guitars which used DRC processing. We also found that acoustic guitars were subgrouped separate to other guitar types in 13 of the mixes we examined. Furthermore, in five of the 13 mixes, EQ or DRC subgroup processing was being applied to the acoustic guitars.

Interestingly, only four out of the 72 mixes did not use any subgrouping at all and three of these were of the same song. On examination of the instrumentation of the song where three mix engineers did not create any subgroups, we found there were flute, harp, vibraphone, piano and violin tracks. There was also no guitar tracks and only one vocal track. It might have been through inexperience that the mix engineers may not have known how to approach creating subgroups for instruments such as flutes, harps and vibraphones. However, it was found in [15] that six out of the ten professional mix engineers that were interviewed created subgroups based on genre. This suggests there could have been a style or genre dependency on how the mix engineers in the experiment created the subgroups for this particular song.

Table 4 shows that the most hierarchically subgrouped instrument type was drums. It was found on examining the many different mixes, in eight of the mixes, the mix engineers chose to separate the overhead microphones from the rest of the drum recordings. As the overhead microphones are often

treated as a stereo pair with left and right microphones, grouping these into one channel allows simultaneous processing. We also found that some mix engineers chose to group the kick, snare and hi-hats separately. The kick, snare and hi-hats are the most important instruments in a drum kit and we found seven mixes where this occurred. Furthermore, 19 out of the 72 mixes used some form of hierarchical subgrouping, so this shows that it is a style of subgrouping that is practised often.

Table 8 shows there is a strong significant Spearman correlation of 0.62 ($p < 0.01$) between the average *Subgroup - Audio Track Ratio* per mix engineer and the median mix preference rating. This implies that the more the mix engineer creates subgroups on average, the higher the mix preference rating they receive.

In Table 8 there is a strong significant Spearman correlation of 0.67 ($p < 0.01$) between the average *EQ Subgroup - Audio Track Ratio* per mix engineer and the median mix preference rating. The strong *EQ Subgroup - Audio Track Ratio* correlation implies that the more EQ subgroup processing that occurs the higher a mix preference rating the mix engineer receives. The strong correlation also gives us confidence that this type of subgroup processing is an important mixing technique. This subgroup processing technique might be done frequently by a mix engineer, so that they can apply EQ to a group of instruments as a whole and stop them from masking another group of instruments [15].

Table 8 shows there is a moderate significant Spearman correlation of 0.45 ($p < 0.05$) between the average *DRC Subgroup - Audio Track Ratio* per mix engineer and the median mix preference rating. We were surprised to see such a low correlation for the *DRC Subgroup - Audio Track Ratio* as we would have expected people to process a lot of their subgroups with DRC. This seems to go against the assumption made in [2], but this may be because the participants in our experiment do not have the same level of experience as the mix engineers interviewed in [2] or we simply have not examined enough mixes to see this trend.

Table 8 shows a moderate significant Spearman correlation of 0.59 ($p < 0.05$) between the average *EQ + DRC Subgroup - Audio Track Ratio* per mix engineer and the median mix preference rating. We also

expected the relationship between subgroups created that use EQ + DRC processing and mix preference rating to be stronger, but it is probably not as strong as we hoped since it corresponds with the moderate correlation for DRC subgroup processing.

Table 9 show there is a weak significant Spearman correlation of 0.32 ($p < 0.01$) between the *Subgroup - Audio Track Ratio* per mix and the median mix preference rating. This implies that there is very little relationship between the amount of subgroups created and mix preference when we consider each mix individually. This suggests that the assumption that creating more subgroups leads to a higher mix preference does not apply to mixes universally, but is more specific to the mix engineer. What we mean by this is that there may be latent variables involved we are not yet considering.

Table 9 shows there is a moderate significant Spearman correlation of 0.40 ($p < 0.01$) between *EQ Subgroup - Audio Track Ratio* and mix preference over all the mixes created. This is not as strong as the result in Table 8. In Table 9 we see a weak significant Spearman correlation of 0.35 ($p < 0.01$) between *DRC Subgroup - Audio Track Ratio* and mix preference over all the mixes created. Table 9 also shows a weak significant Spearman correlation of 0.38 ($p < 0.01$) between *EQ + DRC Subgroup - Audio Track Ratio* and mix preference over all the mixes created. This shows that the correlations are not strong for subgroup processing when we consider each mix individually, but are stronger when we examine each mix engineer individually. This leads us to further believe that there are other factors that we are not considering and the results from Table 8 may not be generalisable. Subgrouping and subgroup processing may only work well for some mix engineers.

Figure 2 plots the distribution of all the variables we correlated and are ranked from left to right in descending median mix preference value for each mix engineer. The distributions of *Subgroup - Audio Track Ratio's* of the top three ranked mix engineers (M, E and C) show that overall, the median value are higher than 10 of the other mix engineers. It also shows that the amount of subgroups they created varied over each of their mixes if we include the outlier for mix engineer C. This implies that each mix engineer considers how many subgroups

they will create for each mix as opposed to an arbitrary number of subgroups. If we look at the *EQ Subgroup - Audio Track Ratio's*, the median results are similar for the top three mix engineers, but it varies more from left to right. The inverse seems to be true for the *DRC Subgroup - Audio Track Ratio* as the median decreases going from left to right, as well as the amount of variance. If we compare the results of the top three mix engineers with the rest of the mix engineers we do see a trend of higher *Subgroup - Audio Track Ratios*, *EQ Subgroup - Audio Track Ratio's*, *DRC Subgroup - Audio Track Ratios* and *EQ + DRC Subgroup - Audio Track Ratios* than the other mix engineers. This is not true in all cases, but is a general observation.

5. CONCLUSION

From the experimental results we found that subgroups are mainly made up of similar instrumentation, but in some cases can be a combination of different types of instrumentation. However, we found the former to occur much more often. We found that the three instrument types that were subgrouped together the most were drums, vocals and guitars. We also found that when hierarchical subgrouping occurred, it was usually applied to drums and to a lesser extent vocals. We were able to show there was a strong significant Spearman correlation when looking at the median mix preference score of all the mixes done by each mix engineer and the amount of subgroups this mix engineer created on average. We also found a strong significant Spearman correlation when looking at the median mix preference score of all the mixes done by each mix engineer and the amount of EQ subgroup processing this mix engineer used on average. There was also a moderate significant Spearman correlation when looking at the median mix preference score of all the mixes done by each mix engineer and the amount of DRC subgroup processing this mix engineer used on average.

The results provide an important insight into the relationship between mix preference and the ubiquitous, but poorly documented practice of subgrouping. There appears to be a very distinct relationship between the number of subgroups used and mix preference. This may be because the mix engineer is able to exercise greater control over the mix through subgrouping as well as being able to treat an entire

instrument group with effects processing. However, we don't know whether these findings apply to every mix engineer, since we only examined the mixes of 16 mix engineers in one university. There is also potential for bias due to how they may have been taught to mix by the instructor. Overall, this paper contributes to a deeper understanding of this poorly documented mixing practice. Informed by these results, further research questions emerge that require a larger dataset, and which we will attempt to answer by collecting and analysing a larger and more diverse set of mixes. Future work will be to further examine the link between EQ subgroup processing, DRC subgroup processing and mix preference. We would also like to see if any of our finding here could be used to improve any existing automatic mixing systems.

6. ACKNOWLEDGEMENTS

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