ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF ARTS AND SOCIAL SCIENCES

AESTHETICS OF GENRE-APPROPRIATE REVERB

M.A. THESIS

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MÜZİK TÜRÜNE UYGUN REVERB ESTETİĞİ

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Hüseyin KARADENİZ, a M.A. student of ITU Graduate School of Arts and Social Sciences, student ID 409141107, successfully defended the thesis entitled "AESTHETICS OF GENRE-APPROPRIATE REVERB", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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FOREWORD

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ABBREVIATIONS

AES : Audio Engineering Society

AKG : Akustische und Kino-Geräte

AMS : AMS Neve

Aux : Auxiliary

CPU : Central Processing Unit

dB : Decibel

DSP : Digital Signal Processing

EMT : Elektro-Mess-Technik

EQ : Equalizer

HPF : High Pass Filter

Hz : Hertz

IR : Impulse Response

L-C-R : Left-Center-Right

LPF : Low Pass Filter

L-R : Left-Right

ms : millisecond

SPL : Sound Pressure Level

TSM : Turkish Art Music

UAD : Universal Audio

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AESTHETICS OF GENRE-APPROPRIATE REVERB

SUMMARY

It is essential to create an acoustic space for instruments, almost in every genre of music. First reason of this is about aesthetics. It is about being able to put instruments background or up front as desired. Second reason is listener's traditions for certain genres. They shape the recording and mixing phase of the music for certain genres.

The main goal of this work is to interrogate the validity of these common expectations of reverb usage for certain genres and to understand the reasons behind their existence. The secondary goal of this work is to inquire the possibility of breaking the expectations about using reverbs and to suggest new possibilities.

The first stage tried to explain the terms about reverberation. A brief history of reverb is given and types of reverbs are explained.

The second stage covered basic concepts of digital reverberation units. Common parameters of digital units are explained.

The third stage consisted of the aesthetics of reverb. The reasons to add dimension to a mix, using reverb units on individual instruments, creative usage of reverb units are explained.

The fourth stage of this work tried to collect data from three different groups of participants who are fifty-five people in total: Musicians, sound engineers, and non-musicians. Results are analyzed in this stage.

The conclusion of this work presents comparison of the participants' preferences according to playback system they used. Analysis of the questions, which have distinctive results, and their possible reasons are covered. In addition, to be able to get more reliable results, suggestions for future research are given.

MÜZİK TÜRÜNE UYGUN REVERB ESTETİĞİ

ÖZET

Enstrümanlar için akustik mekan oluşturmak neredeyse tüm müzik türleri için çok büyük önem taşır. Bunun ilk sebebi estetiktir. Enstrümanların istenilen şekilde öne çıkarılması veya arka planda bırakılmasına imkan sağlamaktır. Ikinci sebep ise dinleyicilerin belirli müzik türleri için sahip oldukları alışkanlıklardır. Bu alışkanlıklar müzik türlerine göre kayıt ve düzenleme evrelerini şekillendirir.

Bu çalışmanın ana fikri belirli müzik türlerinde reverb kullanımı ile ilgili genel beklentilerin geçerliliğini sorgulamak ve bu beklentilerin varoluşlarının arkasındaki gerçekleri anlamaktır. Çalışmanın bir diğer amacı ise reverb kullanımı ile ilgi bu beklentilerin dışına çıkma olanağını değerlendirmek ve yeni imkanlar sunmaktır.

Ilk bölümde reverb ile ilgili tanımlar ve terimlerin açıklanmasına çalışıldı. Reverb hakkında kısa bir tarihçe anlatıldı ve reverb türleri açıklandı.

İkinci bölümde dijital reverb üniteleriyle ilgili temel kavramlar verildi. Dijital reverb ünitelerinde yaygın olarak kullanılan parametreler açıklandı.

Üçüncü bölüm reverb estetiğinden oluşmaktadır. Bir mikse derinlik ekleme nedenleri, bireysel enstrümanlar üzerinde reverb kullanımı ve reverb efektinin yaratıcı kullanımları anlatıldı.

Dördüncü bölümde toplamda elli beş kişi olan üç ayrı katılımcı grubundan bilgiler toplanmaya çalışıldı: Müzisyenler, ses mühendisi ve diğerleri. Bu bölümde sonuçlar analiz edildi.

Bu çalışmanın son bölümü katılımcıların tercihleri kullandıkları ses sistemine göre karşılaştırma sunmaktadır. Belirgin cevapları olan sorular ve bunların olası nedenleri ele alındı. Ek olarak, daha güvenilir sonuçlar alabilmek adına, gelecek araştırmalar için tavsiyeler verildi.

1. INTRODUCTION

Echoes are sound waves that bounce back from hard surfaces. Reverberation is a series of multiple echoes that are so close and dense; our ears can no longer distinguish them as separate slices of sound (Parsons, 2010).

Without the reverberation, hearing only direct sounds make people mostly nervous (Url-1). Each enclosed space has its own unique characteristics of reverberation. Some rooms, which are called anechoic chambers, are designed to completely absorb reverberant energy. Otherwise, there is no such place on earth naturally. Our hearing system is evolved in such a way, that one can immediately pinpoint a sound source in an enclosed space, by evaluating the sound of the room and source.

On the other hand, listening certain genres on certain concert venues, such as classical music in a concert hall or rock music in a stadium, helps engineers to shape an acoustic space in the mix according to genre.

1.1 The Aim of the Study

The primary aim of this research is to interrogate the validity of common expectations of reverb usage on various genres of music. To accomplish this, 5 songs in different genres have been mixed with different types and parameters of reverb. In some of the mixes, usage of reverb suits the tradition for the genre. In the others, it doesn't. Based on the short samples of these mixes, a survey, which will be made with participants consisting of sound engineers, musicians, and non-musicians, is created to question these traditions of reverb usage for a genre.

The secondary aim is to evaluate the eligibility of unconventional choices of reverb for a genre. For this reason, songs are also mixed with unusual sounding reverbs.

1.2 The Method

The method of this research consists of following steps:

- Analysis of artificial reverb techniques and commonly used styles through the history of mixing
- Defining the genres, types of reverbs and parameters to differentiate for the survey

- Mixing 5 songs with different reverbs which are consist of conventional and unconventional choices
- Preparing the survey with the samples of these mixes
- Surveying musicians, sound engineers and others
- Evaluating the results of the survey and defining which applications of reverb are chosen by participants
- Presentation of all result delivered through survey

The first chapter will also cover definitions about reverberation, history of artificial reverberation and types of reverbs.

The second chapter will cover basic concepts of digital reverb units. Common parameters of digital reverb units will be explained.

The third chapter will go into detail of the aesthetics of reverb. The reasons to add dimension to a mix, choosing the appropriate reverb for the genre, fitting the reverb into a mix, using reverb units on individual instruments and creative usage of reverb units will be explained.

The fourth chapter will cover the survey questions, participant's profile, and evaluation of the results. Based on the dominating answers of every question, preferences of the participants will be covered and graphical descriptions will be given.

The final chapter will give conclusion about results. Observations and recommendations will be stated for future research.

1.3 Hypothesis

This research will capture the aesthetics of reverb in 5 main genres of music from the perspective of a group of people who were the subjects of the survey on this topic. It will surely deliver some results, which will give an idea of people's reverb choices for different genres. Because of the listening samples of the survey are not in lush settings, it will also give an idea of people's attention on reverb.

1.4 Definition of Reverb

Reverberation is defined as 'prolongation of a sound, resonance' according to Oxford Dictionaries (Url-2). Indeed, there is a prolongation of sound, but this definition is not enough for technical speaking. Reverberation consists of the source itself, thousands of repetitions and randomly reflections, which can be divided as early and late reflections.

Reverberation is the persistence of sound after direct reception from source has stopped (Olson and Bleazey, 1960). Digital reverb unit is defined as ‘a type of signal processor that reproduces the spatial sound of an environment’ according to Bobby Owsinski (Owsinski, 2006).

Instruments are recorded with close-miking technique and dry sound of instruments is captured without the information about the space they are played. Some of the instruments such as synthesizers and samplers lack both ambience and depth. In the mixing process, it is possible to add these elements and shape them with the help of reverb units.

Reverb is occurred mostly in enclosed spaces such as corridors and rooms. For instance, when hands clapped or a gun fired in an empty room, sound radiates in a globular way. A listener in the room will primarily hear the source, which is called dry sound. Because dry sound travels the shortest way from the source to the listener. Secondly, listener will hear the reflections, which will be bounces from the surfaces of the room such as floor, ceiling, and walls. These reflections are called early reflections. Consequently, the reflections, which will be bounced many times from many surfaces, will arrive to the listener. These denser reflections are called late reflections. Reverb consists of these early and late reflections, which the listener will hear them as a complex.

1.5 History of Reverb

In the beginning of electric recording in 1920s, reverb level of a recording was being determined by physical distance between the sound source and the microphone. Studios were chosen according to their characteristic differences for a desired effect.

When the jukebox was introduced in mid 1930s, due to playback system they suffered from the early technology. Reproducing of the recordings, which instruments were captured with the room ambience, on the jukebox was not satisfying. Therefore, recording instruments along with the room ambience was abandoned. This is the primary reason of most recordings between mid-1930s until 1950s sounds dry (Url-3).

First Hammond Organ is introduced in 1935. People were familiar with the organ sound in churches or theaters. When they put the organ in their living room, organ did not sound familiar, due to lack of reverberation. In 1939, first spring reverb unit is added to Hammond Organ by Laurens Hammond and Bell Labs (Url-4).

Bill Putnam Sr. is credited with the first use of artificial reverb on a pop record in 1947 (Parsons, 2010). The song was Peg O’ My Heart by The Harmonicats (Url-5).

He placed a speaker and a microphone in the bathroom of the studio, fed the speaker with the dry signal and recorded the response of the room with the microphone. After that, dedicated echo chambers became popular feature for studios.

In 1957, German company EMT released the EMT 140 Reverberation Unit, which is the first plate reverb (Url-3). It was an expensive and massive device in those days, but it was still cheaper than building a reverb chamber. It became popular quickly.

The first digital reverb was created by EMT and Dynatron companies in 1976 (Url-3).

Convolution reverb became popular in 2000s, with the increase of digital signal processing.

1.6 Types of Reverb

Two ways can be used to add reverb into tracks: Recording natural reverberation onto separate tracks at the same time with the original performance, or using reverb units that create desired ambient sound in the mixing process.

1.6.1 Room tracks

Before reverb emulators invented, capturing the natural room sound with a set of microphones was the earliest way to incorporate reverb into a mix. Producers used to position musicians and room microphones to achieve the desired sound. Back in those days, different studios were chosen according to their natural reverberation characteristics, as even today. Otherwise, moving acoustic panels and gobos are used to have a certain degree of control over the room acoustics.

Recording natural room sound onto separate tracks along with the close-miked tracks, allows having more control over the amount of reverb in the mix.

1.6.2 Reverb chambers

A reverb chamber is an enclosed space in which a number of microphones are placed in order to capture the sound emitted from a number of speakers and the reverb caused by surface reflections (Izhaki, 2008). These purposely built rooms can be of any size and shape. Places like corridors, bathrooms; even staircases can be used for such a purpose. Heaven by Bryan Adams and Avalon by Roxy Music, which are mixed by Bob Clearmountain, are good examples of reverb, which comes from staircases (Url-6). Room tracks can be added after the recording session with a send from the control room feeding the speakers in the reverb chamber. Microphones are placed in the reverb chamber to capture the room sound.

Reverb chambers have some advantages over the artificial reverb units. Reverb units are design to emulate the real room by mathematical calculations or sampling. But, reverb chambers are built to produce very high quality reverb, which reverb units can never emulate exactly. Each chamber has its own unique sound, but it can be altered to a certain point by placing absorbent or reflective materials between microphones and speakers or, by changing distance between microphones and speakers.

Similar to larger rooms, larger chambers have more flat and balanced frequency response than the smaller ones. However, it costs more to build and not every studio can afford it.

Figure 1.1: An example of a reverb chamber (Url-7)

1.6.3 Spring reverbs

Spring reverb is a simple electromechanical device, which consists of steel springs and transducers to emulate reflections. The input transducer makes the spring vibrate according the level of the input signal. These vibrations are transmitted across via steel spring. Some of the vibrations bounce backwards and forwards along the way. At the end of the spring, an output transducer transforms all of these vibrations into the output signal.

The original device was conceived by Bell Labs researchers, who tried to simulate the delays occurring over long telephone lines. The development of the spring reverb, starting as early

> as 1939, is credited to engineers from Hammond Company who tried to put life into dry sound of the organ. During the early 1960s, Leo Fender added Hammond's spring reverb to its guitar combo and was later followed by manufacturers such as Marshall and Peavey (Izhaki, 2008).

Spring reverbs exist on many guitar amplifiers, as their reverb units. Because of spring reverb units are comparably cheaper to produce and smaller in size. When it comes to simulating a natural reverb, spring reverbs are far away from the task, but these devices have their own unique sound. Standalone rack units are still in production today, because most of the digital reverb emulators fail to reproduce the sound of a real electromechanical spring reverb. Considering their frequency response, quiet operation and flat frequency response is not an asset for them. But they are famous with their limited, sometimes unpleasant sound.

Figure 1.2: AKG BX20 (Url-8)

1.6.4 Plate reverbs

Spring reverbs are mostly considered as one-dimensional reverb units according to steel inside, which can be count as a line segment. Plate reverbs come one step further from springs. They are usually considered as two-dimensional reverb units due to its thin metal sheet inside of the box, which can be count as a plane. The working principle of a plate reverb is quite similar to that of a spring reverb, with the exception of the vibrations are transmitted over a thin metal plate hanged in a wooden box. The input transducer vibrates the plate and the output transducer is there to pick up the vibrations. Two-dimensional surface of the plate increase the amount of the vibrations.

German company EMT made a great breakthrough in 1957 with the release of the EMT 140 Reverberation Unit, the first plate reverb (Url-3). This model had massive dimensions of 250*130*35 cm and weight of 170 kg (Url-9).

These plate units were quite expensive, but they were still much cheaper than the constructing a reverb chamber. The sound of this plate reverb can be heard on countless productions including Pink Floyd's Dark Side of the Moon (Url-10) and Daft Punk's Random Access Memories (Url-11). Although mobility is possible but not one of its main features, sonic qualities are better than the spring reverb. The EMT 140 can provide up to 6 seconds of reverb (Url-9). However, for the most of the applications, this decay time is too long. To adjust the reverb time to desired length, a fiberglass damping pad, hanged parallel to the plate, can be moved closer to reduce the decay time. Continuous adjustments of reverb time can be made on a dial on top of it. Comparing the spring reverb, frequency response of this device is more balanced. Even if the sound does not resemble a natural reverb and is slightly metallic, it has a bright, dense and smooth character. It can be blended well with every instrument, especially with vocals and snares.

Figure 1.3: EMT 140 (Url-12)

1.6.5 Digital emulators

The invention of digital reverberation is credited to Manfred Schroeder, then a researcher at Bell Laboratories, who demonstrated a simple reverberation system back in 1961 (Izhaki, 2008).

They were destined to take over the market as tangible commercial machines, but not until the performance rise of DSP chips and the fall of their price.

The EMT 250 Electronic Reverberator was introduced at the Zurich AES Convention in 1976. It was designed to be an alternative to the EMT 140 Classic Plate Reverberator, which was huge by comparison and needed good isolation to avoid sympathetic resonances. The EMT 250 offered a diverse sound in relatively compact and convenient dimensions (Url-13).

Because of the complexity of a reverb, which is created in a real room, digital emulators will never be able to produce a reverb perfectly identical to it. In a real room, there are thousands of reflections, different frequencies to spread out, different surface materials to diffuse and absorb sound in a different way; even the heat of the room affects the sound. In the early days of production of digital reverbs, manufacturers have to shorten the path of the emulation regarding the DSP power. Day by day, with the continuous rise of the processing power, they take fewer shortcuts. The lesser shortcuts the more realistic the reverb is likely to be.

Back in the 1990s, when real-time plugins emerged, CPUs had less than a tenth of processing power compared to modern processors and could only handle a few plugins at a time (Izhaki, 2008). Today, it is possible to do all recording and mixing process in the box, from start to end. According to number of tracks and inserts, additional processing power might be needed. External hardware units or internal DSP expansion cards can achieve it.

Digital reverb units are highly flexible and versatile devices, because they have no physical and mechanical limitations. They present a multitude of controls to tweak almost every property of the reverb. For this reason they are the most common type of reverb in many mixing scenarios. One downside about high quality emulators is that they consume large amount of processing power according to their quality.

Figure 1.4: EMT 250 (Url-13)

1.6.6 Convolution reverb

Capturing the reverb characteristics of an acoustic space makes possible to apply it later to any kind of recording in the mixing process. This operation requires lots of calculations and big amount of DSP. Even if the dream of capturing the reverb of a space started in the 1970s, it became possible in the 2000s with the rise of DSP power.

Sampling the reverb of an acoustic space can be done in two ways after placing a stereo microphone in that space. One way is to create a short impulse like a handclap or gunfire, and record the room response. The other way is to create a sine sweep through the speakers and record it. Removing the original sound from the recording leaves the impulse response of the particular space alone. Loading the impulse response into a convolution reverb, which evaluates the IR and creates a massive matrix, makes possible to use IR or the particular room on every source desired.

> An emulator can be based on one of two types of convolution, either one that is done in the time domain (pure convolution) or one that is based on the frequency domain (convolution or Fourier based) – each generates the same result, only in some situations one will be faster than other. If pure convolution is used, an impulse response of 6 seconds at 44.1 kHz would require 23 billion mathematical operations per second – an equivalent to the processing power offered by a 2.2 GHz processor (Izhaki, 2008).

With the convolution reverbs, it is possible to add the reverb of many special venues and places to any signal. This is a game changer for the film industry. Engineers can record the reverb of any location and engage it in the post-production process. Although using the reverb characteristics of exotic venues does not contribute to most of the music genres such as rock, pop, or blues. But the impulse responses of places like a garage, small room or medium hall can be applied to almost every mix. The quality of the equipment used in the recording of the impulses affects directly the quality of impulse responses.

Convolution reverbs can also emulate the impulse responses of any of the vintage units such as EMT 140, EMT 250 or AMS RMX16.

An issue with the convolution reverbs is that it is almost impossible to tweak its parameters without some quality penalty. Most of the parameters on most of the convolution reverbs can be tweaked only for a limited amount. To achieve more natural results, manufacturers record a variety of impulse responses of the same space, with a different recording setup each time.

Figure 1.5: Logic Pro X's Space Designer (Url-14)

2. BASIC CONCEPTS OF DIGITAL REVERB

Digital reverb emulators can vary in their purpose of design. Some are designed for one specific application and some are designed for another. The controls on reverb emulators can vary largely from one to another. Also the names of controls can vary according to the manufacturer company of the emulator. But there are some common parameters, which can be seen on almost every digital emulator.

2.1 Direct Sound

Direct sound is the sound that travels the shortest distance from the source to listener. It is basically not part of a reverb. Direct sound is the first instance of the sound to reach to the listener and it presents an important psychoacoustic cue. The direct sound is the dry signal, which is fed into to a reverb emulator, thus it is able to produce a simulation of a reverb. Some emulators might have a parameter that is named as dry/wet mix to determine whether dry signal is mixed with reverberated signal.

2.2 Pre-delay

Pre-delay is the difference of time between the arrival of the direct sound and early reflections to the listener. It is important because of it gives the listener a definitive information regarding the size of the room. In larger rooms, it takes more time for reflections to travel to the boundaries of the room and to reflect to the listener. Therefore, in larger rooms, pre-delay time is longer than smaller rooms. Pre-delay also gives the listener a decisive cue regarding the distance between the source and the listener. When the source gets closer to the listener, relative distance between the direct sound and the reflected sound gets longer. Thus, it makes the pre-delay longer.

2.3 Early Reflections

Bounced reflections from the closest surfaces start reaching to the listener shortly after the direct sound. Even if the early reflections reach to the listener comparatively long time intervals, our brain diagnose them as distinct sounds, which are connected to the direct signal. To define the spatial characteristics of the room and the distance

between the source and the listener, early reflections provide crucial information to human brain.

Regarding the room shape and properties, early reflections might reach to the listener within the first 100 ms after the direct sound. Human brain perceives the early reflections within 30 ms, which counts as Haas delays, in somewhat different way (Senior, 2011).

The level of the early reflections provides information about the size of the room. In a bigger room, it will take more time for the early reflections to travel to the boundaries of the room and to reflect back to the listener. The level of early reflections is also affected by the surface material.

Early reflections are the closest sound to the dry sound, hence they are the main cause for timbre distortion and comb-filtering. One of the biggest challenges in designing a reverb emulator involves the production of early reflections that do not color the dry sound (Izhaki, 2008).

2.4 Reverberation (Late Reflection)

In some emulators reverberation is referred to as the reverb tail. The reverberation contains the reflection, which is bounced from many surfaces many times. Every time the sound encounters a surface, it is absorbed. This decays amplitude of reverberation. The level of reverberation is an essential element in our perception of depth.

2.5 Reverb Ratio and Depth

Further away the listener from the source is the lower the ratio is between the direct sound and the reverberation. This ratio determines the perceived depth of a source. For instance, in order to put the instruments further away in the mix, ratio must be decreased.

Critical distance is the distance at that the direct sound and the reverberations are equal in level. Beyond the critical distance, reverberation will be louder than the direct signal, and this will disrupt the clarity of the direct sound.

2.6 Decay Time

Decay time is the time that it takes for sound in a location to decay by 60 dB, which is shown as RT60. Practically, 60 dB is the difference between loudest sound and

hardly audible sound comes from the source. This parameter on the reverb emulators determines the length of the reverb. Some emulators measure it regarding to direct sound, some regarding to level of the first early reflection.

Decay time gives information regarding the size of a room and reflectiveness of the surface materials in that room. In larger rooms, distance between surfaces is bigger and it takes more time for the reflections to diminish.

In most of the digital emulators, decay time is established by the size of the room.

2.7 Room Size

This parameter makes possible to adjust the dimensions of the simulated room. It is mostly linked to the decay time and the early reflections. In general, smaller rooms have more coloration. In some situations, increasing the size of the room can create stronger early reflection patterns and longer pre-delay. Shorter decay times with this set up can make the reverb sound more prominent.

2.8 Density

Density parameter of a reverb emulator can stand for the early reflections only, for the reverberation only, or for both together. The density of the early reflections provides information about the size of the room. In a smaller room, sound reflects more quickly than a bigger room, due to closer surfaces. Therefore, denser reflections address smaller room.

2.9 Diffusion

This parameter controls the spreading of sound. A proper diffusion makes frequency response more uniform and reverb more pleasant. In order to achieve uniform frequency response, diffusers are being manufactured for both control rooms and live rooms. Bookshelves do the task with some quality penalty for home studios. Diffusion is affected by many factors such as the shape of the room or materials of the surfaces. Some materials diffuse sound more, and some less. For instance, concrete walls diffuse the sound more than surface of the books. Irregular shaped rooms create more diffused sound compared to cubic or rectangular rooms. Diffusion affects the reflection pattern of a room, makes them more complex in terms of spacing and level.

Most of the manufacturers bond the diffusion parameter with the density parameter. Increasing the diffusion can result in amplifying the density. Also, it can make reflection patterns irregular.

2.10 Frequencies and Damping

Frequency treatment of reverb sound can be done at three spots along the signal path:

- Pre-reverb
- Damping
- Post-reverb

Unwanted frequencies, which can damage or distort the sound of the reverb, can be reduced before those frequencies reach the reverb in the signal path. This treatment is mostly done by high and low pass filters or shelving filters. Low frequency content of a mix, which is produced mostly by kick drum or bass guitar, can result a muddy reverb sound and this can easily ruin the mix.

Frequency treatment can also be done in the reverb algorithm. Most of the reverb emulations have limited control over EQ, but treating unwanted frequencies in the reverb algorithm makes the sound of the reverb more natural. Damping parameter of the reverb usually stands for the ratio between decay time of the reverb and decay time of the frequencies.

But the most common way to treat undesired frequencies is to EQ the output of the reverb, so that the reverb can fit better in the mix. When reverb sound overlaps the direct sound, it can be tuned in this way. For instance, lowering high frequencies makes the reverb sound warmer and instruments further in the mix.

Some manufacturers offer frequency treatment at all three spots, some offers only damping. When the options are limited, an EQ plugin before or after the reverb makes possible to tune the sound of the reverb.

3. DIMENSION: REASONS TO ADD, CHOOSING THE APPROPRIATE REVERB, AND CREATIVE USE OF REVERB

Dimension is the ambience where tracks sit. It can be captured during the recording the original performance. But, most of the times it must be created or enlarged in the mixing process using effects like reverb and delay. According where to add, dimension can be simple process such as re-creating an acoustic space, or it can be the process of adding width or depth to an instrument or also changing the character of a flat sounding track.

3.1 Main Reasons to Add Dimension to a Mix

There are four main reasons to add dimension to a mix:

3.1.1 To create an acoustic space

With the advantage of overdubbing, bands do not need to play together in the recording process. In fact, modern recording sessions encourage doing so. For instance, a modern rock production usually starts with the drum recording. Bass recording must wait for editing the drums. Bass and drums do sometimes play together. Guitars are recorded after that. Vocals need to wait until the very end of the recording session. In some of the cases, musicians are recorded not just at different times, but also in different studios. In the mixing process, it is essential to create an ambience field, where all tracks sit together, with the help of reverb units.

3.1.2 To add excitement

Character of a track can be changed by adding effects. This is mostly done for flat or boring sounding tracks. For instance, a flat sounding guitar can be enhanced by chorus and reverb, or a dull sounding synthesizer can be excited by sending it to a stereo delay.

3.1.3 To make a track sound bigger, wider, or deeper

Some of the tracks can sound small at the start of mixing process. The reasons can be various. It can be miked so to control the leakage when the band plays together in the recording session or it can be the nature of that particular instrument. These

instruments can sound bigger or wider by adding effects. For instance, drums can sound larger by sending them to a small reverb, or guitars can sound bigger by sending them to a short delay.

3.1.4 To move a track back in the mix

L-C-R position of a track in the mix can be changed by using pan knob, while effects allow them to place the tracks front to rear in the mix. The instruments, which are needed to sound in front of the others, must have less reverb than the others.

3.2 Using Reverb in the Mix

There are some basic approaches to working with reverbs and other effects in order to have more control and flexibility, and to be able to make critical decisions about the sound of the effects.

Most common way to apply a reverb or delay to a track is using send and return model. Using aux sends and aux returns provides maximum flexibility when dealing with effects (Savage, 2014). Even for using the effect for just one track, the control over the level, panning, dynamics and frequency spectrum of the effect in this model has major advantages over inserting the effect on the track and using wet/dry parameter on the effect to make level adjustments. But in case of short delays such as chorus and flanger, they are usually inserted on the track to create an integrated sound.

Figure 3.1: Send and return model (on the left) vs. Insert (on the right)

In most of the cases, when any individual track or sub groups are soloed, effect returns of those instruments are needed to be heard. In order to do this, without having to click the solo button on the aux track every time, soloing function of the aux tracks needs to be isolated. Even if multiple tracks are sent to the same effect, when one of those instruments is soloed, the others and their sends will be muted (Savage, 2014).

Figure 3.2: Solo isolate (on the left) vs. normal aux usage (on the right)

Like the other effects, reverbs can be used in lush settings, in which case it is straightforward to hear; or they can be used very subtly, in which case it is challenging to hear the effect. It can be still challenging to hear the effect, even if one instrument is soloed, because of the effects such as reverbs and delays are generally obscured by following sound. To hear better the actual sound of reverb and delay in the mix, it is best to solo the tracks, which are sent to the effects and stop playback, therefore it is easy to hear the tail of the effects. Doing this makes sense according to one of the definitions of reverberation that is the persistence of sound after direct reception from the source has stopped (Olson and Bleazey, 1960). If the soloed instrument is sent to multiple effects, it can be beneficial to do this one by one and muting the other effect returns.

In most cases, reverbs and delays are used in post-fader position. This makes possible to control the level of the reverb according to level of the direct signal's loudness in the mix. In other words, when the fader of a track is lowered, the level of the effect send is lowered by itself. Sending tracks to effects in pre-fader position makes possible to listen to effects only, by muting the direct signal. This can be useful, in some situations.

Figure 3.3: Post-fader (on the left) vs. Pre-fader (on the right)

3.3 Choosing the Appropriate Reverb and Tuning It

In the mixing process, all the effect processors are available to add dimension to the tracks. Some of the tools can be combined, or none of them can be used. In most cases, these choices are special for that particular mix and probably won't work for another mix regarding the mood, feeling, tempo, dynamics and frequency spectrum. Even if same reverb plugin is used in two different mixes, some parameters such as the reverb time or the frequency response of the reverb return are needed to be adjusted. Decisions about adding dimension are needed to be done according to song.

3.3.1 Reverbs vs. delays

To build an acoustic environment for a mix, using reverbs and delays or both, is a good starting point. Reverbs have more realistic and richer sound than delays, but they cover more space in the frequency spectrum and can end up with muddiness and blur. At this point, delays can be used for adding ambience to a track. Because of delays do not exist in a pure form in nature, they may call attention to themselves and be distracting (Savage, 2014).

3.3.2 Tweaking the parameters of reverb

As discussed in the earlier chapter, digital reverbs have a lot of parameters. These parameters may make sense and have an audible effect while listening to one track sent to reverb. However, in a crowded mix, they usually do not, except for some parameters such as reverb time and pre-delay. In this case, it is better to choose an appropriate preset, and consider small alterations. For instance, if a large hall preset, which reverb time is 2.5 seconds is chosen, and it is needed to be reduced to 1 second. In this case, starting with a small hall preset in the first place is a reasonable way. Reverbs consist of a set of early reflections and reverb tail. All the parameters connected to each other in a way. Tweaking one of them fiercely can cause a disruption on artificial space.

3.3.3 Short vs. long reverbs

Choosing reverb for the mix usually starts with the basic decision between a short reverb and a long reverb. Short reverbs are roughly 1.5 seconds and shorter. Long reverbs are roughly 1.5 seconds and longer. No matter what length is chosen, reverbs create a sense of space in the mix. But reverbs also can cloud the mix. Mostly long reverbs do. In these kinds of situations, short reverbs can be a good starting point. Background elements, which have mostly sustained notes, may be richer with long reverbs to increase their atmospheric quality. Combining a short reverb with a small amount of a long reverb can create a good sense of a richer acoustic environment, without blurring the mix.

3.3.4 Warm vs. bright reverbs

Wood-paneled rooms, churches and concert halls can be count as warm reverbs. Tiled rooms, plate, and spring reverbs usually sound brighter. In between warm and bright can be regular rooms and chambers. Trying all and accomplishing new sounds is possible in the mix, but some points need to be considered regarding the frequency spectrum. For instance, choosing a warm reverb for bright female vocal, or a bright reverb for warm male vocal can help to build a balanced frequency spectrum in the mix.

3.3.5 Timing reverbs

Some mixing engineers like to adjust the time of the reverb according to tempo of the song. They calculate the time between the hits of a rhythmic instrument such as snare, and they set the reverb time equal to calculated time. The point is giving enough time to reverb to decay before the following hit. The accepted standard to calculate the reverb time by how long it takes

for a reverb signal to drop by 60 dB from the initial level of the reverb. Because the perception of where decay ends will change depending on how loud the listening level is. Listening louder makes the reverb sound like it is longer (Savage, 2014).

It is better to adjust reverb by ears. It needs to be adjusted until it feels like it is breathing in a way with the direct sound, supporting the tempo of the song.

3.3.6 EQ'ing reverbs

It has always been common to EQ the reverb return from the early days of artificial reverberation (Owsinski, 2006). According to reverb choice, it is possibly needed to add frequencies that are missing, or to tune the reverb by removing unwanted frequencies. To make the reverb more audible, return of the reverb needs to be brightened up by adding high frequencies. To make it blend in with the rest of the mix, return of the reverb needs to be darkened by filtering high frequencies. If the direct signal is a busy instrument such as drums, both low and high end of the reverb return need to be rolled of not to blur the mix.

3.4 Using Reverb on Individual Instruments

When main reverb is chosen for a particular mix, it does not make sense to send each instrument to that reverb at equal levels. Also for multi-miked instruments such as drums, send levels for each track need to be adjusted. In the mix, each instrument will sit on a created sense of space. Some will be on the left or right, some will be on the center, and some will be in the background or up the front. L-C-R position of the instruments is adjusted by pan knobs, proximity of the instruments is mostly adjusted by reverb.

3.4.1 Drums

Drum effects may include reverb, delay or modulation effects, but reverb is the most important one to put the drums in an acoustic space. Because of the rhythmic and repetitive nature of the drums, reverb needs to be timed in such a way to reinforce the rhythmic structure (Savage, 2014). Therefore, the reverb time is the most important parameter to achieve this.

The genre and tempo of the song define the approach to reverb. In general, for the genres like alternative rock, punk, rap or metal, reverb is relatively dry. Whereas, for the genres like pop, country, or traditional rock; reverb is relatively wetter. Slow tempo songs tend to have more and longer reverbs than faster tempo songs.

Drum reverbs might be halls, chambers, plates, rooms, or any other choice of a specific space from convolution reverbs. Brighter reverbs such as plates are appropriate for rock songs, whereas a concert hall may suit better for a pop ballad.

Combining two reverbs, a short reverb and a long reverb, creates a richer sense of space in most cases. According to genre, short reverb may be a room, and long reverb may be a chamber, plate, or hall.

3.4.2 Percussions

Reverbs can be compelling on all percussion instruments, except for high-pitched percussions. In most cases, high-pitched percussions blend with the rest of the mix without having additional ambiences. Percussions such as congas, bongos and timbales can sound good with all types of reverbs. Reverb returns must be panned to same side as the instrument. Stereo returns which are split hard left and hard right can disrupt the place of the instrument in the mix.

3.4.3 Guitars

For electric guitars, reverb choice depends on their place in the mix. In general, rhythm guitars gain some depth with a short reverb, without washing their sound in the mix and putting them further away from the listener. Reverb return must be panned to same side as the instrument. Reverb of the lead guitar will depend on the mood of the track and genre of the song. For instance, lead guitar can have room reverb and plate reverb along with the delays.

In the case of acoustic guitars, all process depends on the genre of the music and place of the acoustic guitar in the mix. In a country song, acoustic guitar has an important role. In a crowded rock mix, acoustic guitar is usually a background instrument.

3.4.4 Keyboards

Acoustic keyboards such as piano, harpsichord and glockenspiel are usually recorded stereo, and they often occupy a large part of the frequency spectrum. These instruments do not have to be panned hard left and hard right. Panning them according to their place in the mix saves space in the frequency spectrum for other instruments. Their reverb returns must be panned as the same spots with the instruments.

Traditional keyboards such as B3, Rhodes and Wurlitzer, have their effects from the source. Leslie rotating speaker of the B3 organ provides a Doppler kind of effect.

The Rhodes piano usually has a stereo vibrato effect. Wurlitzer piano has a very bright sound and it is often played through an overdriven guitar amp.

Synthesizers and samplers can produce endless variety of sound. They are usually sound lack of ambience and depth. In the mixing process, some ambience and depth must be added to them, to make them sound exciting in the mix.

3.4.5 Lead vocals

In general, if there is a vocal track in a song, it is the most important instrument. In this situation, when using reverb on lead vocals, it is important not to distance the singer too far from the listener. It is common to combine a couple of different reverbs such as a short room and a medium room or long plate, along with the delays.

Effects on vocals can be used in a prominent way to create a lush quality, which makes the singer majestic. To choose the length of the reverb and the level of the reverb, tempo of the song is very important. As with the other elements in the mix, slow tempo songs tend to have more space for longer and louder reverbs.

3.4.6 Harmony and background vocals

Harmony vocals sing along with the lead vocal, and harmonize different notes, whereas background vocals sing at different times and different parts. Both can be treated in various ways according to their place in the mix and the genre of the song.

3.4.7 Horns

Reverb choice for horns is similar to reverb choice for lead guitar. According the song, horns can be sent to a room reverb by just a touch, or they can be sent to a long reverb to create a lush environment.

3.4.8 Strings

In genres like pop and rock, strings are usually used as pad instruments. If this is the case, mixing them with reverb and panning them wide in the spectrum is often the best approach.

If the strings are needed to sit in front of the mix, like in the song Eleanor Rigby by Beatles, it is a real challenge without making them unnaturally loud. Automating the return of the reverb and panning of the strings, allows them to move in the mix.

3.5 Creative Usage of Reverb

Reverbs are not only used for creating natural-like spaces, but also for unnatural or otherworldly ambiences. An odd-sounding choice of reverb today, can be a tradition in the future. For instance, Peter Gabriel's third album, which is released in 1980, is the first album that the gated reverb is heard. After it was released, many others such as Duran Duran, Phil Collins and Kate Bush have followed this creative usage of reverb. Gated reverb is to be mentioned as the sound of 1980s (Url-15).

3.5.1 Layering reverbs

Each instrument has its own ambient environment, and each environment is often created artificially by a combination of effects such as reverbs and delays. The important point here is that these ambient environments do not conflict with each other due to frequency spectrum. To achieve this, some points need to be considered.

When layering reverbs, longest reverb must be the brightest and the shortest must be the darkest by frequency response. Reverbs do not need to be returned in stereo to sound big, sending tracks to mono reverbs and panning them accordingly keeps the mix clear. Sending each major elements of the mix to the longest reverb just by a touch, ties all the environments together (Owsinski, 2006).

3.5.2 Re-amping

Re-amping is a process, which is done by sending the signal of a recorded track such as electric guitar or synthesizer back to an amplifier in the live room and recording it with a set of close microphones, and from a distance to capture the sound of the room. Then it is mixed with the direct signal. This process makes possible to capture the sound of a desired room.

3.5.3 Flanging reverb

Flanging means artificially created comb filter, which is achieved by slowing down a reel of the tape by touching the edge of it. Flange is the name of the metal piece on each side of the tape, which holds the reel together. In the digital domain, it can be created in a few steps: Making a copy of the region to another track, changing the pitch of the copied track by 5-10 cents, nudging the flanged track backward a couple of milliseconds, and playing both tracks together. Applying this process or simply using a flanger plugin on the reverb track creates otherworldly soundscapes.

3.5.4 Reverse reverb

In the analog days, reverse reverb is achieved by playing tape backwards, sending backward track to a reverb, recording the reverb to another track, and then forward playing it. In digital domain, this effect is achieved by making a copy of the region, where the reverse reverb is wanted, reversing it, and adding reverb to reversed track. One of the creative ways to use reverse reverb is to use it before for a solo or vocal entrance. Reverse reverb nicely precedes the solo or vocal entrance according to reverb time.

3.5.5 Compressed reverb

In some situations, instruments such as tambourine lose their impact and power when sent to a reverb in the mix. A compressor, which is inserted on the reverb track, transforms the reverb into a new sound. Fast release adds noise and energy that every hit of the tambourine triggers.

3.5.6 Gated reverb

> Gated reverb is accidentally discovered in the recording of Peter Gabriel's third album in 1979. According to engineer Hugh Padgham, they had a new recording console with some new features that included a microphone hanging in the studio to talk to the band. The microphone captured the sound of a simple beat played by the drummer Phil Collins. As it is today, the talkback microphone had a heavy compressor on it. Also, console had a noise gate to reduce the noise floor. All these factors created the gated reverb and it became the sound of the 1980s (Url-15).

In the modern days of mixing, it is easy to apply this effect. On the reverb track, a gate plugin needs to be inserted after the reverb. The reverb time is usually long, to create a sense of a very big space. By the courtesy of the gate it ends abruptly, so reverb tail does not blur the mix, but keeps the sense of a big space.

3.5.7 Longer pre-delay time on short reverb

Using long pre-delay times on short reverbs reinforces the rhythm of the song. This makes the direct signal unnaturally followed by a cloud of delayed sound. When this effect used in a subtle way, it creates a large sense of space without having to use too much reverb. When it is used in a blatant way, it creates a strange and supernatural effect.

3.5.8 Using pan knob

When effects are inserted onto tracks, panning options may be limited. When a mono effect is inserted onto a mono track, effect will automatically be panned with the track. Most of the stereo effects, when inserted onto a mono track, transform a mono track into a track with stereo output. In most cases, it disrupts the place of the instrument in the mix (Savage, 2014).

Using effects in send and return model provides more flexibility than inserting them onto tracks. For instance, a mono reverb can be panned according to the direct signal, which goes to reverb. Doubled electric guitars can be sent to different stereo reverbs. Reverb return of the left guitar can be panned anywhere between hard left and center. Reverb return of the other guitar can be panned anywhere between hard right and center. With this method, relative panning position will be maintained and ambience across whole spectrum will be spread.

Figure 3.4: Using pan knob for aux channels

3.5.9 Automating the reverb

Automating reverb return according to song sections and arrangement of those sections keeps the song progressing. In the sparse parts of the arrangement such as the beginning of the song, vocals can be dryer and upfront, and then it can start to build up according to arrangement.

4. SURVEY

4.1 Preparing the Survey

For the survey, five songs are mixed with different types of reverb for some questions, and different parameters of the same reverb for other questions. First song is a classical music tune, which consists of piano and vocal. Second one is a TSM tune, which consists of percussions, bass, oud, qanun, kemenche, ney and vocals. Third one is a jazz tune, which consists of drums, bass, piano, electric guitar, brass section and vocals. Fourth song is a pop/rock tune, which consists of drums, bass, organ, piano, electric guitar and vocals. Finally, fifth one is an electronic/pop tune, which consists of many drum loops, synths, and vocals.

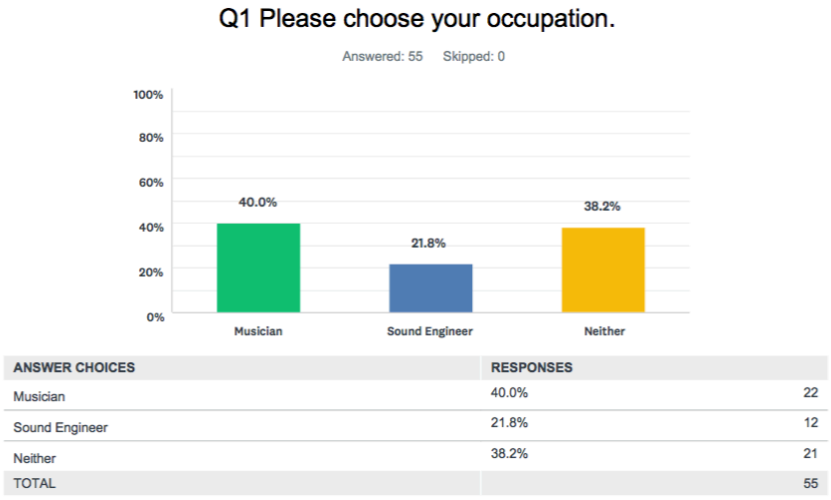
UAD EMT 250 is used as algorithmic reverb, Logic Pro X's Space Designer is used as convolution reverb, UAD EMT 140 is used as plate reverb and UAD AKG BX20 is used as spring reverb. For all reverb tails, a HPF with the cut-off frequency of 148 Hz and a LPF with the cut-off frequency of 7500 Hz is applied. Reverb tails are also tuned with 3 notch filters in the mid band. Levels of the reverb tails are matched as far as possible. To compare them fairly, no room tracks used in the mixes.

The samples are uploaded to Soundcloud (Appendix A) and the participants answered the questions without knowing what is changed (Appendix B).

4.1.1 Subjects of the survey

Regarding the aesthetics of reverb for different genres, three groups of people stand exactly in the zone of interest: Musicians, sound engineers, and non-musicians. The reason for this is simple: Musicians are the creators of the music and the decision makers about the aesthetics of their music. Sound engineers are the people who make ideas of musicians come to life. In some situations, they are also the decision makers. Non-musicians are the consumer of the records. They judge the recordings they listen, according to their own taste.

As seen in Figure 4.1, 55 people attended the survey. 40% of the participants (22 people) are musicians, 21.8% of the participants (12 people) are sound engineers and 38.2% of the participants (21 people) are non-musicians.

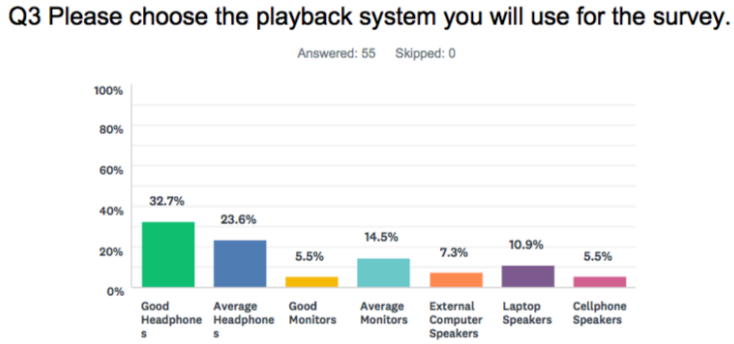


ANSWER CHOICES	RESPONSES	
Musician	40.0%	22
Sound Engineer	21.8%	12
Neither	38.2%	21
TOTAL		55

Figure 4.1: Participants of the survey

4.1.2 Playback systems used by participants

Participants are asked about the playback system they used for the survey. As illustrated in Figure 4.2, 32.7% of the participants (18 people) have used good quality headphones. 23.6% of the participants (13 people) have used average headphones. 5.5% of the participants (3 people) have used good monitors. 14.5% of the participants (8 people) have used average monitors. 7.3% of the participants (4 people) have used external computer speakers. 10.9% of the participants (6 people) have used laptop speakers. 5.5% of the participants (3 people) have used cellphone speakers.



ANSWER CHOICES	RESPONSES	
Good Headphones	32.7%	18
Average Headphones	23.6%	13
Good Monitors	5.5%	3
Average Monitors	14.5%	8
External Computer Speakers	7.3%	4
Laptop Speakers	10.9%	6
Cellphone Speakers	5.5%	3
TOTAL		55

Figure 4.2: Playback systems used by participants for the survey

4.2 Questions and Answers

After asking the questions about occupation, name and playback system of participants, the questions of the survey can be categorized into five main topics.

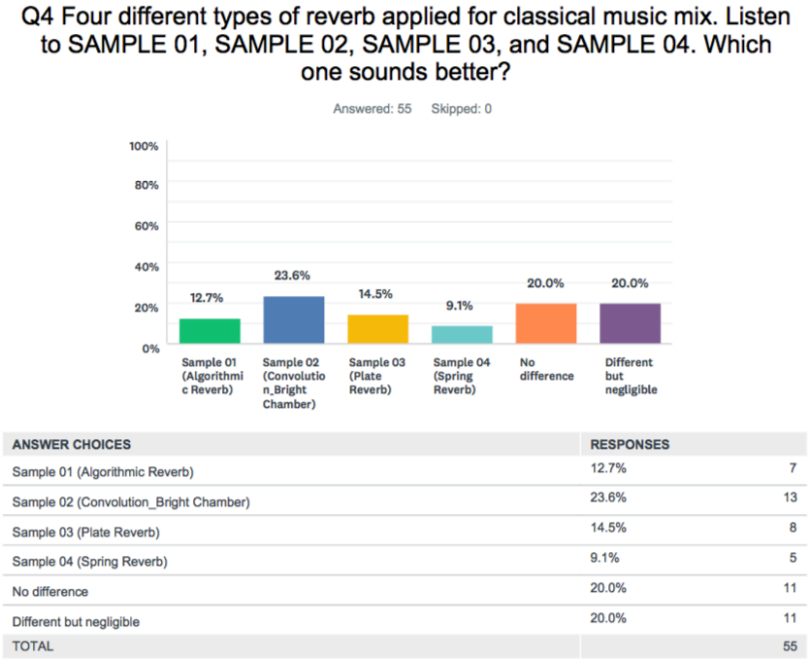
For the first topic, which consists of question 4, 5, 6, 7 and 8 of the survey, these five tunes are mixed down with algorithmic reverb, convolution reverb, plate reverb and spring reverb separately. And then, participants are asked which type of reverb sounds better for each tune.

4.2.1 Question 4

Classical music tune is mixed down with different types of reverb for this question. The reverb time is 1.8 seconds for EMT 250, Space Designer and EMT 140. For the AKG BX20, reverb time is 2 seconds, which is the shortest reverb time for this spring reverb plugin. Pre-delay time is around 40 milliseconds for each reverb.

Sample 01 is mixed down using algorithmic reverb (EMT 250). Sample 02 is mixed down using convolution reverb (Space Designer's Bright Chamber preset). Sample 03 is mixed down using plate reverb (EMT 140). Sample 04 is mixed down using spring reverb (AKG BX20).

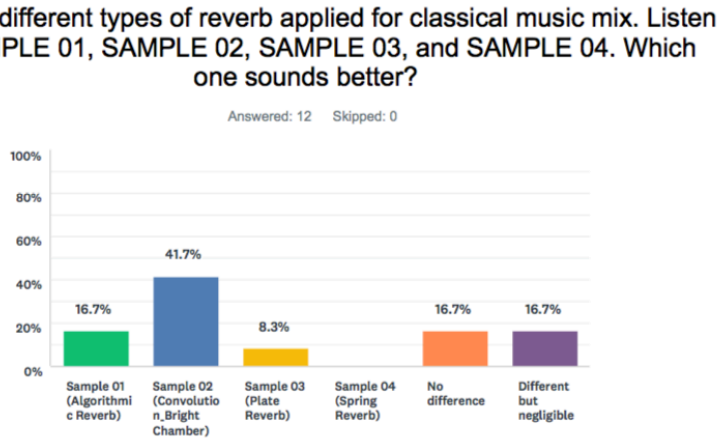
As seen in Figure 4.3, 13 participants preferred convolution reverb's bright chamber preset. 11 participants answered as no difference and 11 participants answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 01 (Algorithmic Reverb)	12.7%	7
Sample 02 (Convolution_Bright Chamber)	23.6%	13
Sample 03 (Plate Reverb)	14.5%	8
Sample 04 (Spring Reverb)	9.1%	5
No difference	20.0%	11
Different but negligible	20.0%	11
TOTAL		55

Figure 4.3: General results of question 4

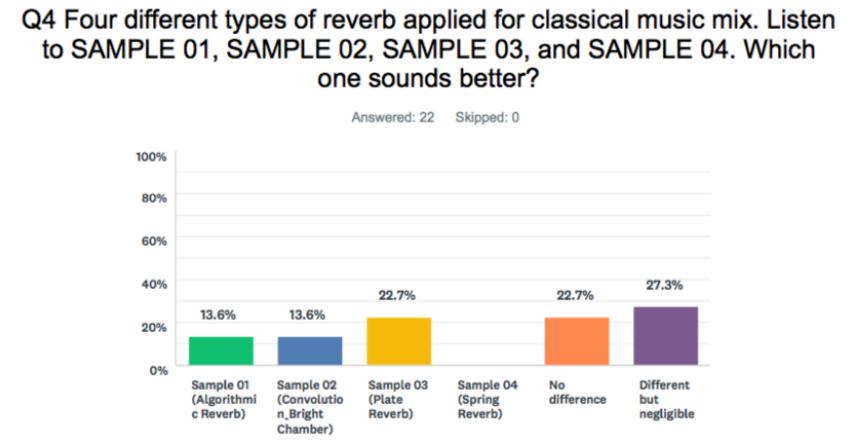
As seen in Figure 4.4, 5 out of 12 sound engineers preferred convolution reverb's bright chamber preset. None of the sound engineers preferred spring reverb for this question.



ANSWER CHOICES	RESPONSES	
Sample 01 (Algorithmic Reverb)	16.7%	2
Sample 02 (Convolution_Bright Chamber)	41.7%	5
Sample 03 (Plate Reverb)	8.3%	1
Sample 04 (Spring Reverb)	0.0%	0
No difference	16.7%	2
Different but negligible	16.7%	2
TOTAL		12

Figure 4.4: Sound engineers' results of question 4

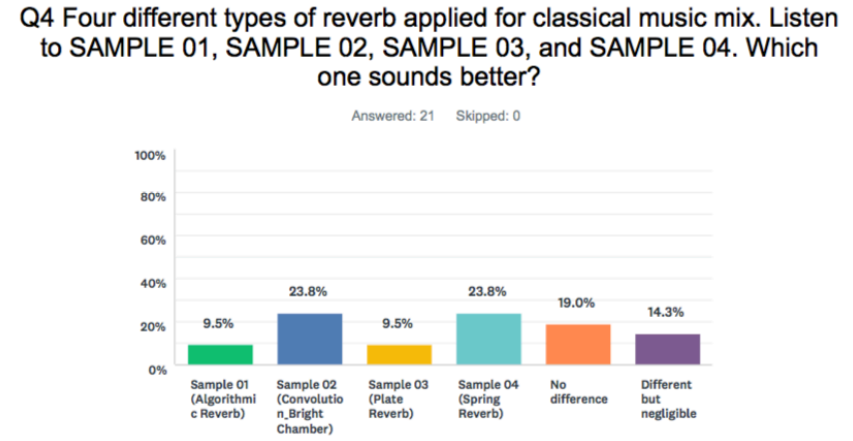
As seen in Figure 4.5, 6 musicians answered as different but negligible. No difference and plate reverb answers got 5 votes each. None of the musicians chose spring reverb.



ANSWER CHOICES	RESPONSES	
Sample 01 (Algorithmic Reverb)	13.6%	3
Sample 02 (Convolution_Bright Chamber)	13.6%	3
Sample 03 (Plate Reverb)	22.7%	5
Sample 04 (Spring Reverb)	0.0%	0
No difference	22.7%	5
Different but negligible	27.3%	6
TOTAL		22

Figure 4.5: Musicians' results of question 4

As seen in Figure 4.6, convolution reverb's bright chamber and spring reverb answers got 5 votes each. 4 participants answered as no difference, and 3 participants answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 01 (Algorithmic Reverb)	9.5%	2
Sample 02 (Convolution_Bright Chamber)	23.8%	5
Sample 03 (Plate Reverb)	9.5%	2
Sample 04 (Spring Reverb)	23.8%	5
No difference	19.0%	4
Different but negligible	14.3%	3
TOTAL		21

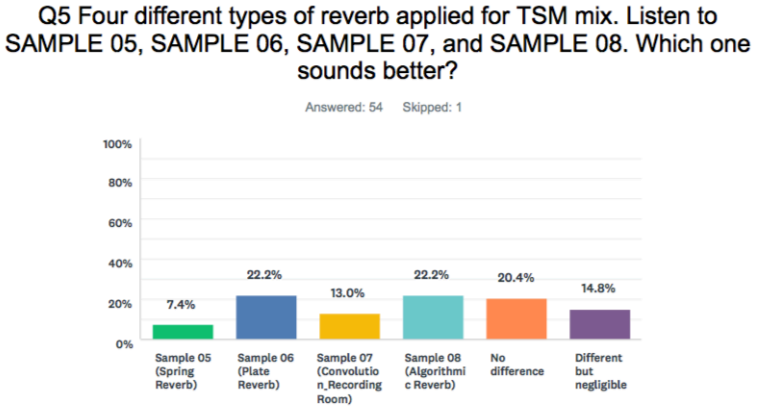
Figure 4.6: Non-musicians' results of question 4

4.2.2 Question 5

TSM tune is mixed down with different types of reverb for this question. Reverb time is 1.2 seconds for EMT 250, Space Designer and EMT 140. For the AKG BX20, reverb time is 2 seconds. Pre-delay time is around 40 milliseconds for each reverb.

Sample 05 is mixed down using spring reverb (AKG BX20). Sample 06 is mixed down using plate reverb (EMT 140). Sample 07 is mixed down using convolution reverb (Space Designer's Recording Room preset). Sample 08 is mixed down using algorithmic reverb (EMT 250).

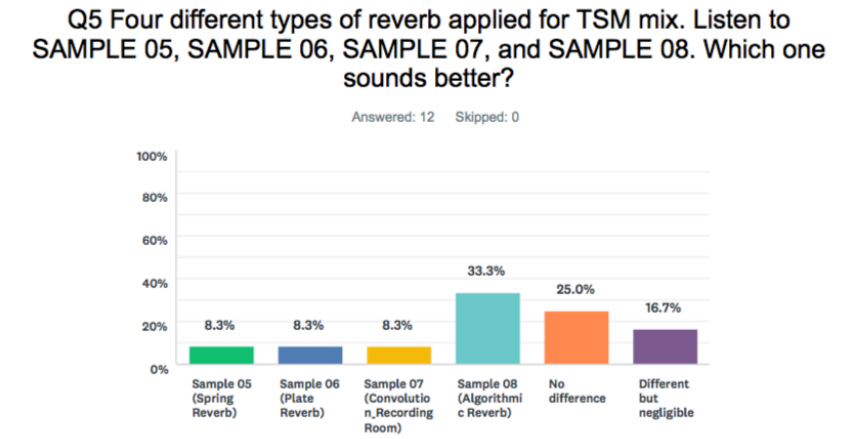
As seen in Figure 4.7, plate reverb and algorithmic reverb answers got 12 votes each. 11 participants answered as no difference, 8 participants answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 05 (Spring Reverb)	7.4%	4
Sample 06 (Plate Reverb)	22.2%	12
Sample 07 (Convolution_Recording Room)	13.0%	7
Sample 08 (Algorithmic Reverb)	22.2%	12
No difference	20.4%	11
Different but negligible	14.8%	8
TOTAL		54

Figure 4.7: General results of question 5

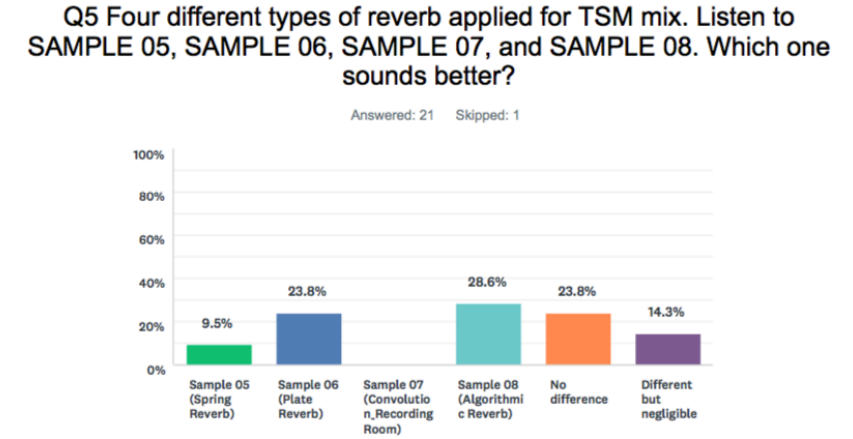
As seen in Figure 4.8, 4 out of 12 sound engineers preferred algorithmic reverb for this question. 3 sound engineers answered as no difference, 2 sound engineers answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 05 (Spring Reverb)	8.3%	1
Sample 06 (Plate Reverb)	8.3%	1
Sample 07 (Convolution_Recording Room)	8.3%	1
Sample 08 (Algorithmic Reverb)	33.3%	4
No difference	25.0%	3
Different but negligible	16.7%	2
TOTAL		12

Figure 4.8: Sound engineers' results of question 5

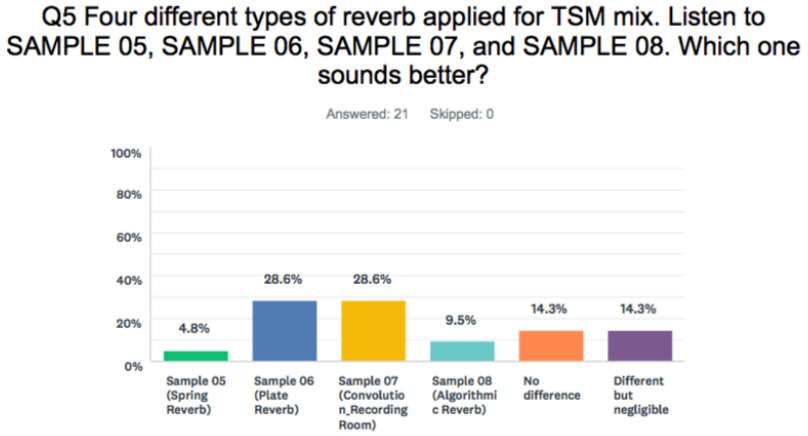
As seen in Figure 4.9, 6 out of 21 musicians preferred algorithmic reverb. Plate reverb and no difference answers got 5 votes each. None of the musicians preferred convolution reverb's recording room preset.



ANSWER CHOICES	RESPONSES	
Sample 05 (Spring Reverb)	9.5%	2
Sample 06 (Plate Reverb)	23.8%	5
Sample 07 (Convolution_Recording Room)	0.0%	0
Sample 08 (Algorithmic Reverb)	28.6%	6
No difference	23.8%	5
Different but negligible	14.3%	3
TOTAL		21

Figure 4.9: Musicians' results of question 5

As seen in Figure 4.10, plate reverb and convolution reverb answers got 6 votes each, from non-musicians.



ANSWER CHOICES	RESPONSES	
Sample 05 (Spring Reverb)	4.8%	1
Sample 06 (Plate Reverb)	28.6%	6
Sample 07 (Convolution_Recording Room)	28.6%	6
Sample 08 (Algorithmic Reverb)	9.5%	2
No difference	14.3%	3
Different but negligible	14.3%	3
TOTAL		21

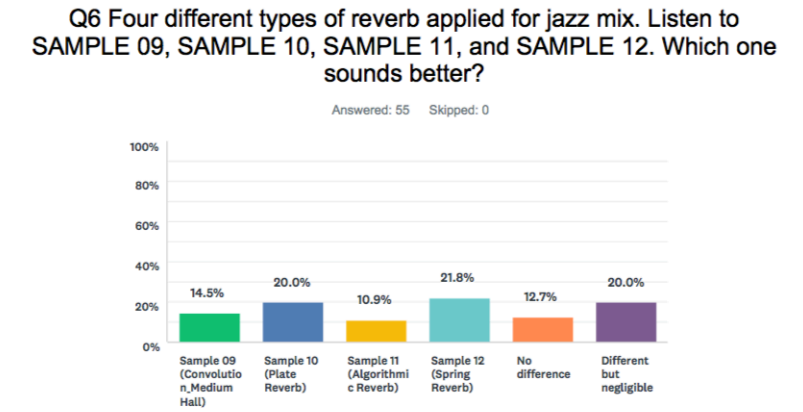
Figure 4.10: Non-musicians' results of question 5

4.2.3 Question 6

Jazz tune is mixed down with different types of reverb for this question. Reverb time is 1.2 seconds for EMT 250, Space Designer and EMT 140. Reverb time for AKG BX20 is 2 seconds. Pre-delay time is around 40 milliseconds.

Sample 09 is mixed down using convolution reverb (Space Designer's Medium Hall preset). Sample 10 is mixed down using plate reverb (EMT 140). Sample 11 is mixed down using algorithmic reverb (EMT 250). Sample 12 is mixed down using spring reverb (AKG BX20).

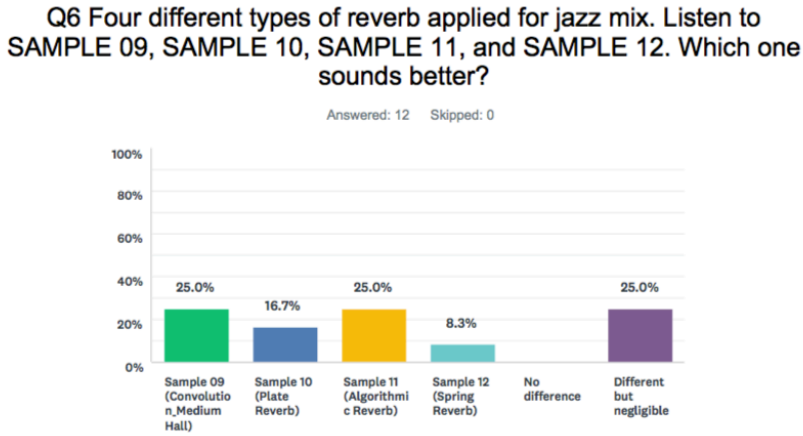
As seen in Figure 4.11, 12 out of 55 participants preferred spring reverb for jazz mix. Different but negligible and plate reverb answers got 11 votes each.



ANSWER CHOICES	RESPONSES	
Sample 09 (Convolution_Medium Hall)	14.5%	8
Sample 10 (Plate Reverb)	20.0%	11
Sample 11 (Algorithmic Reverb)	10.9%	6
Sample 12 (Spring Reverb)	21.8%	12
No difference	12.7%	7
Different but negligible	20.0%	11
TOTAL		55

Figure 4.11: General results of question 6

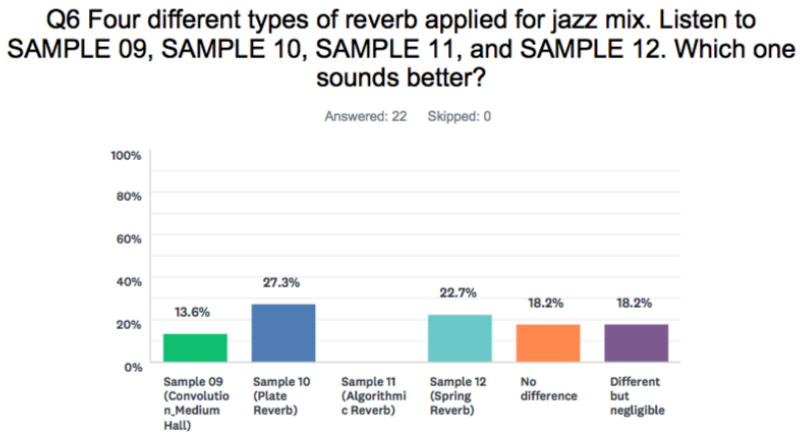
As seen in Figure 12, convolution reverb, algorithmic reverb and different but negligible answers got 3 votes each.



ANSWER CHOICES	RESPONSES	
Sample 09 (Convolution_Medium Hall)	25.0%	3
Sample 10 (Plate Reverb)	16.7%	2
Sample 11 (Algorithmic Reverb)	25.0%	3
Sample 12 (Spring Reverb)	8.3%	1
No difference	0.0%	0
Different but negligible	25.0%	3
TOTAL		12

Figure 4.12: Sound engineers' results of question 6

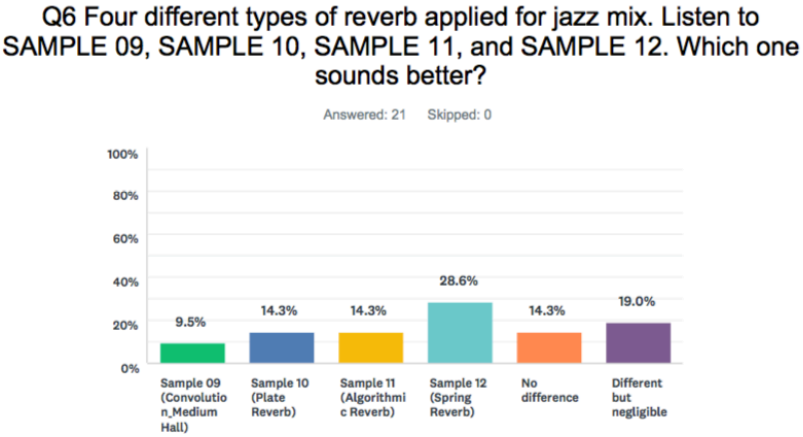
As seen in Figure 4.13, 6 out of 22 musicians preferred plate reverb, 5 musicians preferred spring reverb.



ANSWER CHOICES	RESPONSES	
Sample 09 (Convolution_Medium Hall)	13.6%	3
Sample 10 (Plate Reverb)	27.3%	6
Sample 11 (Algorithmic Reverb)	0.0%	0
Sample 12 (Spring Reverb)	22.7%	5
No difference	18.2%	4
Different but negligible	18.2%	4
TOTAL		22

Figure 4.13: Musicians' results of question 6

As seen in Figure 4.14, 6 out of 21 non-musicians preferred spring reverb for this question. 4 non-musicians answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 09 (Convolution_Medium Hall)	9.5%	2
Sample 10 (Plate Reverb)	14.3%	3
Sample 11 (Algorithmic Reverb)	14.3%	3
Sample 12 (Spring Reverb)	28.6%	6
No difference	14.3%	3
Different but negligible	19.0%	4
TOTAL		21

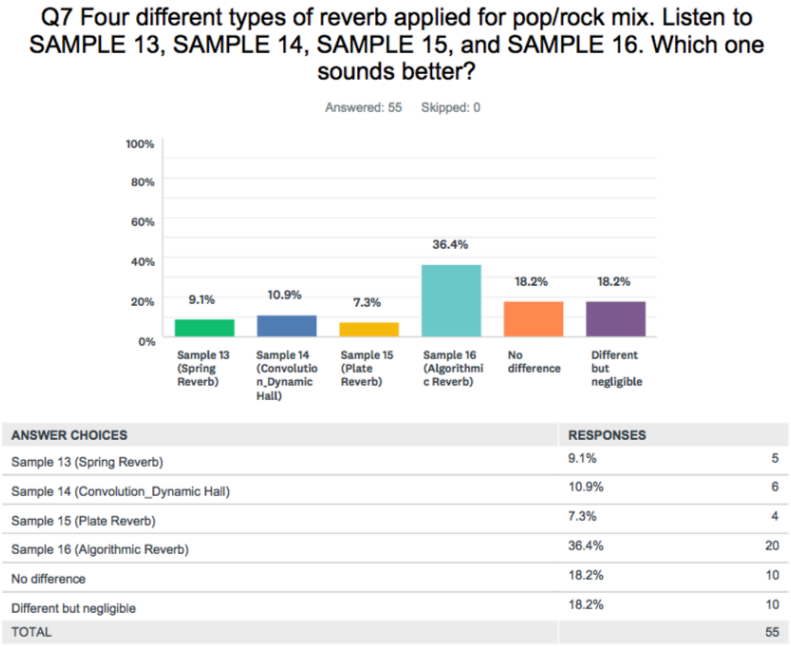
Figure 4.14: Non-musicians' results of question 6

4.2.4 Question 7

Pop/rock tune is mixed down with different types of reverb for this question. Reverb time is 1 second for EMT 250, Space Designer and EMT 140. Reverb time for AKG BX20 is 2 seconds. Pre-delay time is around 40 milliseconds.

Sample 13 is mixed down using spring reverb (AKG BX20). Sample 14 is mixed down using convolution reverb (Space Designer's Dynamic Hall preset). Sample 15 is mixed down using plate reverb (EMT 140). Sample 16 is mixed down using algorithmic reverb (EMT 250).

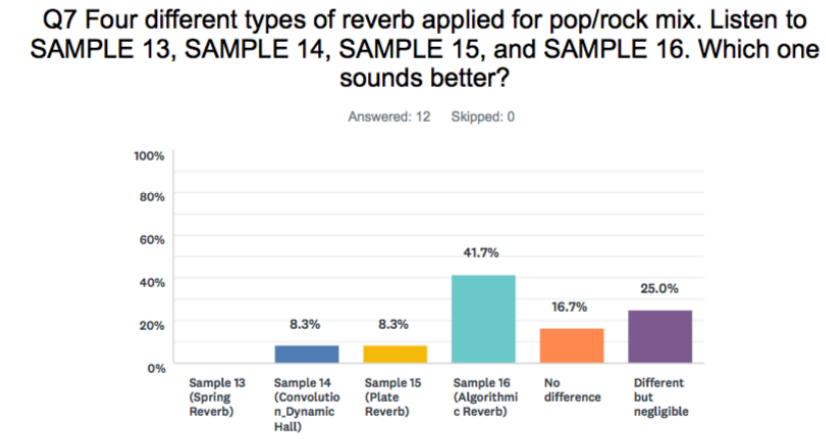
As seen in Figure 4.15, 20 out of 55 people preferred algorithmic reverb for pop/rock tune. No difference and different but negligible answers got 10 votes each.



ANSWER CHOICES	RESPONSES	
Sample 13 (Spring Reverb)	9.1%	5
Sample 14 (Convolution_Dynamic Hall)	10.9%	6
Sample 15 (Plate Reverb)	7.3%	4
Sample 16 (Algorithmic Reverb)	36.4%	20
No difference	18.2%	10
Different but negligible	18.2%	10
TOTAL		55

Figure 4.15: General results of question 7

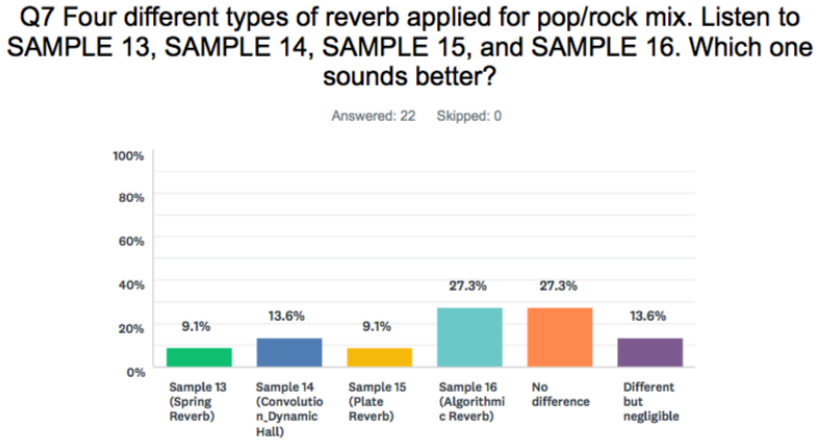
As seen in Figure 4.16, 5 out of 12 sound engineers preferred algorithmic reverb.



ANSWER CHOICES	RESPONSES	
Sample 13 (Spring Reverb)	0.0%	0
Sample 14 (Convolution_Dynamic Hall)	8.3%	1
Sample 15 (Plate Reverb)	8.3%	1
Sample 16 (Algorithmic Reverb)	41.7%	5
No difference	16.7%	2
Different but negligible	25.0%	3
TOTAL		12

Figure 4.16: Sound engineers' results for question 7

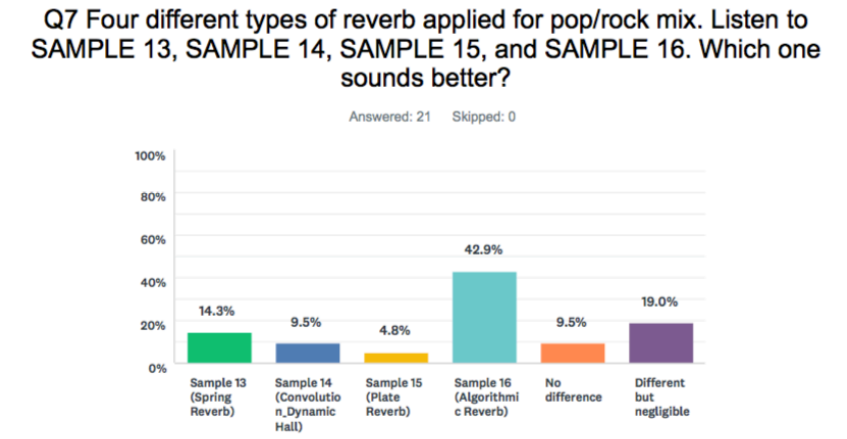
As seen in Figure 4.17, algorithmic reverb and no difference answers got 6 votes each from musicians.



ANSWER CHOICES	RESPONSES	
Sample 13 (Spring Reverb)	9.1%	2
Sample 14 (Convolution_Dynamic Hall)	13.6%	3
Sample 15 (Plate Reverb)	9.1%	2
Sample 16 (Algorithmic Reverb)	27.3%	6
No difference	27.3%	6
Different but negligible	13.6%	3
TOTAL		22

Figure 4.17: Musicians' results for question 7

As seen in Figure 4.18, 9 out of 21 non-musicians preferred algorithmic reverb for pop/rock tune.



ANSWER CHOICES	RESPONSES	
Sample 13 (Spring Reverb)	14.3%	3
Sample 14 (Convolution_Dynamic Hall)	9.5%	2
Sample 15 (Plate Reverb)	4.8%	1
Sample 16 (Algorithmic Reverb)	42.9%	9
No difference	9.5%	2
Different but negligible	19.0%	4
TOTAL		21

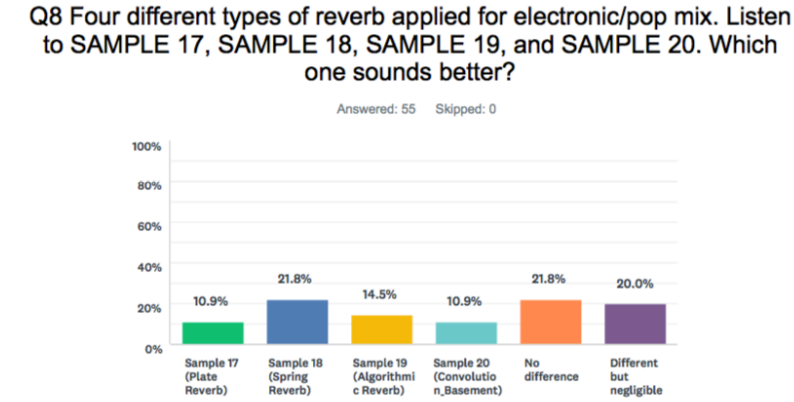
Figure 4.18: Non-musicians' results of question 7

4.2.5 Question 8

Electronic/pop tune is mixed down with different types of reverb for this question. Reverb time is 1.5 seconds for EMT 250, Space Designer and EMT 140. Reverb time for AKG BX20 is 2 seconds. Pre-delay time is around 40 milliseconds.

Sample 17 is mixed down using plate reverb (EMT 140). Sample 18 is mixed down using spring reverb (AKG BX20). Sample 19 is mixed down using algorithmic reverb (EMT 250). Sample 20 is mixed down using convolution reverb (Space Designer's Basement preset).

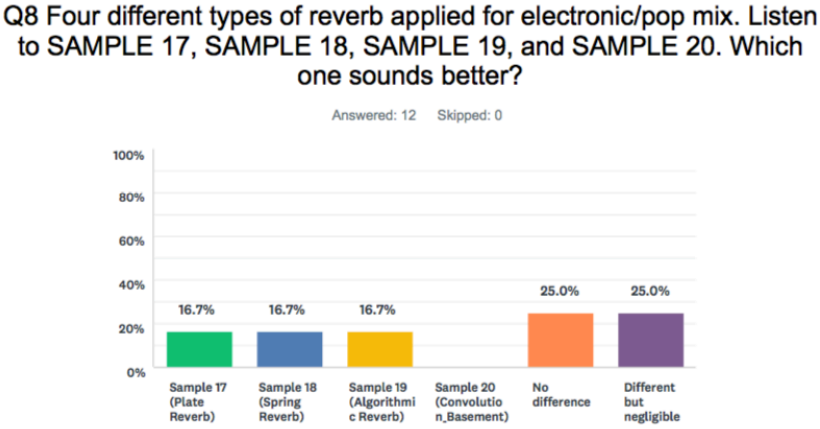
As seen in Figure 4.19, spring reverb and no difference answers got 12 votes each. 11 participants answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 17 (Plate Reverb)	10.9%	6
Sample 18 (Spring Reverb)	21.8%	12
Sample 19 (Algorithmic Reverb)	14.5%	8
Sample 20 (Convolution_Basement)	10.9%	6
No difference	21.8%	12
Different but negligible	20.0%	11
TOTAL		55

Figure 4.19: General results of question 8

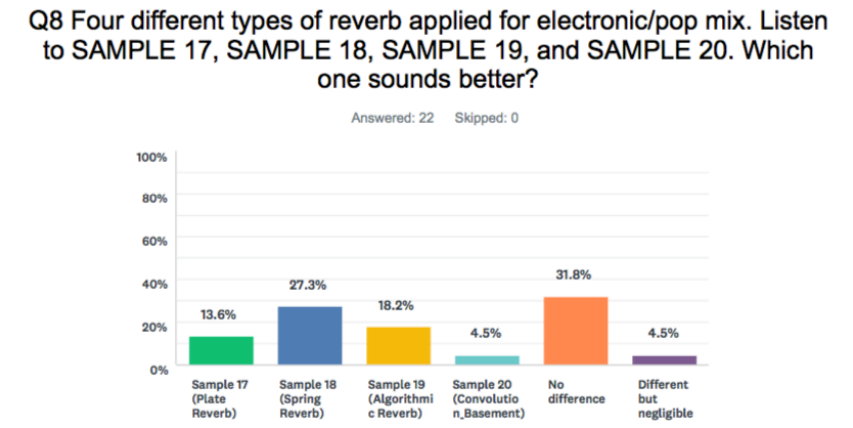
As seen in Figure 4.20, half of the sound engineers answered as no difference or different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 17 (Plate Reverb)	16.7%	2
Sample 18 (Spring Reverb)	16.7%	2
Sample 19 (Algorithmic Reverb)	16.7%	2
Sample 20 (Convolution_Basement)	0.0%	0
No difference	25.0%	3
Different but negligible	25.0%	3
TOTAL		12

Figure 4.20: Sound engineers' results of question 8

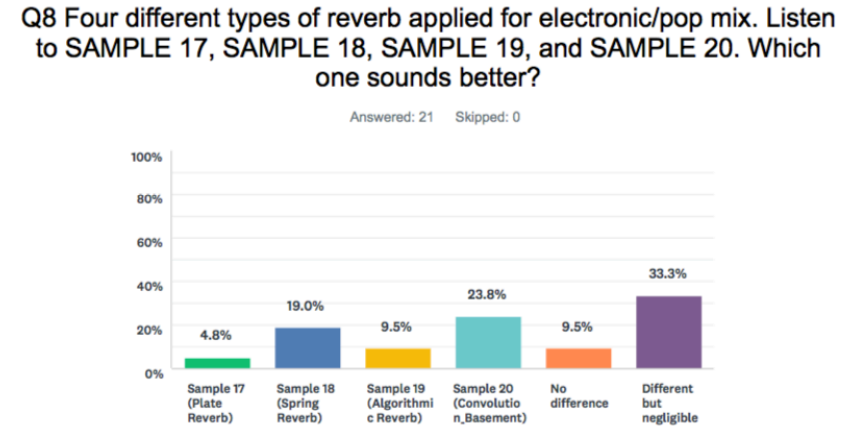
As seen in Figure 4.21, 7 out of 22 musicians answered no difference. 6 musicians preferred spring reverb.



ANSWER CHOICES	RESPONSES	
Sample 17 (Plate Reverb)	13.6%	3
Sample 18 (Spring Reverb)	27.3%	6
Sample 19 (Algorithmic Reverb)	18.2%	4
Sample 20 (Convolution_Basement)	4.5%	1
No difference	31.8%	7
Different but negligible	4.5%	1
TOTAL		22

Figure 4.21: Musicians' results of question 8

As seen in Figure 4.22, 7 out of 21 non-musicians answered as different but negligible. 5 non-musicians preferred convolution reverb's basement preset.



ANSWER CHOICES	RESPONSES	
Sample 17 (Plate Reverb)	4.8%	1
Sample 18 (Spring Reverb)	19.0%	4
Sample 19 (Algorithmic Reverb)	9.5%	2
Sample 20 (Convolution_Basement)	23.8%	5
No difference	9.5%	2
Different but negligible	33.3%	7
TOTAL		21

Figure 4.22: Non-musicians' results of question 8

Second topic of the survey consists of question 9, 10, 11, 12 and 13. Algorithmic reverb (EMT 250) is used for this topic. The reverb times for each song are the same

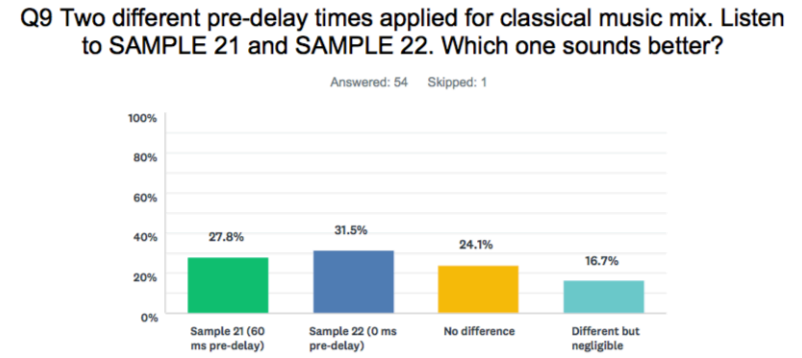
as in the first topic. The only difference is the pre-delay time. The participants are asked to choose between two options. One is 60 milliseconds and the other is 0 milliseconds of pre-delay.

4.2.6 Question 9

Classical music tune is mixed down with two different pre-delay times of algorithmic reverb.

Sample 21 is mixed down with 60 ms pre-delay time and sample 22 is mixed down with 0 ms pre-delay time.

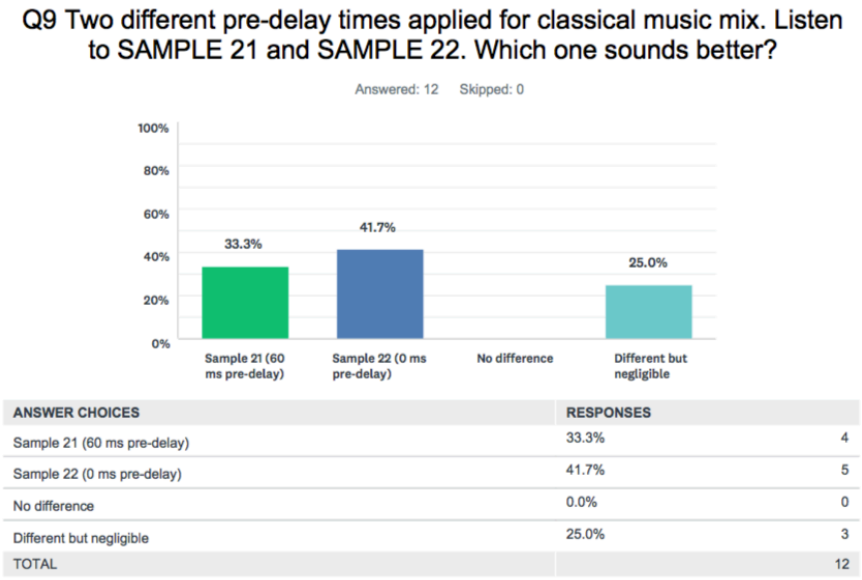
As seen in Figure 4.23, 17 out of 54 participants preferred 0 ms pre-delay. 15 participants preferred 60 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 21 (60 ms pre-delay)	27.8%	15
Sample 22 (0 ms pre-delay)	31.5%	17
No difference	24.1%	13
Different but negligible	16.7%	9
TOTAL		54

Figure 4.23: General results of question 9

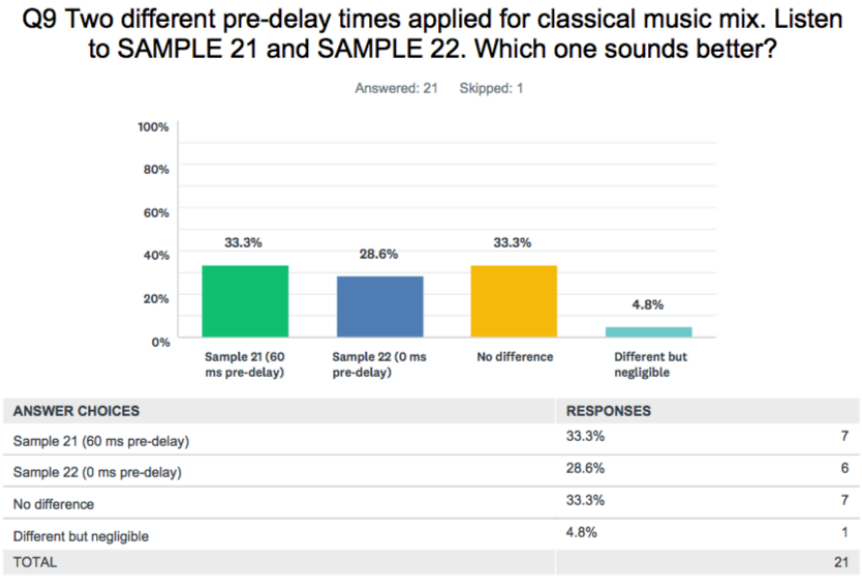
As seen in Figure 4.24, 5 out of 12 sound engineers preferred 0 ms pre-delay. 4 sound engineers preferred 60 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 21 (60 ms pre-delay)	33.3%	4
Sample 22 (0 ms pre-delay)	41.7%	5
No difference	0.0%	0
Different but negligible	25.0%	3
TOTAL		12

Figure 4.24: Sound engineers' results of question 9

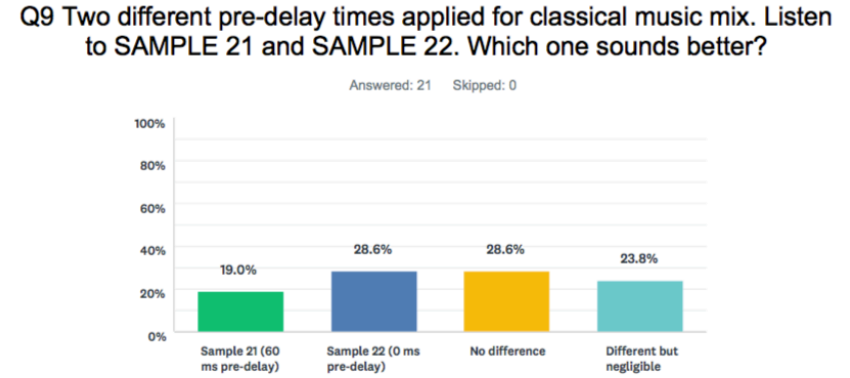
As seen in Figure 4.25, no difference and 60 ms pre-delay answers got 7 votes each. 6 musicians preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 21 (60 ms pre-delay)	33.3%	7
Sample 22 (0 ms pre-delay)	28.6%	6
No difference	33.3%	7
Different but negligible	4.8%	1
TOTAL		21

Figure 4.25: Musicians' results of question 9

As seen in Figure 4.26, no difference and 0 ms pre-delay answers got 6 votes each. 5 non-musicians answered as different but negligible.



ANSWER CHOICES	RESPONSES	
Sample 21 (60 ms pre-delay)	19.0%	4
Sample 22 (0 ms pre-delay)	28.6%	6
No difference	28.6%	6
Different but negligible	23.8%	5
TOTAL		21

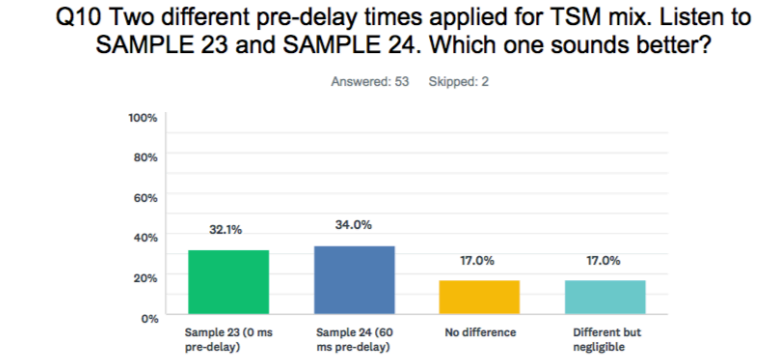
Figure 4.26: Non-musicians' results of question 9

4.2.7 Question 10

TSM tune is mixed down with two different pre-delay times of algorithmic reverb.

Sample 23 is mixed down with 0 ms pre-delay time and sample 24 is mixed down with 60 ms pre-delay time.

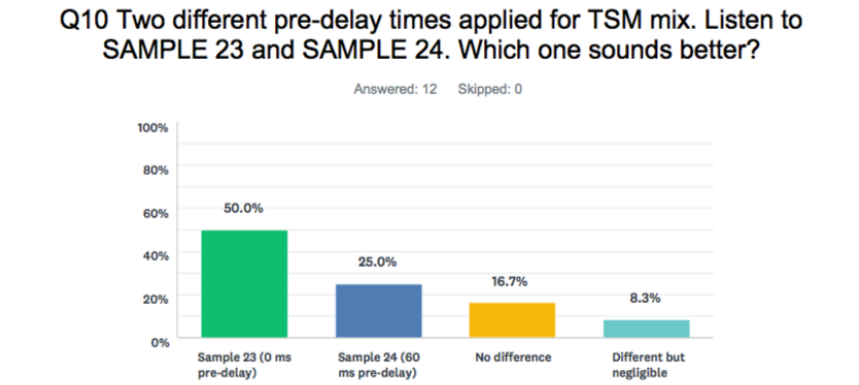
As seen in Figure 4.27, 18 out of 53 participants preferred 60 ms pre-delay. 17 participants preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 23 (0 ms pre-delay)	32.1%	17
Sample 24 (60 ms pre-delay)	34.0%	18
No difference	17.0%	9
Different but negligible	17.0%	9
TOTAL		53

Figure 4.27: General results of question 10

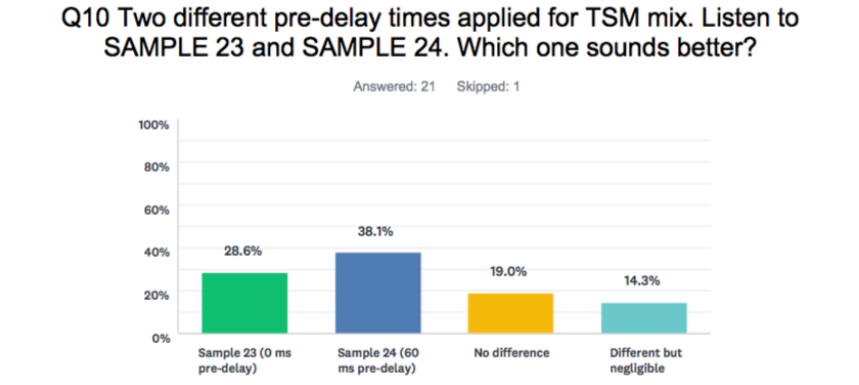
As seen in Figure 4.28, 6 out of 12 sound engineers preferred 0 ms pre-delay for TSM mix. 3 sound engineers preferred 60 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 23 (0 ms pre-delay)	50.0%	6
Sample 24 (60 ms pre-delay)	25.0%	3
No difference	16.7%	2
Different but negligible	8.3%	1
TOTAL		12

Figure 4.28: Sound engineers' results of question 10

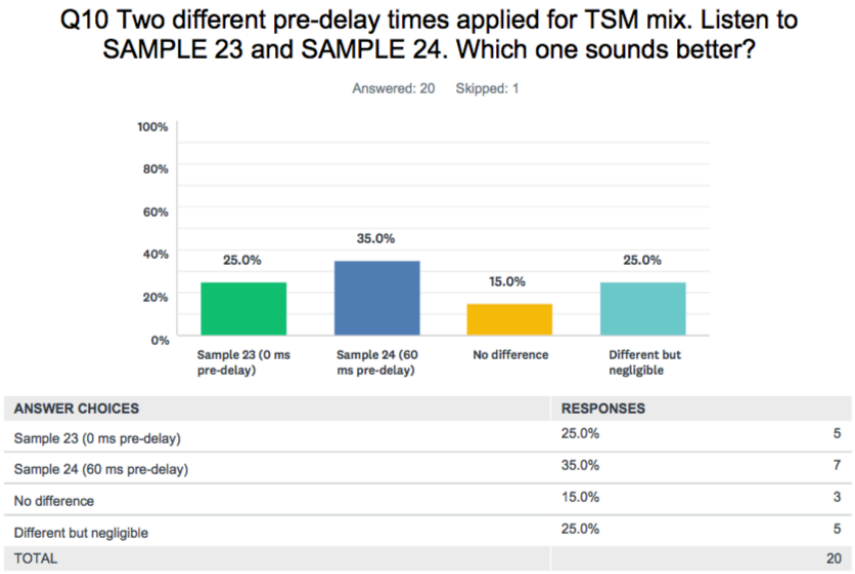
As seen in Figure 4.29, 8 out of 21 musicians preferred 60 ms pre-delay. 6 musicians preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 23 (0 ms pre-delay)	28.6%	6
Sample 24 (60 ms pre-delay)	38.1%	8
No difference	19.0%	4
Different but negligible	14.3%	3
TOTAL		21

Figure 4.29: Musicians' results of question 10

As seen in Figure 4.30, 7 non-musicians preferred 60 ms pre-delay. 5 non-musicians preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 23 (0 ms pre-delay)	25.0%	5
Sample 24 (60 ms pre-delay)	35.0%	7
No difference	15.0%	3
Different but negligible	25.0%	5
TOTAL		20

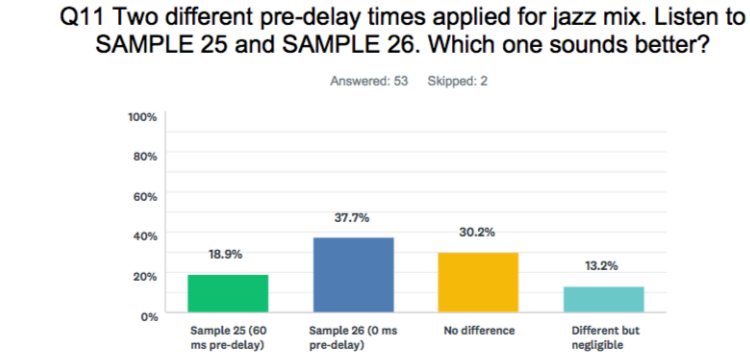
Figure 4.30: Non-musicians' results of question 10

4.2.8 Question 11

Jazz tune is mixed down with two different pre-delay times of algorithmic reverb.

Sample 25 is mixed down with 60 ms pre-delay time and sample 26 is mixed down with 0 ms pre-delay time.

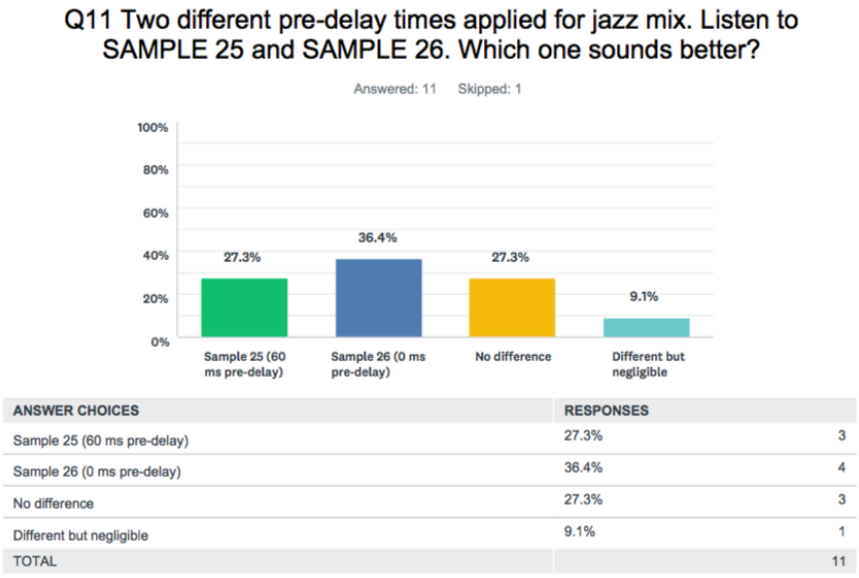
As seen in Figure 4.31, 20 participants preferred 0 ms pre-delay, 16 participants answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 25 (60 ms pre-delay)	18.9%	10
Sample 26 (0 ms pre-delay)	37.7%	20
No difference	30.2%	16
Different but negligible	13.2%	7
TOTAL		53

Figure 4.31: General results of question 11

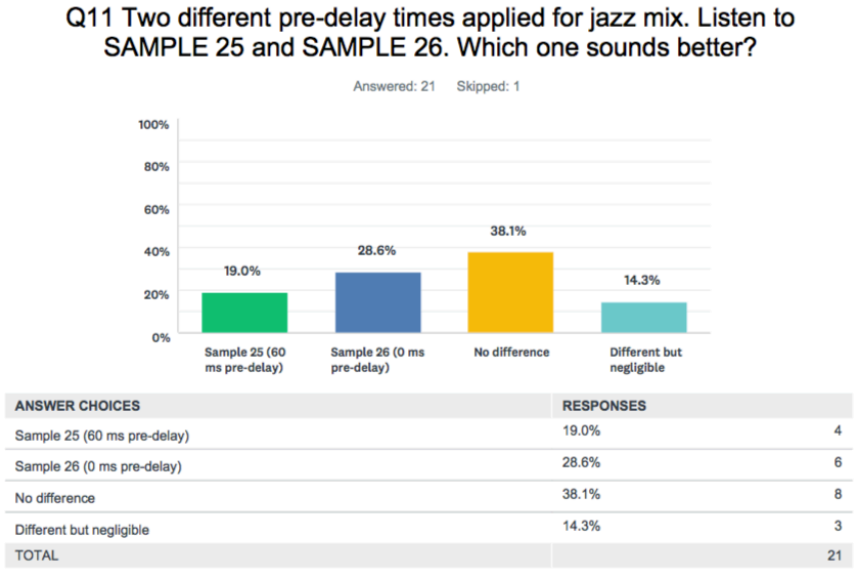
As seen in Figure 4.32, 4 sound engineers preferred 0 ms pre-delay. 60 ms pre-delay and no difference answers got 3 votes each.



ANSWER CHOICES	RESPONSES	
Sample 25 (60 ms pre-delay)	27.3%	3
Sample 26 (0 ms pre-delay)	36.4%	4
No difference	27.3%	3
Different but negligible	9.1%	1
TOTAL		11

Figure 4.32: Sound engineers' results of question 11

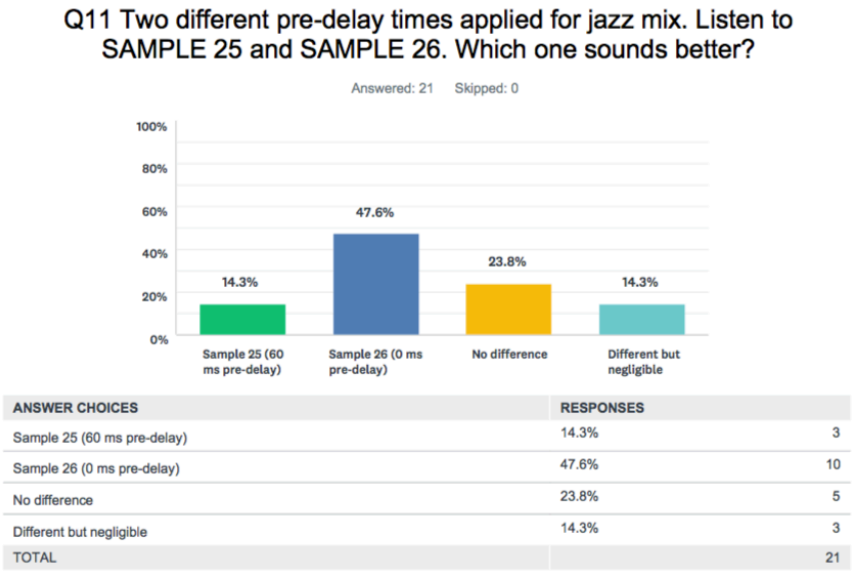
As seen in Figure 4.33, 8 musicians answered as no difference. 6 musicians preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 25 (60 ms pre-delay)	19.0%	4
Sample 26 (0 ms pre-delay)	28.6%	6
No difference	38.1%	8
Different but negligible	14.3%	3
TOTAL		21

Figure 4.33: Musicians' results of question 11

As seen in Figure 3.34, 10 out of 21 non-musicians preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 25 (60 ms pre-delay)	14.3%	3
Sample 26 (0 ms pre-delay)	47.6%	10
No difference	23.8%	5
Different but negligible	14.3%	3
TOTAL		21

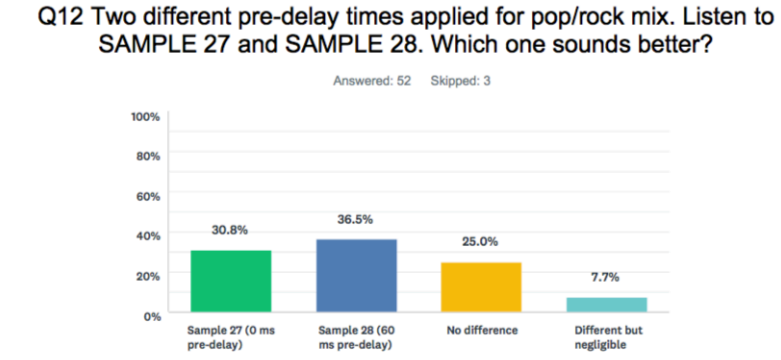
Figure 4.34: Non-musicians' results of question 11

4.2.9 Question 12

Pop/rock tune is mixed down with two different pre-delay times of algorithmic reverb.

Sample 27 is mixed down with 0 ms pre-delay time and sample 28 is mixed down with 60 ms pre-delay time.

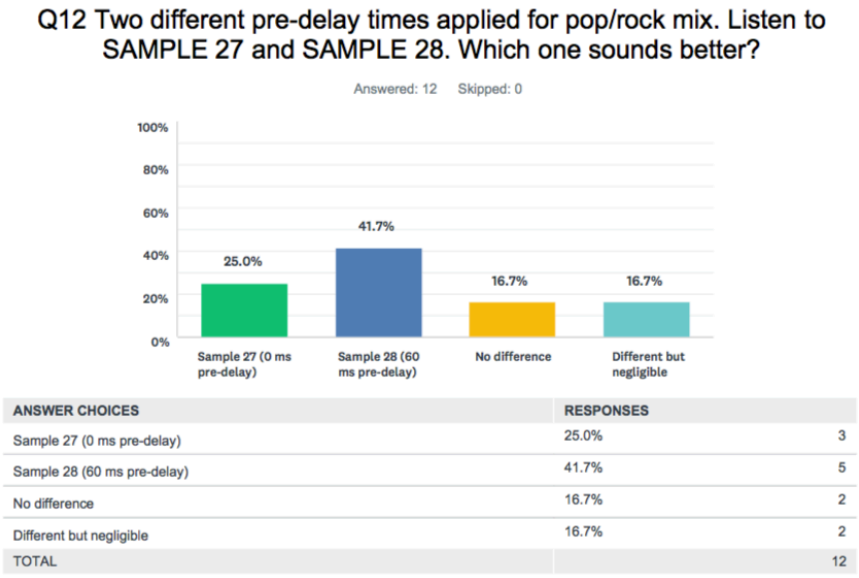
As seen in Figure 4.35, 19 out of 52 participants preferred 60 ms pre-delay. 16 participants preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 27 (0 ms pre-delay)	30.8%	16
Sample 28 (60 ms pre-delay)	36.5%	19
No difference	25.0%	13
Different but negligible	7.7%	4
TOTAL		52

Figure 4.35: General results of question 12

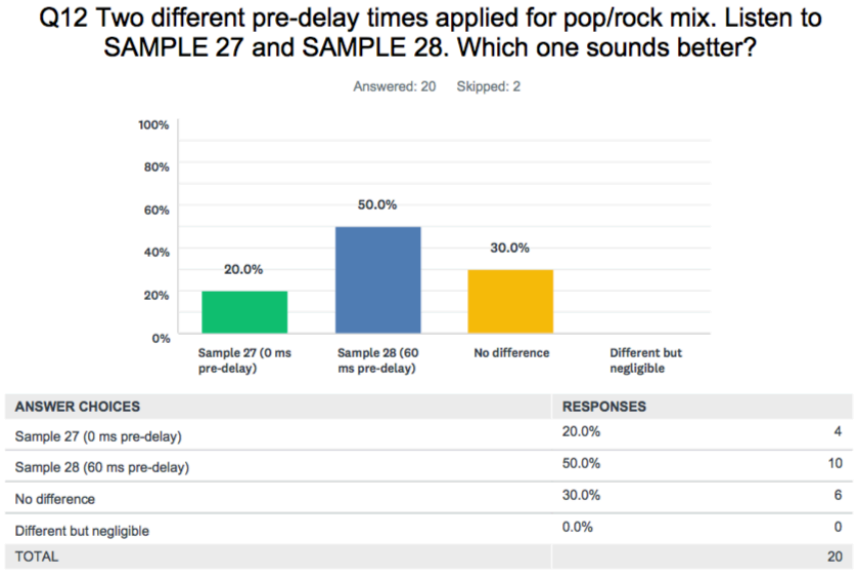
As seen in figure 4.36, 5 sound engineers preferred 60 ms pre-delay, 3 sound engineers preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 27 (0 ms pre-delay)	25.0%	3
Sample 28 (60 ms pre-delay)	41.7%	5
No difference	16.7%	2
Different but negligible	16.7%	2
TOTAL		12

Figure 4.36: Sound engineers' results of question 12

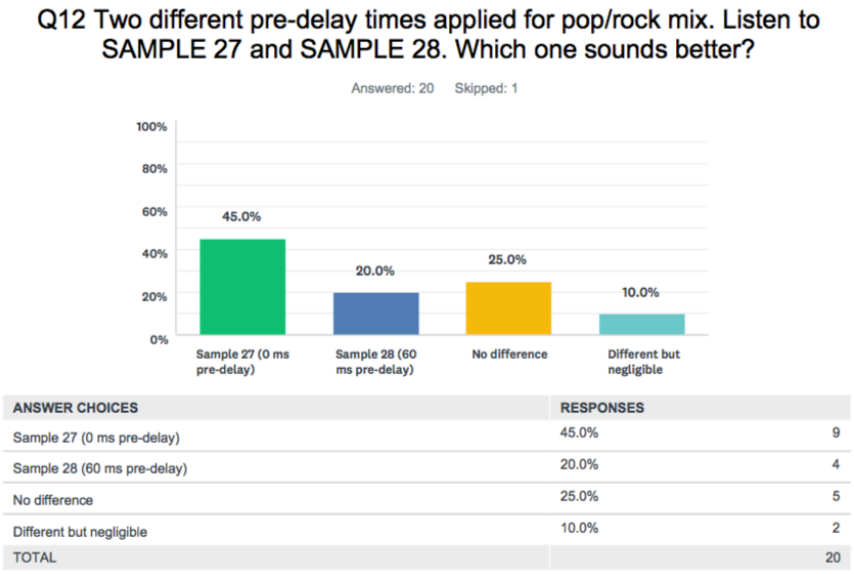
As seen in Figure 4.37, half of the musicians preferred 60 ms pre-delay. 6 musicians answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 27 (0 ms pre-delay)	20.0%	4
Sample 28 (60 ms pre-delay)	50.0%	10
No difference	30.0%	6
Different but negligible	0.0%	0
TOTAL		20

Figure 4.37: Musicians' results of question 12

As seen in Figure 4.38, 9 out of 20 non-musicians preferred 0 ms pre-delay. 5 non-musicians answered as no difference. 4 non-musicians preferred 60 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 27 (0 ms pre-delay)	45.0%	9
Sample 28 (60 ms pre-delay)	20.0%	4
No difference	25.0%	5
Different but negligible	10.0%	2
TOTAL		20

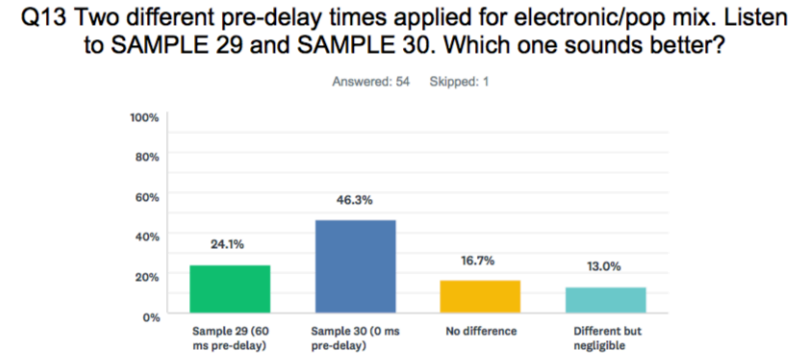
Figure 4.38: Non-musicians' results of question 12

4.2.10 Question 13

Electronic/pop tune is mixed down with two different pre-delay times of algorithmic reverb.

Sample 29 is mixed down with 60 ms pre-delay time and sample 30 is mixed down with 0 ms pre-delay time.

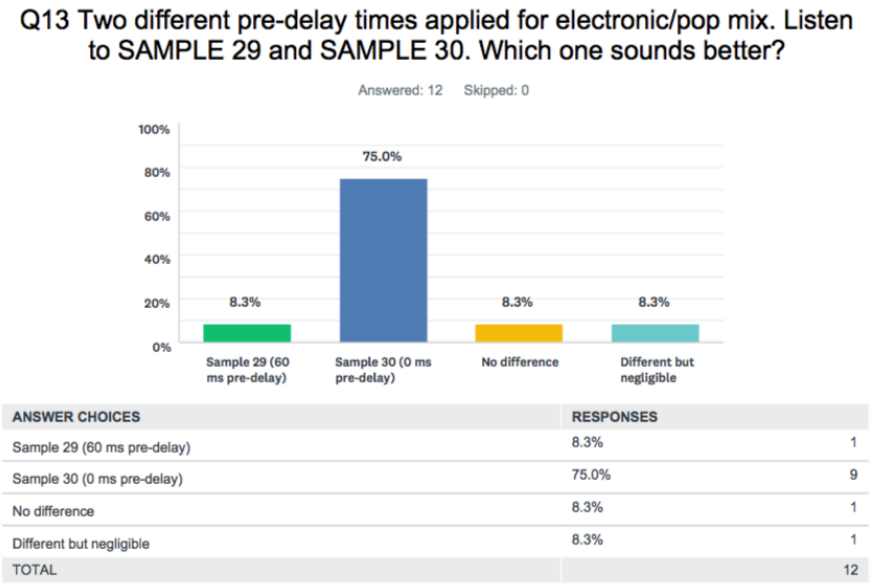
As seen in Figure 4.39, 25 out of 54 participants preferred 0 ms pre-delay time.



ANSWER CHOICES	RESPONSES	
Sample 29 (60 ms pre-delay)	24.1%	13
Sample 30 (0 ms pre-delay)	46.3%	25
No difference	16.7%	9
Different but negligible	13.0%	7
TOTAL		54

Figure 4.39: General results of question 13

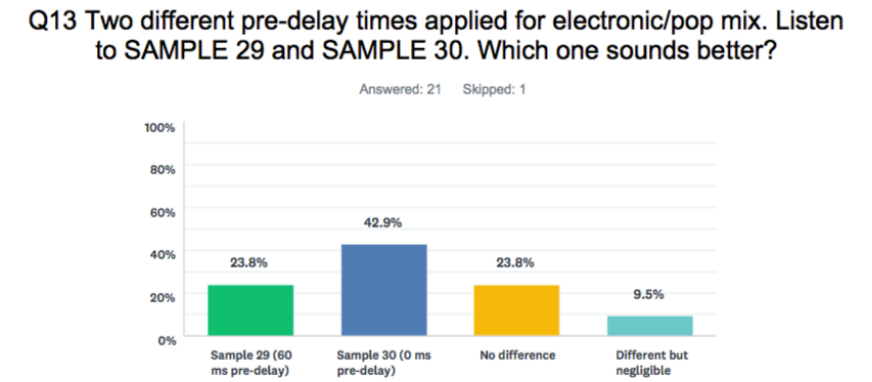
As seen in Figure 4.40, 9 out of 12 sound engineers preferred 0 ms pre-delay.



ANSWER CHOICES	RESPONSES	
Sample 29 (60 ms pre-delay)	8.3%	1
Sample 30 (0 ms pre-delay)	75.0%	9
No difference	8.3%	1
Different but negligible	8.3%	1
TOTAL		12

Figure 4.40: Sound engineers' results of question 13

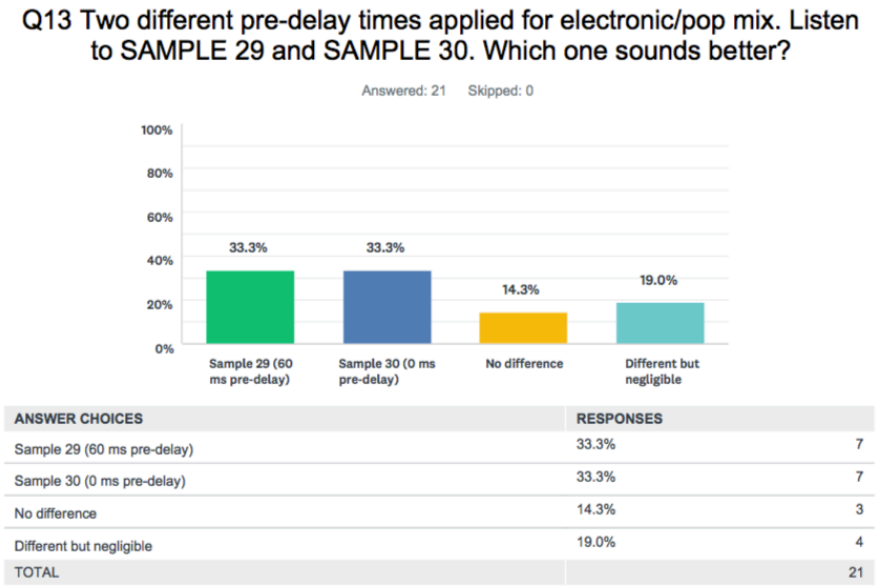
As seen in Figure 4.41, 9 out of 21 musicians preferred 0 ms pre-delay time. 60 ms pre-delay time and no difference answers got 5 votes each.



ANSWER CHOICES	RESPONSES	
Sample 29 (60 ms pre-delay)	23.8%	5
Sample 30 (0 ms pre-delay)	42.9%	9
No difference	23.8%	5
Different but negligible	9.5%	2
TOTAL		21

Figure 4.41: Musicians' results of question 13

As seen in Figure 4.42, 60 ms pre-delay and 0 ms pre-delay answers got 7 votes each from non-musicians.



ANSWER CHOICES	RESPONSES	
Sample 29 (60 ms pre-delay)	33.3%	7
Sample 30 (0 ms pre-delay)	33.3%	7
No difference	14.3%	3
Different but negligible	19.0%	4
TOTAL		21

Figure 4.42: Non-musicians' results of question 13

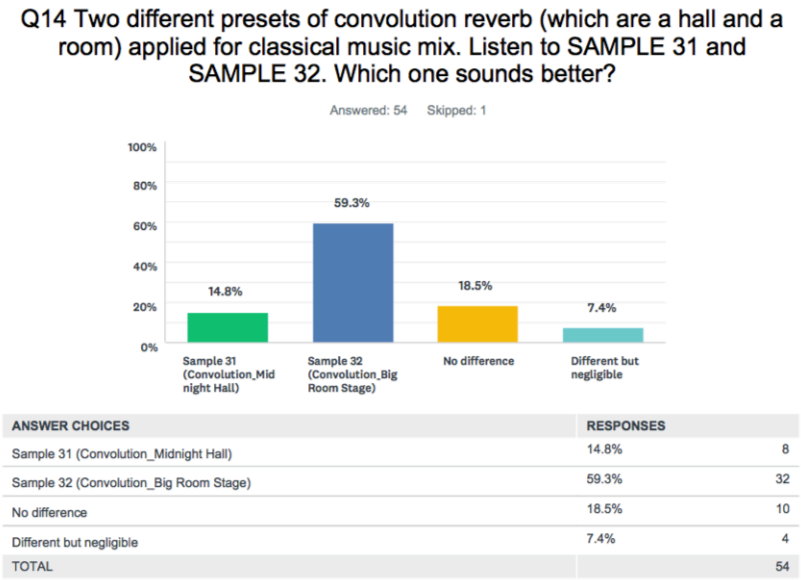
Third topic of the survey consists of question 14, 15, 16 and 17. Convolution reverb (Space Designer) is used for this topic. The songs are mixed down with the same reverb times as in the first topic. One preset is chosen among halls and another is chosen among rooms. Participants are asked to choose between two options. For this topic, electronic/pop tune is excluded.

4.2.11 Question 14

Classic music tune is mixed down with two presets of convolution reverb, which are a hall and a room.

Sample 31 is mixed down using hall preset (Midnight Hall) and sample 32 is mixed down using room preset (Big Room Stage) of Space Designer.

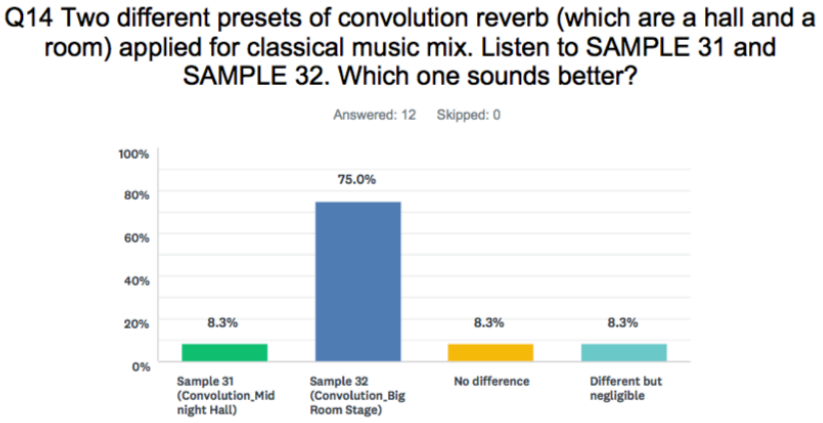
As seen in Figure 4.43, 32 out of 54 participants preferred room reverb. 10 participants answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 31 (Convolution_Midnight Hall)	14.8%	8
Sample 32 (Convolution_Big Room Stage)	59.3%	32
No difference	18.5%	10
Different but negligible	7.4%	4
TOTAL		54

Figure 4.43: General results of question 14

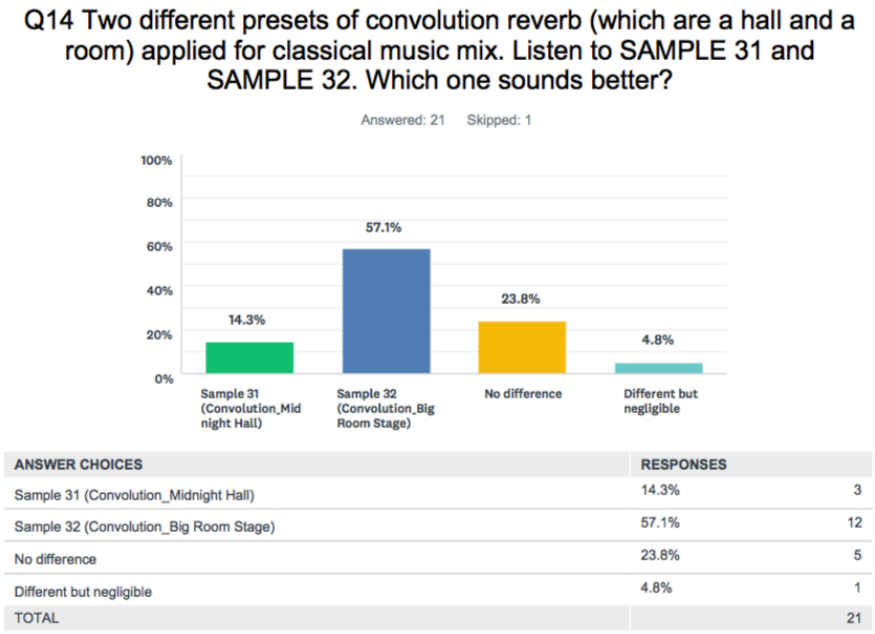
As seen in Figure 4.44, 9 out of 12 sound engineers preferred room reverb.



ANSWER CHOICES	RESPONSES	
Sample 31 (Convolution_Midnight Hall)	8.3%	1
Sample 32 (Convolution_Big Room Stage)	75.0%	9
No difference	8.3%	1
Different but negligible	8.3%	1
TOTAL		12

Figure 4.44: Sound engineers' results of question 14

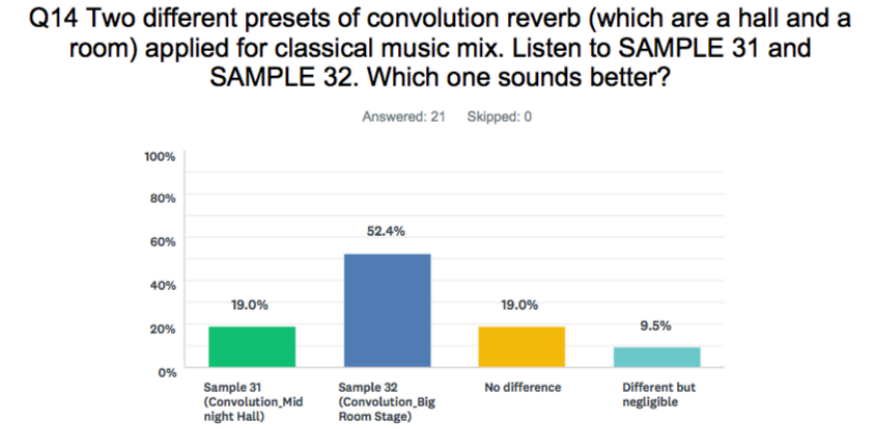
As seen in Figure 4.45, 12 out of 21 musicians preferred room reverb.



ANSWER CHOICES	RESPONSES	
Sample 31 (Convolution_Midnight Hall)	14.3%	3
Sample 32 (Convolution_Big Room Stage)	57.1%	12
No difference	23.8%	5
Different but negligible	4.8%	1
TOTAL		21

Figure 4.45: Musicians' results of question 14

As seen in Figure 4.46, 11 out of 21 non-musicians preferred room reverb.



ANSWER CHOICES	RESPONSES	
Sample 31 (Convolution_Midnight Hall)	19.0%	4
Sample 32 (Convolution_Big Room Stage)	52.4%	11
No difference	19.0%	4
Different but negligible	9.5%	2
TOTAL		21

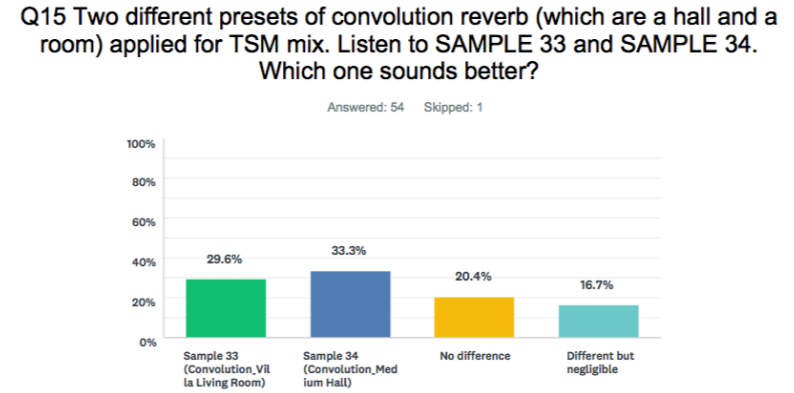
Figure 4.46: Non-musicians' results of question 14

4.2.12 Question 15

TSM tune is mix down with two different presets of convolution reverb, which are a hall and a room.

Sample 33 is mixed down using room preset (Villa Living Room) and sample 34 is mixed down using hall preset (Medium Hall) of Space Designer.

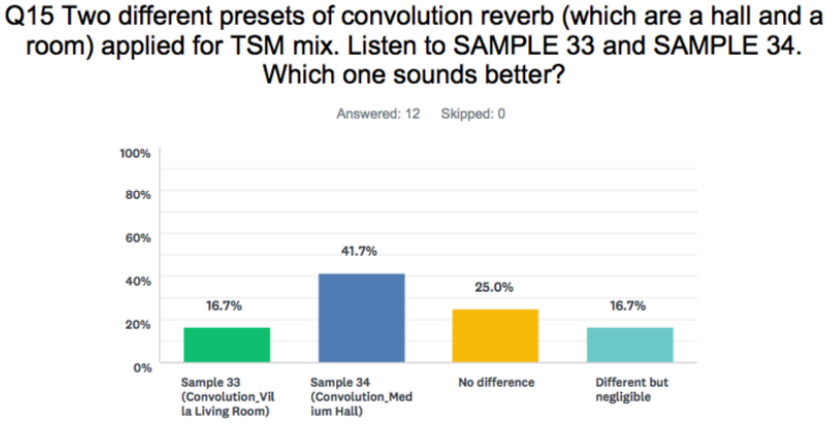
As seen in Figure 4.47, 18 participants preferred hall reverb, 16 participants preferred room reverb.



ANSWER CHOICES	RESPONSES	
Sample 33 (Convolution_Villa Living Room)	29.6%	16
Sample 34 (Convolution_Medium Hall)	33.3%	18
No difference	20.4%	11
Different but negligible	16.7%	9
TOTAL		54

Figure 4.47: General results of question 15

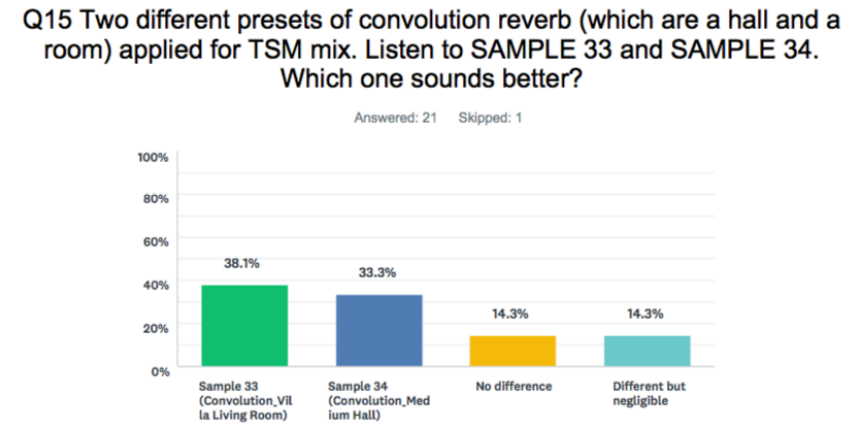
As seen in Figure 4.48, 5 out of 12 sound engineers preferred hall reverb. 3 sound engineers answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 33 (Convolution_Villa Living Room)	16.7%	2
Sample 34 (Convolution_Medium Hall)	41.7%	5
No difference	25.0%	3
Different but negligible	16.7%	2
TOTAL		12

Figure 4.48: Sound engineers' results of question 15

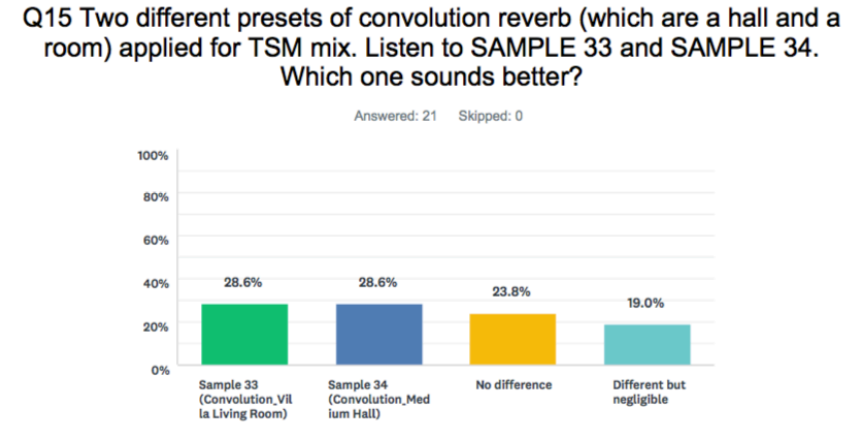
As seen in Figure 4.49, 8 musicians preferred room reverb, 7 musicians preferred hall reverb.



ANSWER CHOICES	RESPONSES	
Sample 33 (Convolution_Villa Living Room)	38.1%	8
Sample 34 (Convolution_Medium Hall)	33.3%	7
No difference	14.3%	3
Different but negligible	14.3%	3
TOTAL		21

Figure 4.49: Musicians' results of question 15

As seen in Figure 4.50, room reverb and hall reverb answers got 6 votes each. 5 non-musicians answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 33 (Convolution_Villa Living Room)	28.6%	6
Sample 34 (Convolution_Medium Hall)	28.6%	6
No difference	23.8%	5
Different but negligible	19.0%	4
TOTAL		21

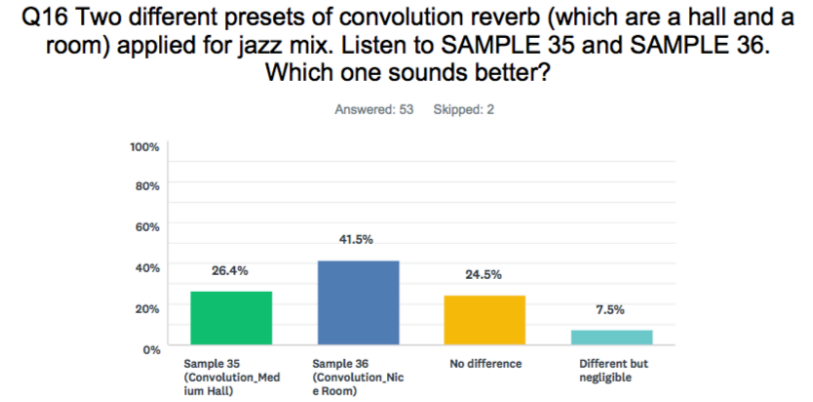
Figure 4.50: Non-musicians' results of question 15

4.2.13 Question 16

Jazz tune is mixed down with two different presets of convolution reverb, which are a hall and a room.

Sample 35 is mixed down using hall preset (Medium Hall) and sample 36 is mixed down using room preset (Nice Room) of Space Designer.

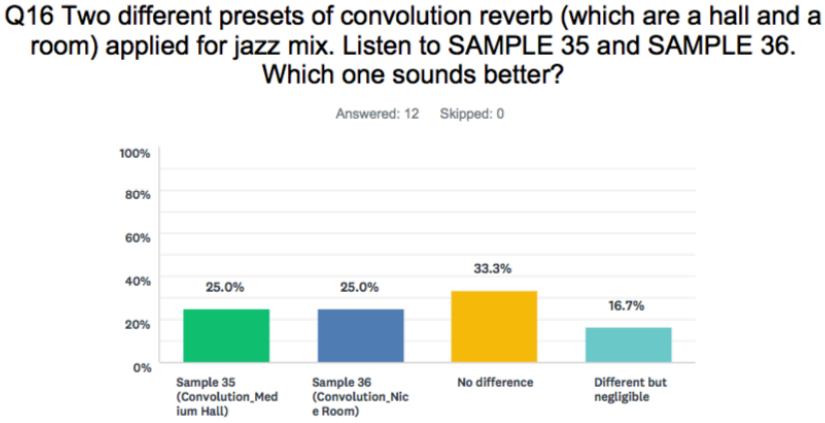
As seen in Figure 4.51, 22 out of 53 participants preferred room reverb. 14 participants preferred hall reverb, and 13 participants answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 35 (Convolution_Medium Hall)	26.4%	14
Sample 36 (Convolution_Nice Room)	41.5%	22
No difference	24.5%	13
Different but negligible	7.5%	4
TOTAL		53

Figure 4.51: General results of question 16

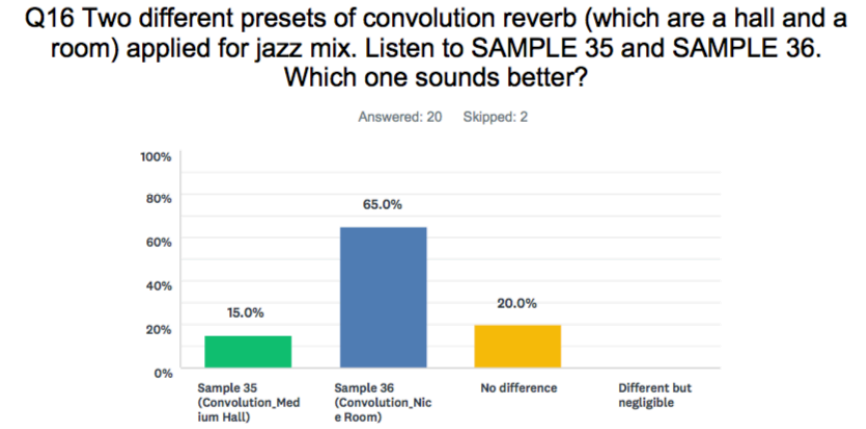
As seen in Figure 4.52, 4 sound engineers answered as no difference. Hall reverb and room reverb answers got 3 votes each.



ANSWER CHOICES	RESPONSES	
Sample 35 (Convolution_Medium Hall)	25.0%	3
Sample 36 (Convolution_Nice Room)	25.0%	3
No difference	33.3%	4
Different but negligible	16.7%	2
TOTAL		12

Figure 4.52: Sound engineers' results of question 16

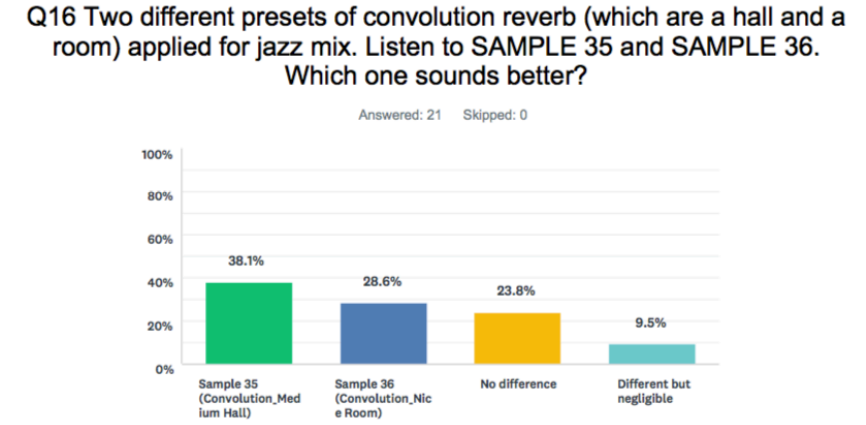
As seen in Figure 4.53, 13 out of 20 musicians preferred room reverb for jazz tune.



ANSWER CHOICES	RESPONSES	
Sample 35 (Convolution_Medium Hall)	15.0%	3
Sample 36 (Convolution_Nice Room)	65.0%	13
No difference	20.0%	4
Different but negligible	0.0%	0
TOTAL		20

Figure 4.53: Musicians' results of question16

As seen in Figure 4.54, 8 out of 21 non-musicians preferred hall reverb, 6 non-musicians preferred room reverb.



ANSWER CHOICES	RESPONSES	
Sample 35 (Convolution_Medium Hall)	38.1%	8
Sample 36 (Convolution_Nice Room)	28.6%	6
No difference	23.8%	5
Different but negligible	9.5%	2
TOTAL		21

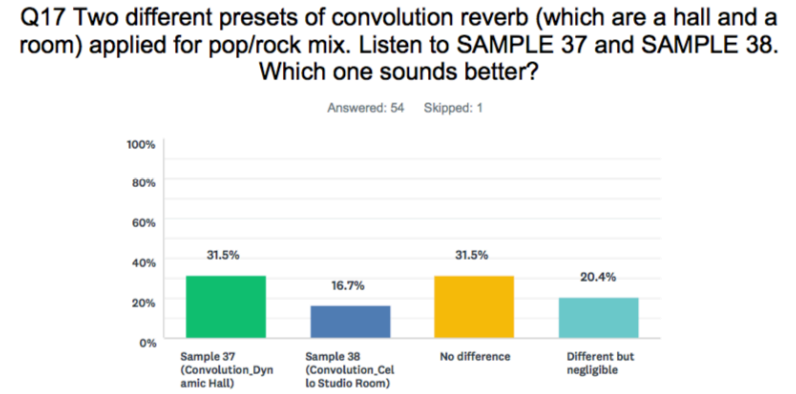
Figure 4.54: Non-musicians' results of question 16

4.2.14 Question 17

Pop/rock tune is mixed down with two different presets of convolution reverb, which are a hall and a room.

Sample 37 is mixed down using hall preset (Dynamic Hall) and sample 38 is mixed down using room preset (Cello Studio Room) of Space Designer.

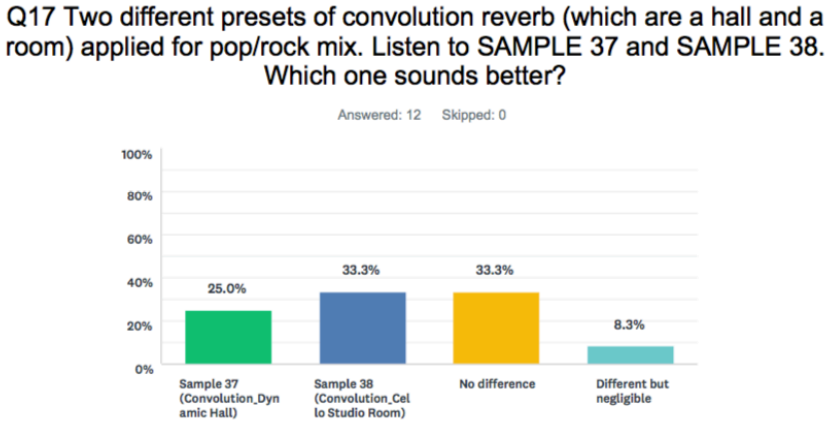
As seen in Figure 4.55, 17 participants answered as no difference, 17 participants preferred hall reverb for pop/rock tune.



ANSWER CHOICES	RESPONSES	
Sample 37 (Convolution_Dynamic Hall)	31.5%	17
Sample 38 (Convolution_Cello Studio Room)	16.7%	9
No difference	31.5%	17
Different but negligible	20.4%	11
TOTAL		54

Figure 4.55: General results of question 17

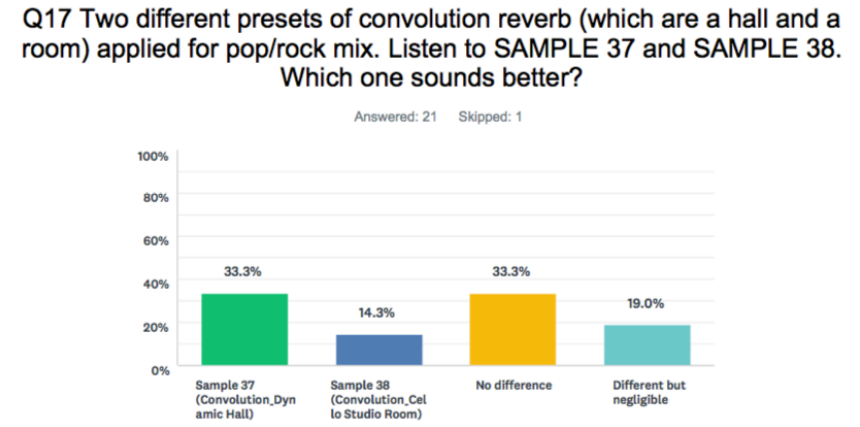
As seen in Figure 4.56, no difference and room reverb answers got 4 votes each. 3 sound engineers preferred hall reverb.



ANSWER CHOICES	RESPONSES	
Sample 37 (Convolution_Dynamic Hall)	25.0%	3
Sample 38 (Convolution_Cello Studio Room)	33.3%	4
No difference	33.3%	4
Different but negligible	8.3%	1
TOTAL		12

Figure 4.56: Sound engineers' results of question 17

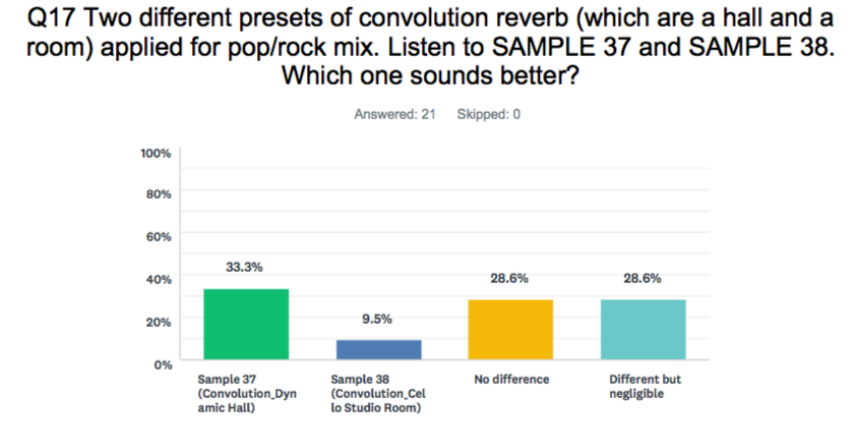
As seen in Figure 4.57, 7 musicians answered as no difference. 7 musicians preferred hall reverb.



ANSWER CHOICES	RESPONSES	
Sample 37 (Convolution_Dynamic Hall)	33.3%	7
Sample 38 (Convolution_Cello Studio Room)	14.3%	3
No difference	33.3%	7
Different but negligible	19.0%	4
TOTAL		21

Figure 4.57: Musicians' results of question 17

As seen in Figure 4.58, 7 non-musicians preferred hall reverb. No difference and different but negligible answers got 6 votes each.



ANSWER CHOICES	RESPONSES	
Sample 37 (Convolution_Dynamic Hall)	33.3%	7
Sample 38 (Convolution_Cello Studio Room)	9.5%	2
No difference	28.6%	6
Different but negligible	28.6%	6
TOTAL		21

Figure 4.58: Non-musicians results of question 17

Fourth topic of the survey consists of question 18, 19, 20 and 21. Electronic/pop tune is excluded. EMT 250 is used for this topic. The amount of reverb between melodic

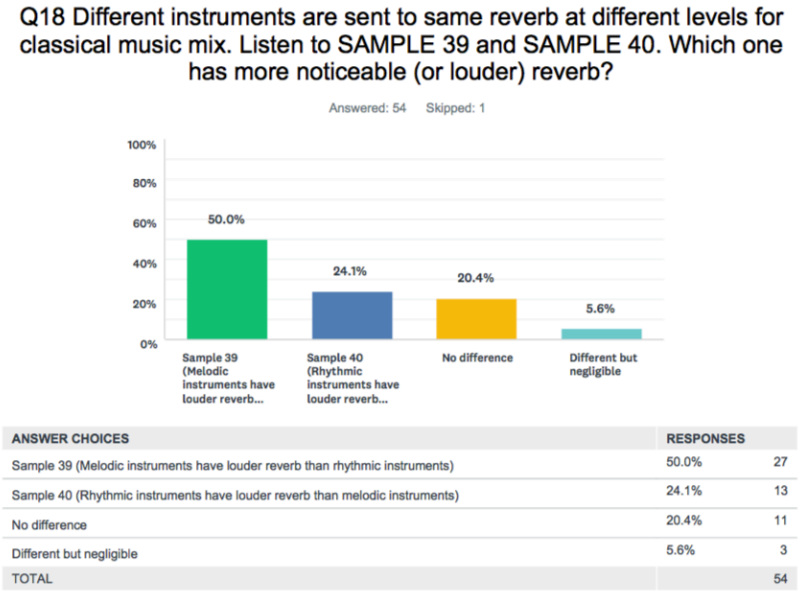
and rhythmic instruments is changed by 3 dB compared to levels in first topic. Participants are asked to choose the track that has more noticeable reverb.

4.2.15 Question 18

Different groups of instruments are sent to same reverb at different levels for classical music mix. The reverb send of the rhythmic instrument, which is piano, is increased by 3 dB and the reverb send of the melodic instrument, which is vocal, is decreased by 3 dB for one sample and vice versa for the other sample.

Sample 39 is mixed down with louder reverb levels on melodic instruments. Sample 40 is mixed down using louder reverb levels on rhythmic instruments.

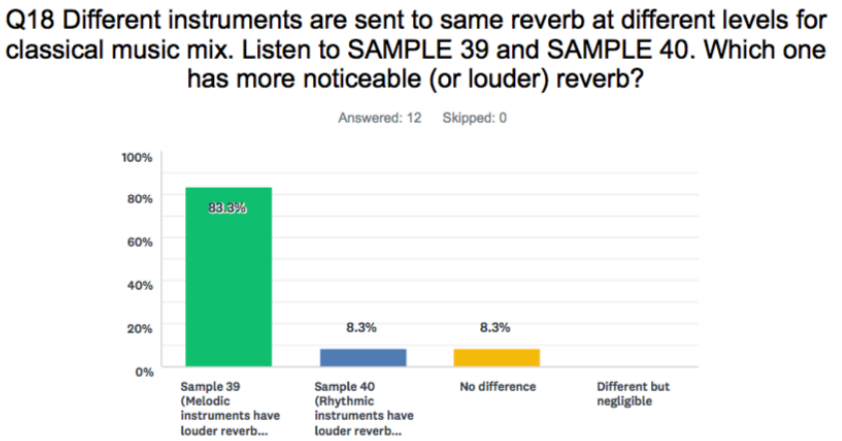
As seen in Figure 4.59, 27 out of 54 participants preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 39 (Melodic instruments have louder reverb than rhythmic instruments)	50.0%	27
Sample 40 (Rhythmic instruments have louder reverb than melodic instruments)	24.1%	13
No difference	20.4%	11
Different but negligible	5.6%	3
TOTAL		54

Figure 4.59: General results of question 18

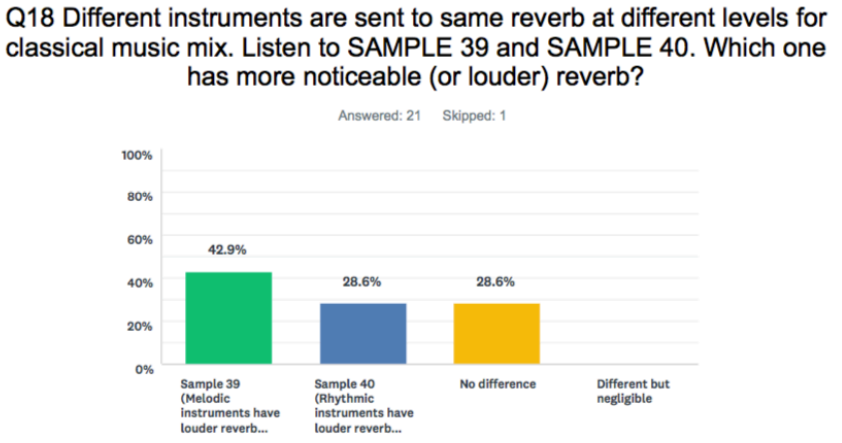
As seen in Figure 4.60, 10 out of 12 sound engineers, preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 39 (Melodic instruments have louder reverb than rhythmic instruments)	83.3%	10
Sample 40 (Rhythmic instruments have louder reverb than melodic instruments)	8.3%	1
No difference	8.3%	1
Different but negligible	0.0%	0
TOTAL		12

Figure 4.60: Sound engineers' results of question 18

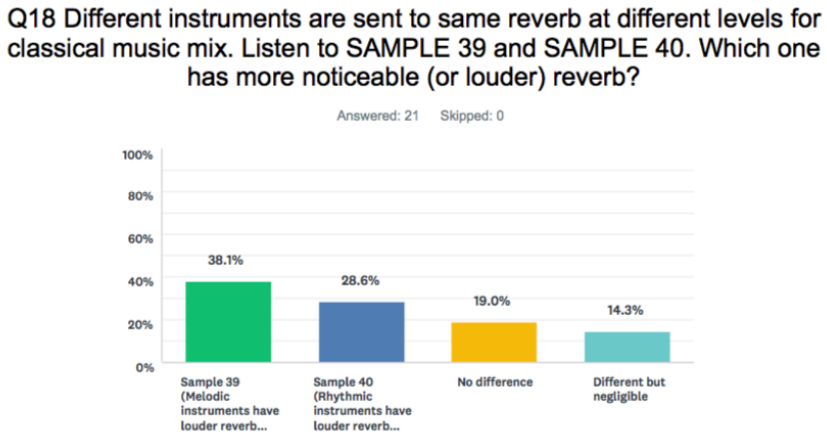
As seen in Figure 4.61, 9 musicians preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 39 (Melodic instruments have louder reverb than rhythmic instruments)	42.9%	9
Sample 40 (Rhythmic instruments have louder reverb than melodic instruments)	28.6%	6
No difference	28.6%	6
Different but negligible	0.0%	0
TOTAL		21

Figure 4.61: Musicians' results of question 18

As seen in Figure 4.62, 8 non-musicians preferred more reverb on melodic instruments as louder reverb, 6 non-musicians preferred the other.



ANSWER CHOICES	RESPONSES	
Sample 39 (Melodic instruments have louder reverb than rhythmic instruments)	38.1%	8
Sample 40 (Rhythmic instruments have louder reverb than melodic instruments)	28.6%	6
No difference	19.0%	4
Different but negligible	14.3%	3
TOTAL		21

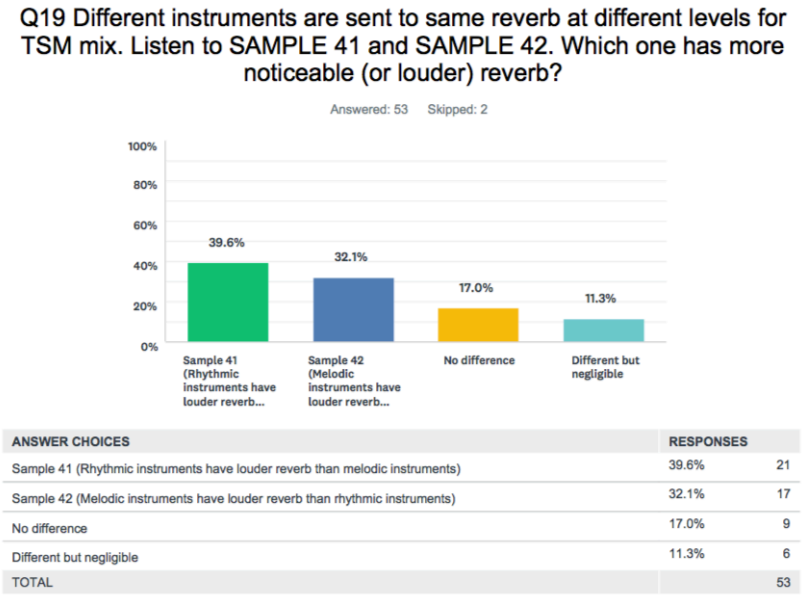
Figure 4.62: Non-musicians' results of question 18

4.2.16 Question 19

Different groups of instruments are sent to same reverb at different levels for TSM mix. The reverb sends of the rhythmic instruments, which are 3 bendirs, and a cajon, are increased by 3 dB and the reverb sends of the melodic instruments, which are oud, qanun, kemenche, ney and vocals, are decreased by 3 dB for one sample and vice versa for the other sample.

Sample 41 is mixed down with louder reverb levels on rhythmic instruments. Sample 42 is mixed down using louder reverb levels on melodic instruments.

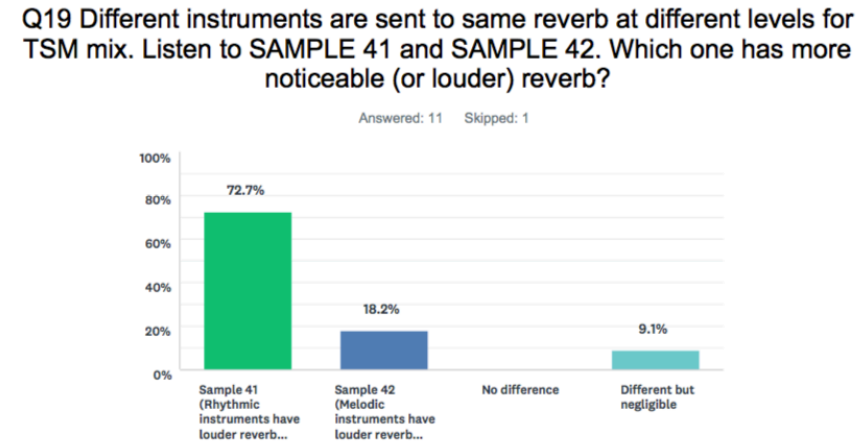
As seen in figure 4.63, 21 out of 53 participants preferred more reverb on rhythmic instruments as more noticeable reverb for TSM mix. 17 participants preferred the other.



ANSWER CHOICES	RESPONSES	
Sample 41 (Rhythmic instruments have louder reverb than melodic instruments)	39.6%	21
Sample 42 (Melodic instruments have louder reverb than rhythmic instruments)	32.1%	17
No difference	17.0%	9
Different but negligible	11.3%	6
TOTAL		53

Figure 4.63: General results of question 19

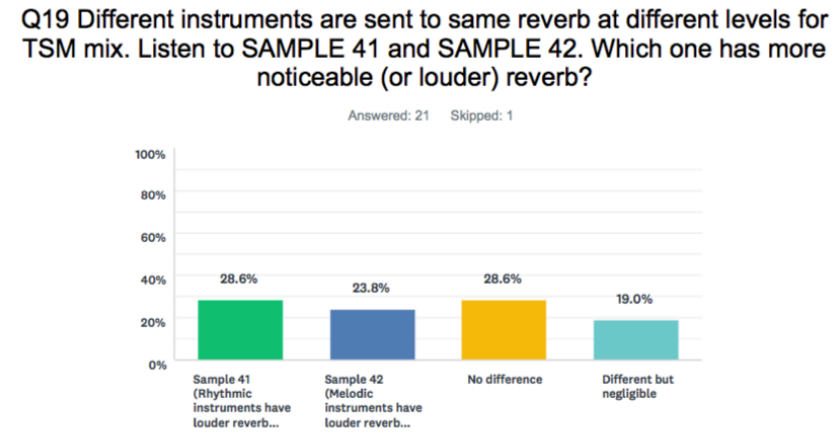
As seen in Figure 4.64, 8 out of 11 sound engineers preferred more reverb on rhythmic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 41 (Rhythmic instruments have louder reverb than melodic instruments)	72.7%	8
Sample 42 (Melodic instruments have louder reverb than rhythmic instruments)	18.2%	2
No difference	0.0%	0
Different but negligible	9.1%	1
TOTAL		11

Figure 4.64: Sound engineers' results of question 19

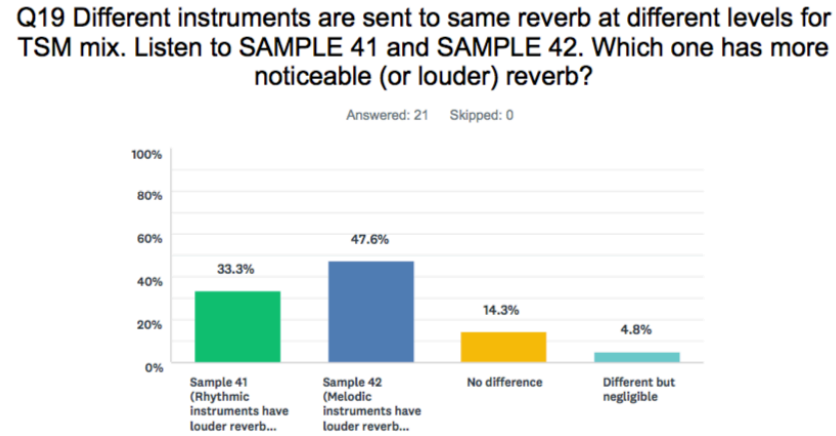
As seen in Figure 4.65, 6 musicians answered as no difference, 6 musicians preferred more reverb on rhythmic instruments and 5 musicians preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 41 (Rhythmic instruments have louder reverb than melodic instruments)	28.6%	6
Sample 42 (Melodic instruments have louder reverb than rhythmic instruments)	23.8%	5
No difference	28.6%	6
Different but negligible	19.0%	4
TOTAL		21

Figure 4.65: Musicians' results of question 19

As seen in Figure 4.66, 10 out of 21 non-musicians preferred more reverb on melodic instruments as more noticeable reverb. 7 non-musicians preferred the other.



ANSWER CHOICES	RESPONSES	
Sample 41 (Rhythmic instruments have louder reverb than melodic instruments)	33.3%	7
Sample 42 (Melodic instruments have louder reverb than rhythmic instruments)	47.6%	10
No difference	14.3%	3
Different but negligible	4.8%	1
TOTAL		21

Figure 4.66: Non-musicians' results of question 19

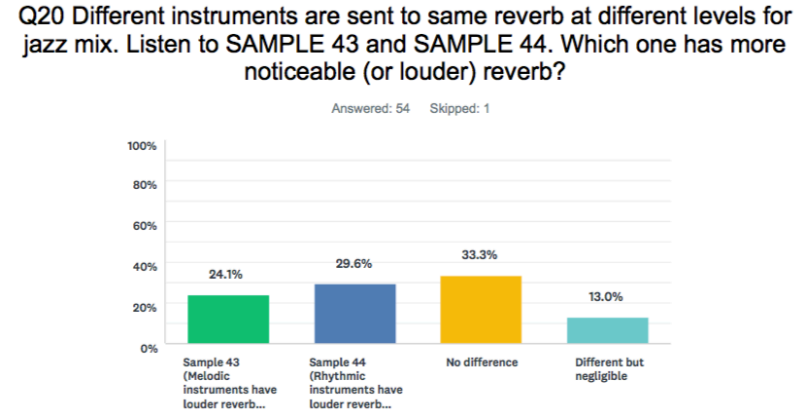
4.2.17 Question 20

Different groups of instruments are sent to same reverb at different levels for jazz mix. The reverb sends of the rhythmic instruments, which are drums, piano and guitar, are increased by 3 dB and the reverb sends of the melodic instruments, which

are brass section and vocal, are decreased by 3 dB for one sample and vice versa for the other sample.

Sample 43 is mixed down with louder reverb levels on melodic instruments. Sample 44 is mixed down using louder reverb levels on rhythmic instruments.

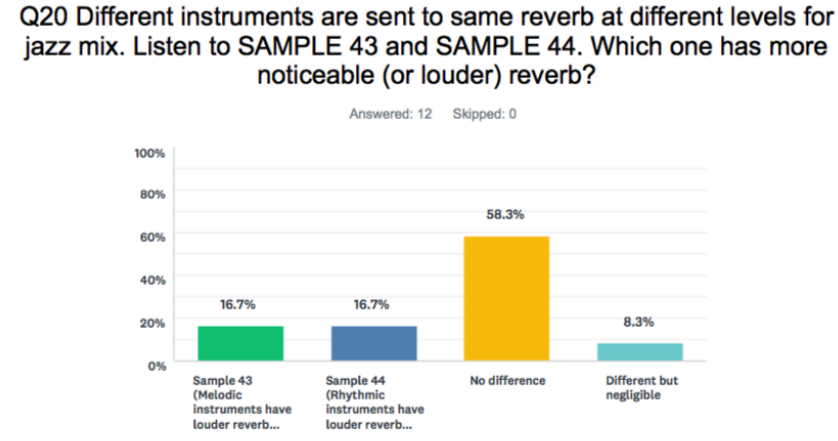
As seen in Figure 4.67, 18 out of 54 participants answered as no difference. 16 participants preferred more reverb on rhythmic instruments as more noticeable reverb. 13 participants preferred the other.



ANSWER CHOICES	RESPONSES	
Sample 43 (Melodic instruments have louder reverb than rhythmic instruments)	24.1%	13
Sample 44 (Rhythmic instruments have louder reverb than melodic instruments)	29.6%	16
No difference	33.3%	18
Different but negligible	13.0%	7
TOTAL		54

Figure 4.67: General results of question 20

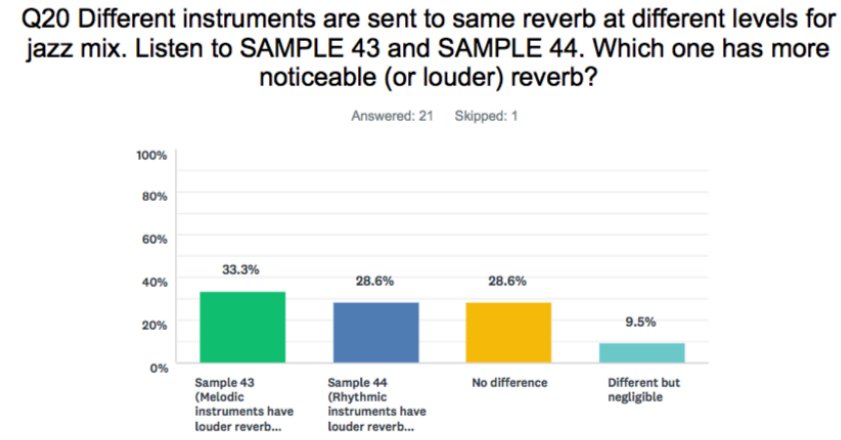
As seen in in Figure 4.68, 7 out of 12 sound engineers answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 43 (Melodic instruments have louder reverb than rhythmic instruments)	16.7%	2
Sample 44 (Rhythmic instruments have louder reverb than melodic instruments)	16.7%	2
No difference	58.3%	7
Different but negligible	8.3%	1
TOTAL		12

Figure 4.68: Sound engineers' results of question 20

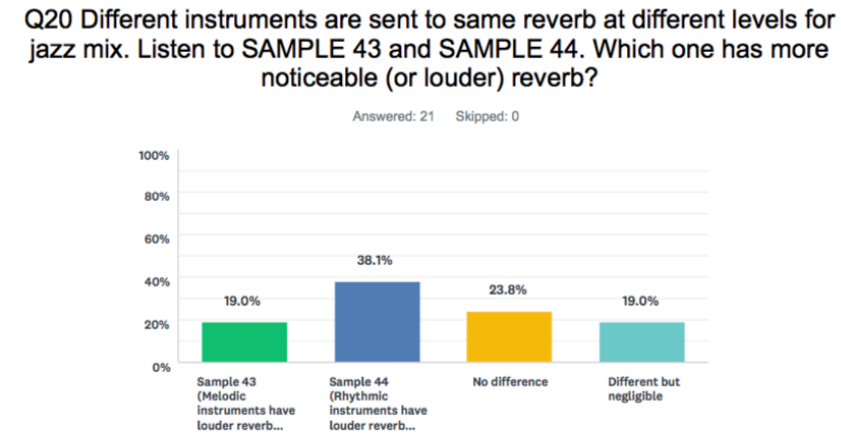
As seen in Figure 4.69, 7 musicians preferred more reverb on melodic reverb as more noticeable reverb. 6 musicians preferred the other.



ANSWER CHOICES	RESPONSES	
Sample 43 (Melodic instruments have louder reverb than rhythmic instruments)	33.3%	7
Sample 44 (Rhythmic instruments have louder reverb than melodic instruments)	28.6%	6
No difference	28.6%	6
Different but negligible	9.5%	2
TOTAL		21

Figure 4.69: Musicians' results of question 20

As seen in Figure 4.70, 8 out of 21 non-musicians preferred more reverb on rhythmic instruments as more noticeable reverb. 5 non-musicians answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 43 (Melodic instruments have louder reverb than rhythmic instruments)	19.0%	4
Sample 44 (Rhythmic instruments have louder reverb than melodic instruments)	38.1%	8
No difference	23.8%	5
Different but negligible	19.0%	4
TOTAL		21

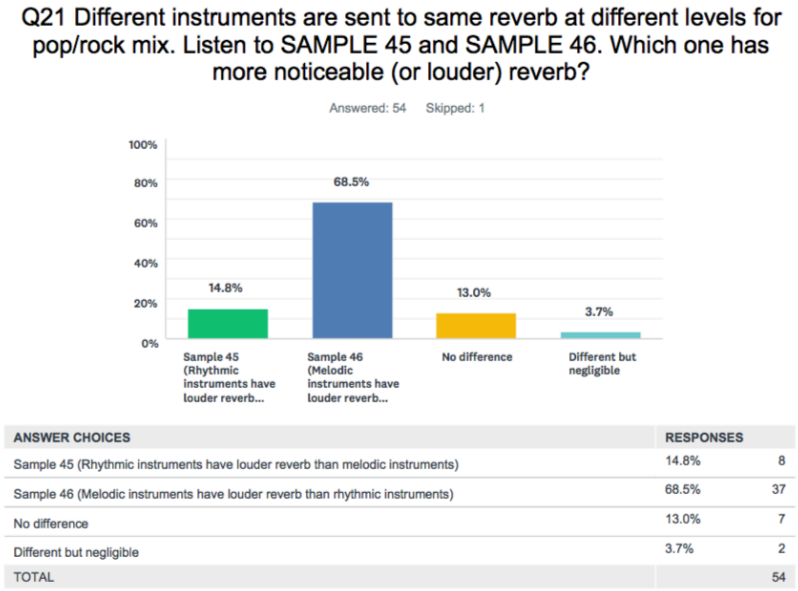
Figure 4.70: Non-musicians' results of question 20

4.2.18 Question 21

Different groups of instruments are sent to same reverb at different levels for pop/rock mix. The reverb sends of the rhythmic instruments, which are drums, tambourine, organ and piano, are increased by 3 dB and the reverb sends of the melodic instruments, which are electric guitars and vocals, are decreased by 3 dB for one sample and vice versa for the other sample.

Sample 45 is mixed down with louder reverb levels on rhythmic instruments. Sample 46 is mixed down using louder reverb levels on melodic instruments.

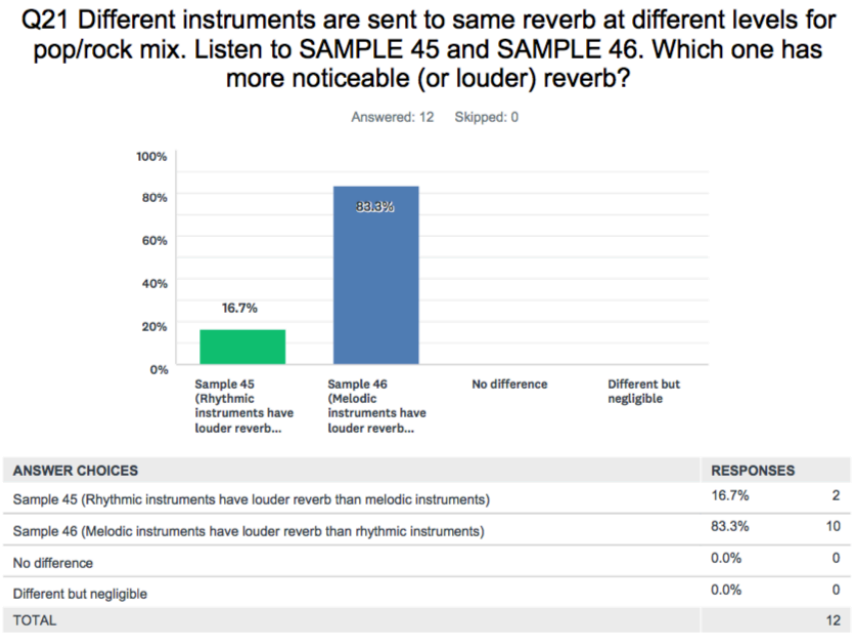
As seen in Figure 4.71, 37 out of 54 participants preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 45 (Rhythmic instruments have louder reverb than melodic instruments)	14.8%	8
Sample 46 (Melodic instruments have louder reverb than rhythmic instruments)	68.5%	37
No difference	13.0%	7
Different but negligible	3.7%	2
TOTAL		54

Figure 4.71: General results of question 21

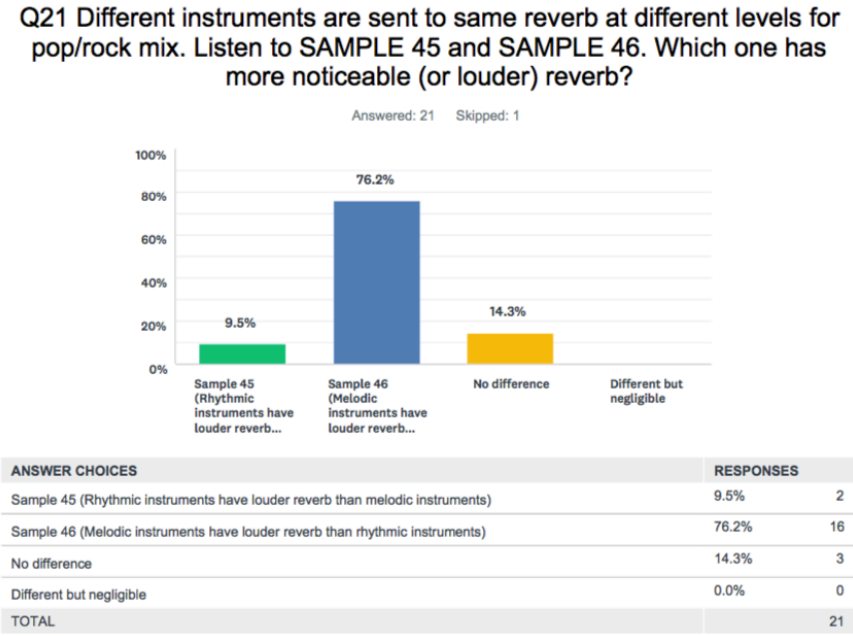
As seen in figure 4.72, 10 out of 12 sound engineers preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 45 (Rhythmic instruments have louder reverb than melodic instruments)	16.7%	2
Sample 46 (Melodic instruments have louder reverb than rhythmic instruments)	83.3%	10
No difference	0.0%	0
Different but negligible	0.0%	0
TOTAL		12

Figure 4.72: Sound engineers' results of question 21

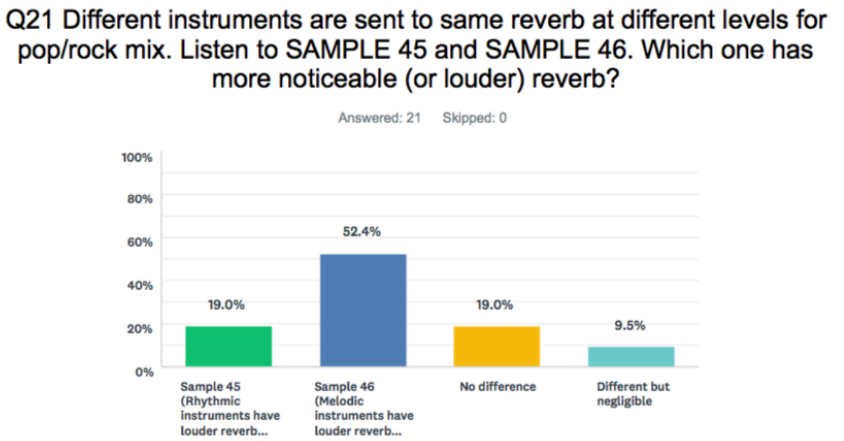
As seen in Figure 4.73, 16 out of 21 musicians preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 45 (Rhythmic instruments have louder reverb than melodic instruments)	9.5%	2
Sample 46 (Melodic instruments have louder reverb than rhythmic instruments)	76.2%	16
No difference	14.3%	3
Different but negligible	0.0%	0
TOTAL		21

Figure 4.73: Musicians' results of question 21

As seen in Figure 4.74, 11 out of 21 non-musicians preferred more reverb on melodic instruments as more noticeable reverb.



ANSWER CHOICES	RESPONSES	
Sample 45 (Rhythmic instruments have louder reverb than melodic instruments)	19.0%	4
Sample 46 (Melodic instruments have louder reverb than rhythmic instruments)	52.4%	11
No difference	19.0%	4
Different but negligible	9.5%	2
TOTAL		21

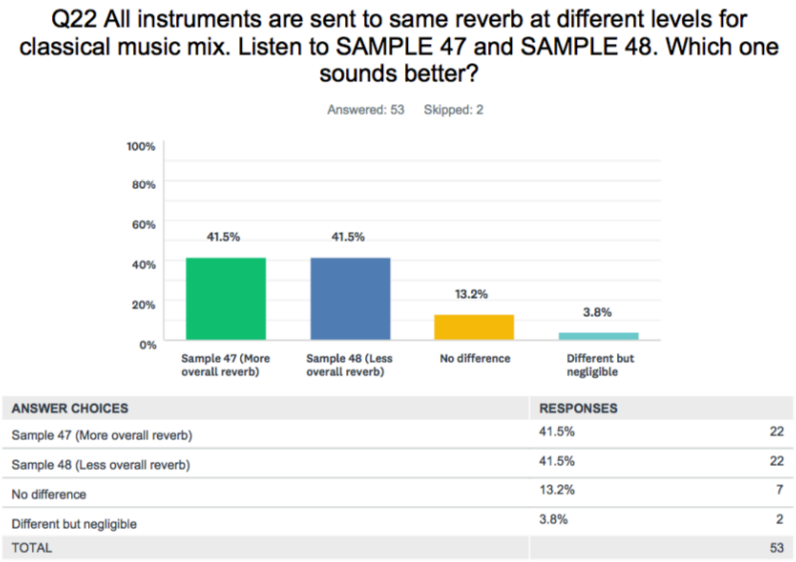
Figure 4.74: Non-musicians' results of question 21

Fifth topic of the survey consists of question 22, 23, 24, 25 and 26. Algorithmic reverb (EMT 250) with same settings as in the first topic, is used again for this one as well. Comparing the reverb send levels in first topic of the survey, each instrument's send level is increased by 3 dB for one sample and is decreased by 3 dB for the other sample. Participants are asked to choose between 2 samples.

4.2.19 Question 22

Classical music tune is mixed down using same algorithmic reverb as in question 4, but with different send levels. Each instrument's reverb send level is increased by 3 dB for sample 47, and is decreased by 3 dB for sample 48.

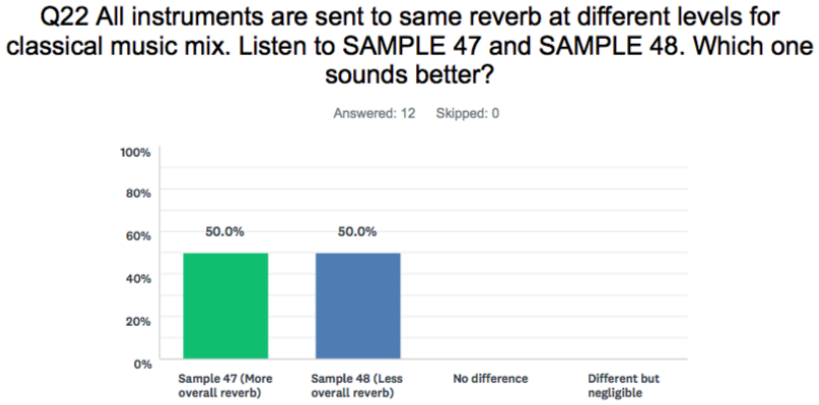
As seen in Figure 4.75, more overall reverb and less overall reverb answers got 22 votes each.



ANSWER CHOICES	RESPONSES	
Sample 47 (More overall reverb)	41.5%	22
Sample 48 (Less overall reverb)	41.5%	22
No difference	13.2%	7
Different but negligible	3.8%	2
TOTAL		53

Figure 4.75: General results of question 22

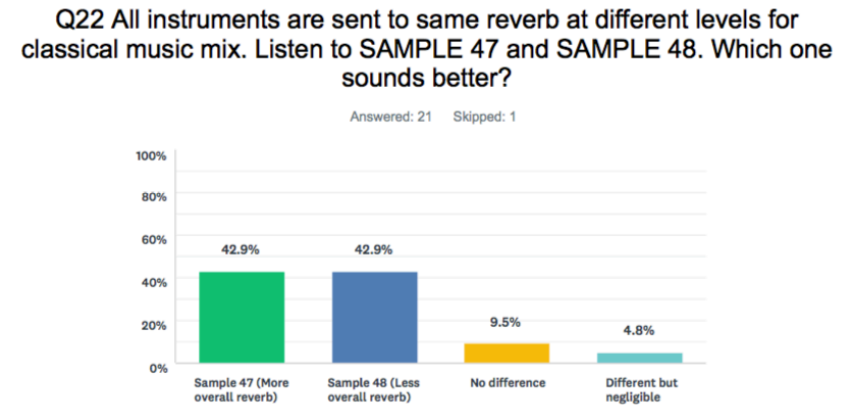
As seen in the Figure 4.76, half of the sound engineers preferred more overall reverb, and the other half preferred less overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 47 (More overall reverb)	50.0%	6
Sample 48 (Less overall reverb)	50.0%	6
No difference	0.0%	0
Different but negligible	0.0%	0
TOTAL		12

Figure 4.76: Sound engineers' results of question 22

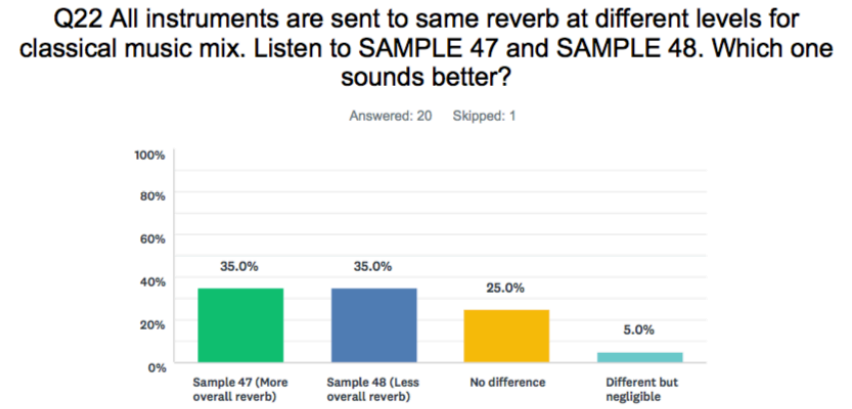
As seen in Figure 4.77, more overall reverb and less overall reverb answers got 9 votes each.



ANSWER CHOICES	RESPONSES	
Sample 47 (More overall reverb)	42.9%	9
Sample 48 (Less overall reverb)	42.9%	9
No difference	9.5%	2
Different but negligible	4.8%	1
TOTAL		21

Figure 4.77: Musicians' results of question 22

As seen in Figure 4.78, more overall reverb and less overall reverb answers got 7 votes each, from non-musicians.



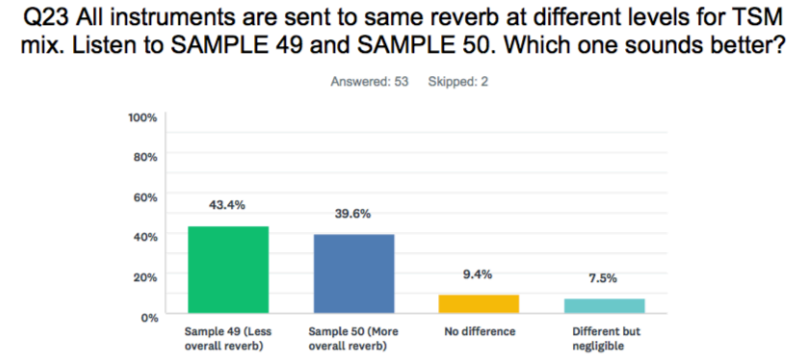
ANSWER CHOICES	RESPONSES	
Sample 47 (More overall reverb)	35.0%	7
Sample 48 (Less overall reverb)	35.0%	7
No difference	25.0%	5
Different but negligible	5.0%	1
TOTAL		20

Figure 4.78: Non-musicians' results of question 22

4.2.20 Question 23

TSM tune is mixed down using same algorithmic reverb as in the question 5, but with different send levels. Each instrument's reverb send level is increased by 3 dB for sample 50 and decreased by 3 dB for sample 49.

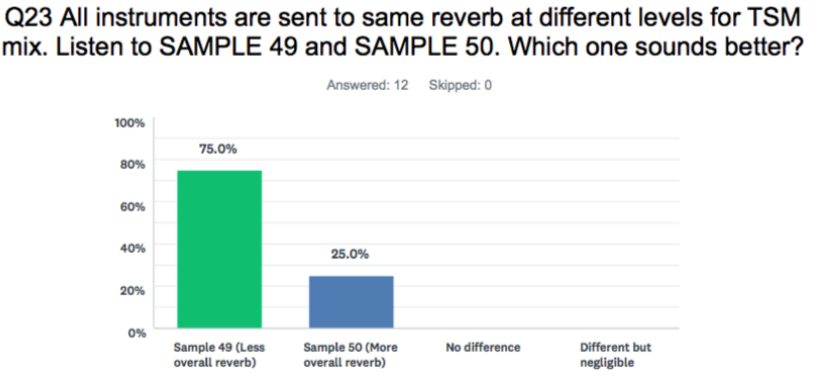
As seen in Figure 4.79, 23 participants preferred less overall reverb for TSM mix. 21 participants preferred more overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 49 (Less overall reverb)	43.4%	23
Sample 50 (More overall reverb)	39.6%	21
No difference	9.4%	5
Different but negligible	7.5%	4
TOTAL		53

Figure 4.79: General results of question 23

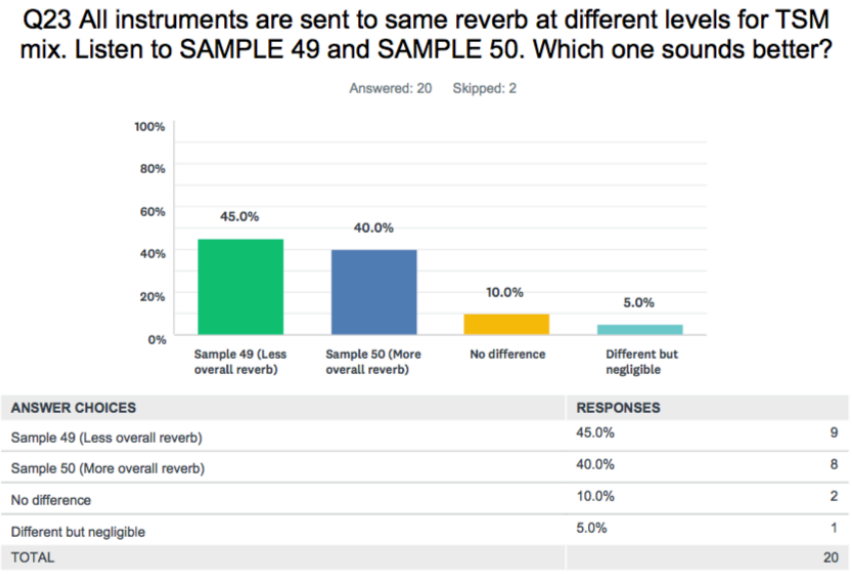
As seen in Figure 4.80, 9 out of 12 sound engineers preferred less overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 49 (Less overall reverb)	75.0%	9
Sample 50 (More overall reverb)	25.0%	3
No difference	0.0%	0
Different but negligible	0.0%	0
TOTAL		12

Figure 4.80: Sound engineers' results of question 23

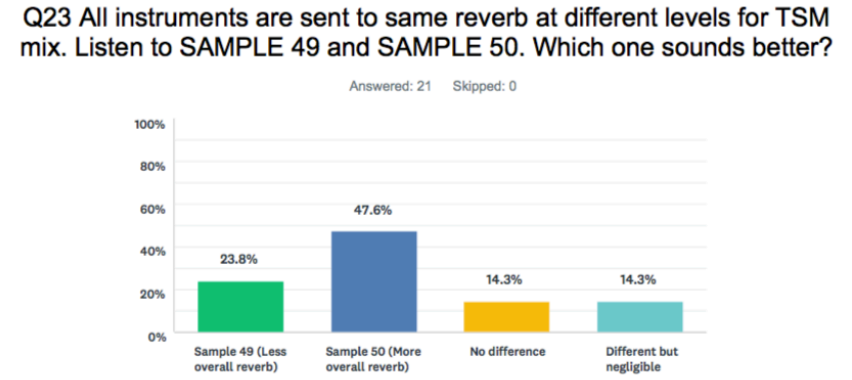
As seen in Figure 4.81, 9 musicians preferred less overall reverb and 8 musicians preferred more overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 49 (Less overall reverb)	45.0%	9
Sample 50 (More overall reverb)	40.0%	8
No difference	10.0%	2
Different but negligible	5.0%	1
TOTAL		20

Figure 4.81: Musicians' results of question 23

As seen in Figure 4.82, 10 out of 21 non-musicians preferred more overall reverb.



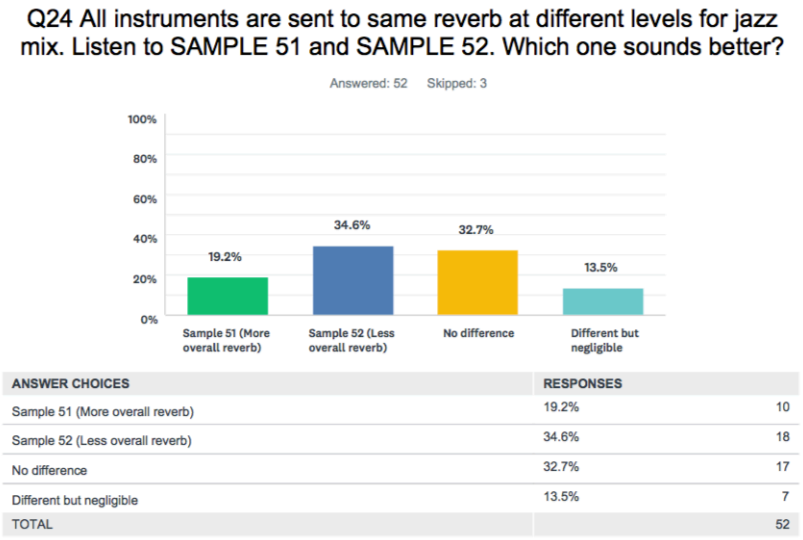
ANSWER CHOICES	RESPONSES	
Sample 49 (Less overall reverb)	23.8%	5
Sample 50 (More overall reverb)	47.6%	10
No difference	14.3%	3
Different but negligible	14.3%	3
TOTAL		21

Figure 4.82: Non-musicians' results of question 23

4.2.21 Question 24

Jazz tune is mixed down using same algorithmic reverb as in question 6, but with different send levels. Each instrument's reverb send level is increased by 3 dB for sample 51, and is decreased by 3 dB for sample 52.

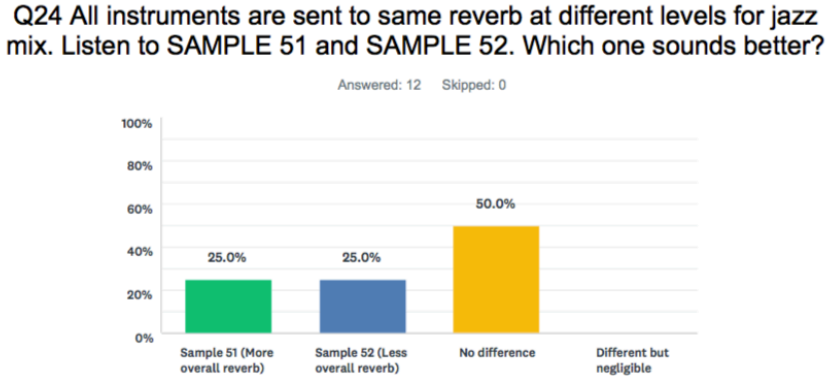
As seen in Figure 4.83, 18 participants preferred less overall reverb. 17 participants answered as no difference.



ANSWER CHOICES	RESPONSES	
Sample 51 (More overall reverb)	19.2%	10
Sample 52 (Less overall reverb)	34.6%	18
No difference	32.7%	17
Different but negligible	13.5%	7
TOTAL		52

Figure 4.83: General results of question 24

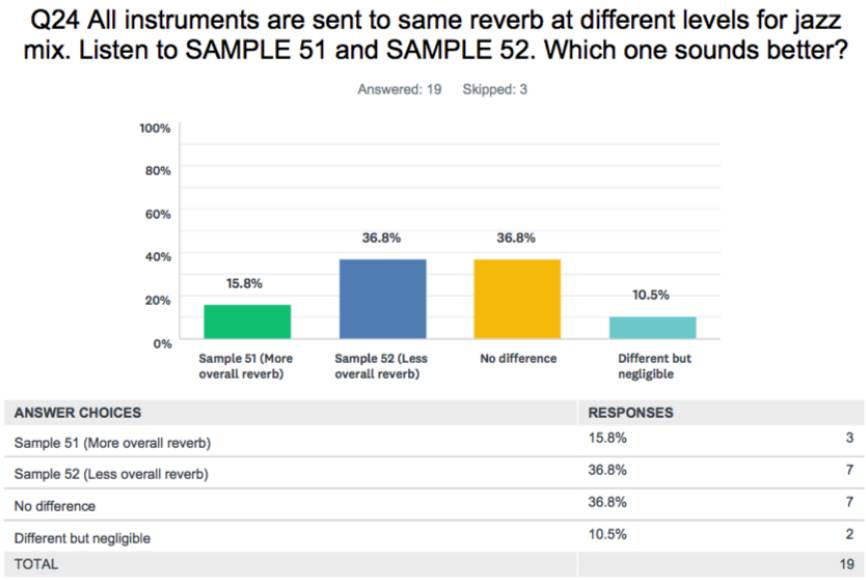
As seen in Figure 4.84, half of the sound engineers answered as no difference. More overall reverb and less overall reverb answers got 3 votes each.



ANSWER CHOICES	RESPONSES	
Sample 51 (More overall reverb)	25.0%	3
Sample 52 (Less overall reverb)	25.0%	3
No difference	50.0%	6
Different but negligible	0.0%	0
TOTAL		12

Figure 4.84: Sound engineers' results of question 24

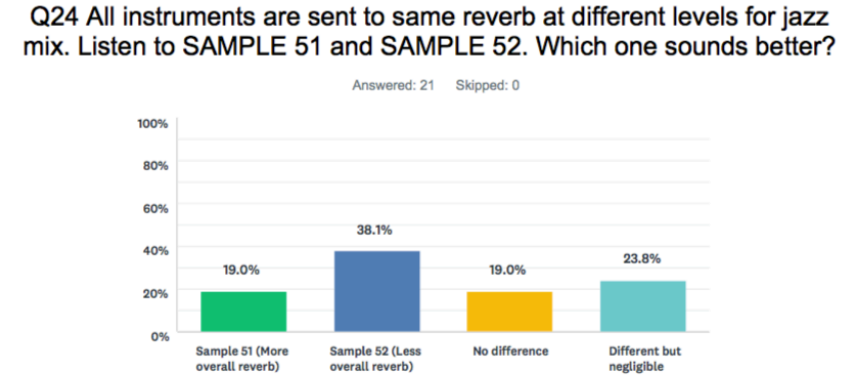
As seen in Figure 4.85, no difference and less overall reverb answers got 7 votes each.



ANSWER CHOICES	RESPONSES	
Sample 51 (More overall reverb)	15.8%	3
Sample 52 (Less overall reverb)	36.8%	7
No difference	36.8%	7
Different but negligible	10.5%	2
TOTAL		19

Figure 4.85: Musicians' results of question 24

As seen in Figure 4.86, 8 non-musicians preferred less overall reverb. 5 non-musicians answered as different but negligible.



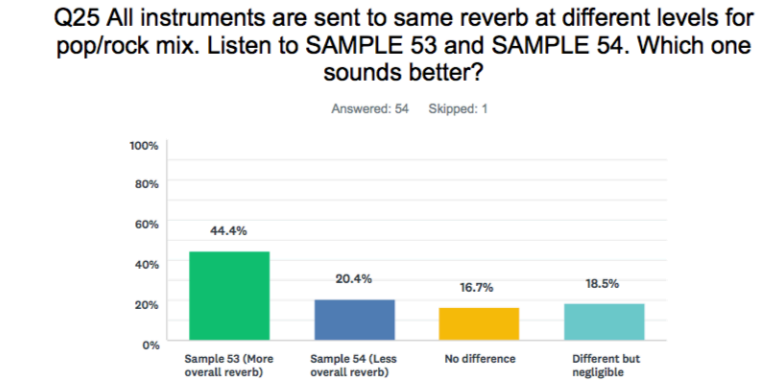
ANSWER CHOICES	RESPONSES	
Sample 51 (More overall reverb)	19.0%	4
Sample 52 (Less overall reverb)	38.1%	8
No difference	19.0%	4
Different but negligible	23.8%	5
TOTAL		21

Figure 4.86: Non-musicians' results of question 24

4.2.22 Question 25

Pop/rock tune is mixed down using same algorithmic reverb as in question 7, but with different send levels. Each instrument's reverb send level is increased by 3 dB for sample 53, and is decreased by 3 dB for sample 54.

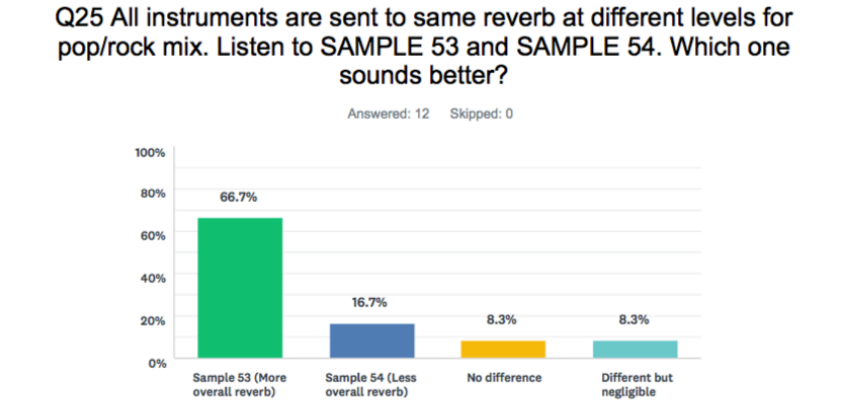
As seen in Figure 4.87, 24 out of 54 participants preferred more overall reverb for pop/rock mix.



ANSWER CHOICES	RESPONSES	
Sample 53 (More overall reverb)	44.4%	24
Sample 54 (Less overall reverb)	20.4%	11
No difference	16.7%	9
Different but negligible	18.5%	10
TOTAL		54

Figure 4.87: General results of question 25

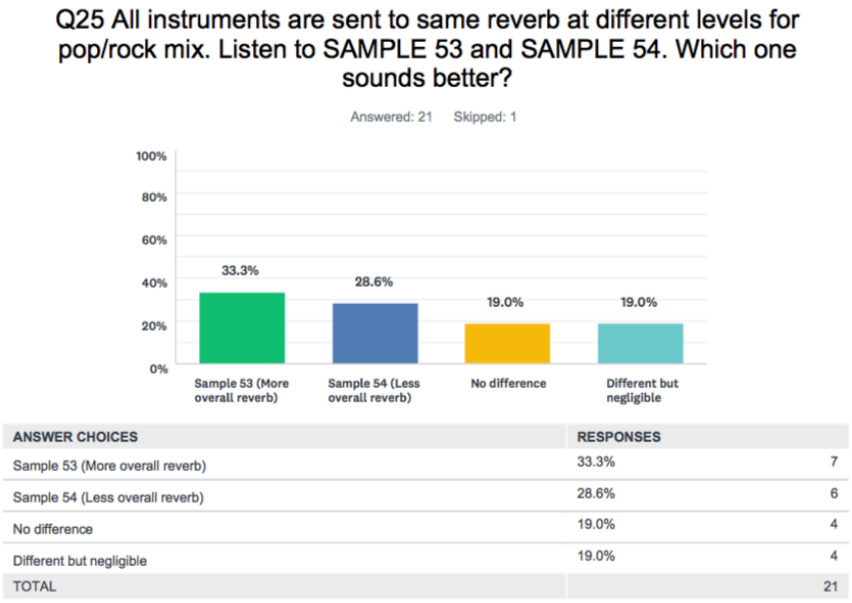
As seen in Figure 4.88, 8 out of 12 sound engineers preferred more overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 53 (More overall reverb)	66.7%	8
Sample 54 (Less overall reverb)	16.7%	2
No difference	8.3%	1
Different but negligible	8.3%	1
TOTAL		12

Figure 4.88: Sound engineers' results of question 25

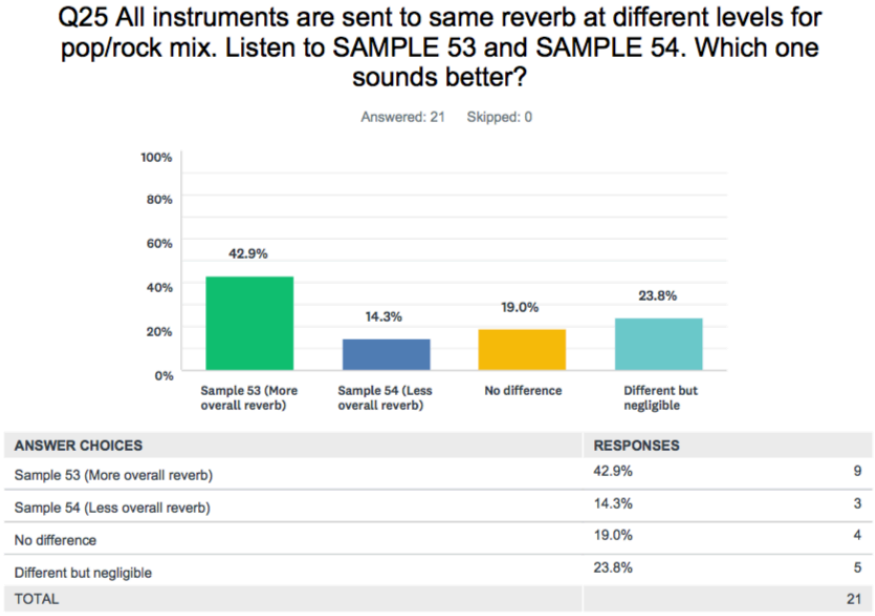
As seen in Figure 4.89, 7 musicians preferred more overall reverb. 6 musicians preferred less overall reverb for pop/rock mix.



ANSWER CHOICES	RESPONSES	
Sample 53 (More overall reverb)	33.3%	7
Sample 54 (Less overall reverb)	28.6%	6
No difference	19.0%	4
Different but negligible	19.0%	4
TOTAL		21

Figure 4.89: Musicians' results of question 25

As seen in Figure 4.90, 9 out of 21 non-musicians preferred more overall reverb.



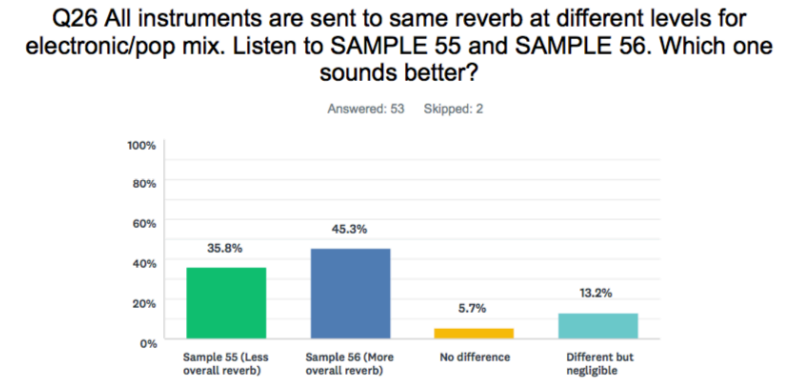
ANSWER CHOICES	RESPONSES	
Sample 53 (More overall reverb)	42.9%	9
Sample 54 (Less overall reverb)	14.3%	3
No difference	19.0%	4
Different but negligible	23.8%	5
TOTAL		21

Figure 4.90: Non-musicians' results of question 25

4.2.23 Question 26

Electronic/pop tune is mixed down using same algorithmic reverb as in question 8, but with different send levels. Each instrument's reverb send level is increased by 3 dB for sample 56, and is decreased by 3 dB for sample 55.

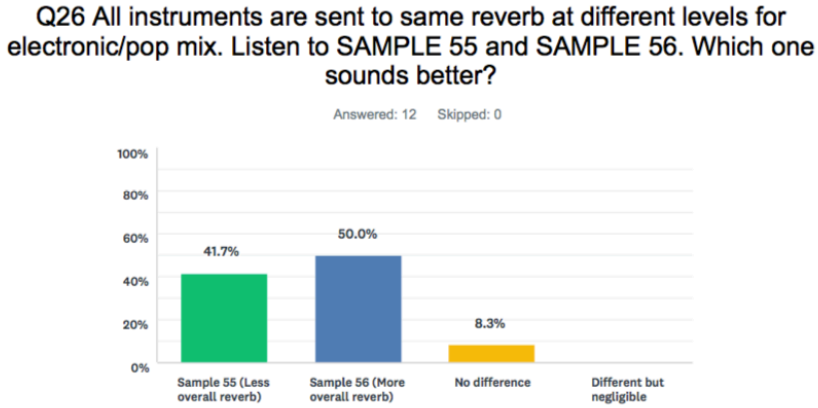
As seen in Figure 4.91, 24 participants preferred more overall reverb for electronic/pop mix. 19 participants preferred less overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 55 (Less overall reverb)	35.8%	19
Sample 56 (More overall reverb)	45.3%	24
No difference	5.7%	3
Different but negligible	13.2%	7
TOTAL		53

Figure 4.91: General results of question 26

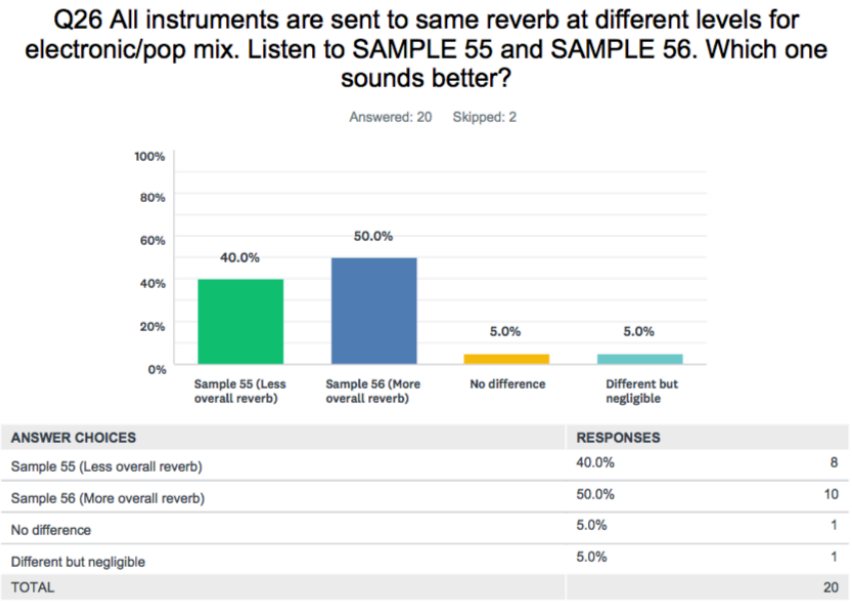
As seen in Figure 4.92, 6 sound engineers preferred more overall reverb, and 5 sound engineers preferred less overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 55 (Less overall reverb)	41.7%	5
Sample 56 (More overall reverb)	50.0%	6
No difference	8.3%	1
Different but negligible	0.0%	0
TOTAL		12

Figure 4.92: Sound engineers' results of question 26

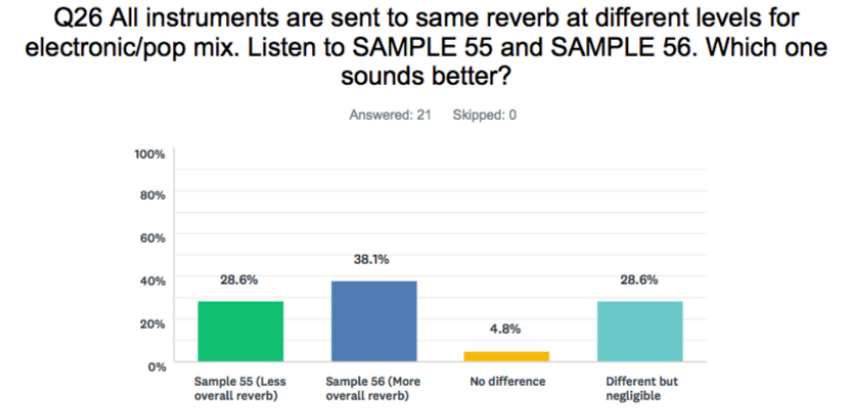
As seen in Figure 4.93, 10 musicians preferred more overall reverb for electronic/pop mix. 8 musicians preferred less overall reverb.



ANSWER CHOICES	RESPONSES	
Sample 55 (Less overall reverb)	40.0%	8
Sample 56 (More overall reverb)	50.0%	10
No difference	5.0%	1
Different but negligible	5.0%	1
TOTAL		20

Figure 4.93: Musicians' results of question 26

As seen in Figure 4.91, 8 non-musicians preferred more overall reverb. Different but negligible and less overall reverb answers got 6 votes each.



ANSWER CHOICES	RESPONSES	
Sample 55 (Less overall reverb)	28.6%	6
Sample 56 (More overall reverb)	38.1%	8
No difference	4.8%	1
Different but negligible	28.6%	6
TOTAL		21

Figure 4.94: Non-musicians' results of question 26

4.3 Evaluation of the Results

4.3.1 First topic of the survey

In the first topic of the survey, which consists of question 4, 5, 6, 7 and 8, participants are asked to choose the sample they liked most. In this topic, 5 different

songs are mixed down using 4 different types of reverb, which are algorithmic, plate, spring and a convolution preset.

For question 4, which is a question about choosing between 4 types of reverb for classical music mix, the expectation was convolution reverb's bright chamber preset. None of the reverb types is chosen distinctively. However, none of the sound engineers and musicians preferred spring reverb. 5 out of 21 non-musicians preferred spring reverb. On the other hand, 5 out of 12 sound engineers and 5 out of 21 non-musicians preferred convolution reverb's bright chamber preset, which makes the convolution reverb the most preferred reverb for this question, with a small difference.

For question 5, which is a question about choosing between 4 types of reverb for TSM mix, the expectation was convolution reverb's recording room preset. And again, none of the reverb types is chosen distinctively. Both plate reverb and algorithmic reverb got 12 votes each. 4 out of 12 sound engineers preferred algorithmic reverb. Only one sound engineer preferred plate reverb. None of the 21 musicians preferred convolution reverb, which is curious. 6 musicians preferred algorithmic reverb and 5 musicians preferred plate reverb. On the contrary, convolution reverb's recording room preset and plate reverb got 6 votes each, from non-musicians. 2 non-musicians preferred algorithmic reverb. As in the question 4, musicians and non-musicians are in conflict.

For question 6, which is a question about choosing between 4 types of reverb for jazz mix, the expectation was algorithmic reverb or convolution reverb's medium hall preset. However, these reverbs are the least preferred ones. 12 out of 55 participants preferred spring reverb and 11 participants preferred plate reverb. Sound engineers' votes diversified homogenously except for spring reverb, which is preferred by only one engineer. None of the musicians preferred algorithmic reverb, which is also curious. 6 musicians preferred plate reverb. 5 musicians and 6 non-musicians preferred spring reverb, which makes the spring reverb most preferred reverb, with a small difference. But, more than one third of the participants answered as no difference or different but negligible.

For question 7, which is a question about choosing between 4 types of reverb for pop/rock mix, the expectation was algorithmic reverb. 20 out of 55 participants preferred algorithmic reverb. Another 20 participants answered as no difference or different but negligible.

For question 8, which is a question about choosing between 4 types of reverb for electronic/pop mix, there is no distinctive answer. 12 out of 55 participants preferred

spring reverb, but 23 participants answered as no difference or different but negligible.

4.3.2 Second topic of the survey

In the second topic of the survey, which consists of question 9, 10, 11, 12 and 13, participants are asked to choose the sample they liked most. In this topic, 5 different songs are mixed down using 2 different pre-delay times, which are 0 ms and 60 ms.

For question 9, which is a question about choosing between 2 different pre-delay times of algorithmic reverb for classical music mix, the expectation was 60 ms pre-delay. But, there is no distinctive answer. 17 participants preferred 0 ms pre-delay. 15 participants preferred 60 ms pre-delay.

For question 10, which is a question about choosing between 2 different pre-delay times of algorithmic reverb for TSM mix, the expectation was 60 ms pre-delay. Again, there is no distinctive answer. 18 participants preferred 60 ms pre-delay. 17 participants preferred 0 ms pre-delay. 6 out of 12 sound engineers preferred 0 ms pre-delay. 3 sound engineers preferred 60 ms pre-delay. 8 musicians and 7 non-musicians preferred 60 ms pre-delay.

For question 11, which is a question about choosing between 2 different pre-delay times of algorithmic reverb for jazz mix, the expectation was 60 ms pre-delay. However, 20 out of 53 participants preferred 0 ms pre-delay. Only 10 participants preferred 60 ms pre-delay. Sound engineers' and musicians' choices are diversified homogenously. But, 10 out of 21 non-musicians preferred 0 ms pre-delay.

For question 12, which is a question about choosing between 2 different pre-delay times of algorithmic reverb for pop/rock mix, the expectation was 60 ms pre-delay. 19 out of 52 participants preferred 60 ms pre-delay, which makes it the most preferred one with a small difference. 16 participants preferred 0 ms pre-delay. 5 out of 12 sound engineers and 10 out of 20 musicians preferred 60 ms pre-delay, although 9 out of 20 non-musicians preferred 0 ms pre-delay.

For question 13, which is a question about choosing between 2 different pre-delay times of algorithmic reverb for electronic/pop music, 25 out of 54 participants preferred 0 ms pre-delay. 9 out of 12 sound engineers and 9 out of 21 musicians preferred 0 ms pre-delay. On the contrary, non-musicians' answers are diversified equally.

4.3.3 Third topic of the survey

In the third topic of the survey, which consists of question 14, 15, 16 and 17, participants are asked to choose the sample they liked most. In this topic, 4 different songs are mixed down using 2 different preset of convolution reverb, which are a hall and a room.

For question 14, which is a question about choosing between 2 presets of convolution reverb for classical music mix, the expectation was the hall reverb. But, 32 out of 54 participants preferred convolution reverb's Big Room Stage preset.

For question 15, which is a question about choosing between 2 different presets of convolution reverb for TSM mix, the expectation was room reverb. But, convolution reverb's medium hall preset is the most preferred one, with 18 votes. 16 participants preferred convolution reverb's Villa Living Room preset. 5 out of 12 sound engineers and 7 out of 21 musicians preferred Medium Hall preset. 2 sound engineers and 8 musicians preferred Villa Living Room preset. Non-musicians' answers are diversified equally.

For question 16, which is a question about choosing between 2 presets of convolution reverb for jazz mix, 22 out of 53 participants preferred convolution reverb's Nice Room preset. Sound engineers' answers are distributed equally. 13 out of 20 musicians preferred Nice Room preset. On the contrary, 8 out of 21 non-musicians preferred Medium Hall preset.

For question 17, which is a question about choosing between 2 presets of convolution reverb for pop/rock mix, 28 out of 54 participants answered as no difference or different but negligible. 17 participants preferred convolution reverb's Dynamic Hall preset and 9 participants preferred Cello Studio Room preset.

4.3.4 Fourth topic of the survey

In the fourth topic of the survey, which consists of question 18, 19, 20 and 21, participants are asked to choose the sample that has more noticeable reverb. In this topic, 4 different songs are mixed down using algorithmic reverb, with different send levels for different instrument groups.

For question 18, participants are asked to choose the sample, which has more noticeable reverb, for classical music mix. Comparing the reverb send levels in question 4, reverb send level of piano is increased by 3 dB, and reverb send level of vocal is decreased by 3 dB for one sample. And vice versa, for the other sample. 27 out of 54 participants chose more reverb on vocal as more noticeable reverb. 14 participants answered as no difference or different but negligible.

For question 19, participants are asked to choose the sample, which has more noticeable reverb, for TSM mix. Comparing the reverb send levels in question 5, reverb send levels of rhythmic instruments, which are 3 bendirs and cajon, are increased by 3 dB, and reverb send levels of melodic instruments, which are oud, qanun, kemenche, ney and vocals, are decreased by 3 dB, for one sample. And vice versa, for the other sample. 21 out of 53 participants preferred more reverb on rhythmic instruments as more noticeable reverb. 17 participants preferred the other. 8 out of 11 sound engineers preferred more reverb on rhythmic instruments. Musicians' answers are diversified homogenously. 10 out of 21 non-musicians preferred more reverb on melodic instruments as more noticeable reverb.

For question 20, participants are asked to choose the sample, which has more noticeable reverb, for jazz mix. Comparing the reverb send levels in question 6, reverb send levels of rhythmic instruments, which are drums, piano and guitar, are increased by 3 dB and the reverb sends of the melodic instruments, which are brass section and vocal, are decreased by 3 dB, for one sample. And vice versa, for another sample. 25 out of 54 participants answered as no difference or different but negligible. 16 participants preferred more reverb on rhythmic instruments as more noticeable reverb. 13 participants preferred the other.

For question 21, participants are asked to choose the sample, which has more noticeable reverb, for pop/rock mix. Comparing the reverb send levels in question 7, reverb send levels of rhythmic instruments, which are drums, tambourine, organ, and piano, are increased by 3 dB and the reverb sends of the melodic instruments, which are electric guitars and vocals, are decreased by 3 dB, for one sample. And vice versa, for another sample. 37 out of 54 participants preferred more reverb on melodic instruments as more noticeable reverb. 8 participants preferred the other.

4.3.5 Fifth topic of the survey

In the fifth topic of the survey, which consists of question 22, 23, 24, 25 and 26, participants are asked to choose the sample they liked most. In this topic, 5 different songs are mixed down using same algorithmic reverb as first topic of survey, with different send levels. Reverb send levels are increased by 3 dB for one sample, and decreased by 3 dB for the other sample comparing the levels in first topic.

For question 22, participants are asked to choose between 2 samples, which are 3 dB louder and 3 dB quieter reverb sends for each instrument, for classical music mix. Both samples are voted equally. It is curious that all 3 subjects of the survey split into half.

For question 23, participants are asked to choose between 2 samples, which are 3 dB louder and 3 dB quieter reverb sends for each instrument, for TSM mix. 23 participants preferred less overall reverb. 21 participants preferred more overall reverb. 9 out of 12 sound engineers preferred less overall reverb. On the other hand, 10 out of 21 non-musicians preferred more overall reverb. Musicians' answers are diversified homogenously.

For question 24, participants are asked to choose between 2 samples, which are 3 dB louder and 3 dB quieter reverb sends for each instrument, for jazz mix. 18 participants preferred less overall reverb. However, 24 participants answered as no difference or different but negligible. 6 out of 12 sound engineers and 7 musicians answered as no difference. 7 musicians and 8 non-musicians preferred less overall reverb.

For question 25, participants are asked to choose between 2 samples, which are 3 dB louder and 3 dB quieter reverb sends for each instrument, for pop/rock mix. 24 out of 54 participants preferred more overall reverb. 19 participants answered as no difference or different but negligible. 8 out of 12 sound engineers and 9 out of 21 non-musicians preferred more overall reverb. Musicians' answers are diversified homogenously.

For question 26, participants are asked to choose between 2 samples, which are 3 dB louder and 3 dB quieter reverb sends for each instrument, for electronic/pop mix. 24 out of 53 participants preferred more overall reverb. 19 participants preferred less overall reverb.

5. CONCLUSION

Playback system is important to hear nuances. Therefore, participants of the survey are asked to state the playback system that they would use for the survey as explained in the section 4.1.2. Brand of the monitors or headphones are not asked, they defined their own equipment whether good or average as they wished. Participants, who used monitors or computer speakers, are also not asked about their room acoustics. It might be one of the reasons that more than half of the questions have no distinctive answer. For future research, controlling the listening environment of the participants might be helpful for getting clearer results.

In first topic of the survey, which consists of question 4, 5, 6, 7 and 8, participants are asked to choose between 4 types of reverb for 5 different mixes. None of the mixes has a distinctive answer, except for pop/rock mix. 20 out of 55 participants preferred algorithmic reverb. 20 participants answered as no difference or different but negligible. But the other types of reverb got less votes, reasoning that the people who participated the survey majorly listen to pop and rock.

Second topic of the survey, which consists of question 9, 10, 11, 12 and 13, participants are asked to choose between 0 ms and 60 ms of pre-delay times for 5 different mixes. There are no distinctive answers for classical music, TSM and pop/rock mixes. But, 25 out of 54 participants preferred 0 ms pre-delay for electronic/pop mix. Also, for jazz mix, 20 participants preferred 0 ms pre-delay, along with the 16 participants who answered as no difference. Both jazz and electronic/pop tracks are mixed with short delay time, which is shorter than 1.5 seconds, as stated in section 3.3.3. 11 out of 18 participants who used good headphones preferred 0 ms pre-delay for jazz mix. Besides, 2 out of 3 participants, who used good monitors as they stated, answered as no difference. Third one skipped this question. Participants might not listen to the samples focusing on pre-delay. As seen in the Appendix B, they are asked to choose the sample they liked most and it is not given in the question that it is about pre-delay comparison.

Third topic of the survey, which consists of question 14, 15, 16 and 17, participants are asked to choose between hall and room presets of convolution reverb for 4 different mixes. 32 out of 54 participants preferred room preset of convolution reverb for classical music mix. Expectation was hall reverb, but the more than half of the

participants preferred room reverb. For future research, different hall and room presets can be questioned.

Fourth topic of the survey, which consists of question 18, 19, 20 and 21, participants are asked to choose the sample with more noticeable reverb. For TSM and jazz mixes, there is no distinctive answer. But, 27 out of 54 participants preferred more reverb on melodic instruments for classical music mix, and 37 out of 54 participants preferred more reverb on melodic instruments for pop/rock mix as more noticeable reverb. Further research is needed, but one can say that people pay more attention to vocals and other melodic instruments.

Fifth topic of the survey, which consists of question 22, 23, 24, 25 and 26, participants are asked to choose between more overall reverb level and less overall reverb level. None of the genres has a distinctive answer, except for pop/rock mix. 24 out of 54 participants preferred more overall reverb.

3 participants, who are 2 sound engineers and 1 musician, stated that they used good monitors for the survey. They answered some questions in the survey distinctively. For instance, they answered question 11, which is participants are asked to choose between 2 different pre-delay times (0 ms and 60 ms) for jazz mix, as no difference. They preferred the sample with more reverb on rhythmic instruments as it has more noticeable reverb for question 19, which is participants asked to choose the sample with more noticeable reverb for TSM mix. But, they answered the same question for pop/rock mix as more reverb on melodic instruments in question 21. They also preferred less overall reverb for classical music mix in question 22, and more overall reverb for electronic/pop mix in question 26.

On the other hand, 3 non-musicians stated that they used cellphone speakers for the survey. According to their answers they heard no difference for most of the questions, which is expected. Because, they have probably listened to the samples in mono through the cellphone speakers. But, for the first topic of the survey, which participants are asked to choose between 4 types of reverb for 5 different mixes. 1 out of 3 non-musicians preferred spring reverb for classical music, jazz, and pop/rock mixes. The others answered these questions as no difference or different but negligible. Characteristics such as uneven frequency response of the spring reverb might be the reason for that. He or she might have noticed the difference on the frequency spectrum and answered so.

Results of the survey points that controlling listening environment of the participants rather than leaving it to them can make the results clearer. Choosing participants equally according to their occupation and taste of music might help to get more reliable results. Increasing the number of samples and differentiating them by tempo

and orchestration for questioning each type or parameter of reverb might provide more trustable results.

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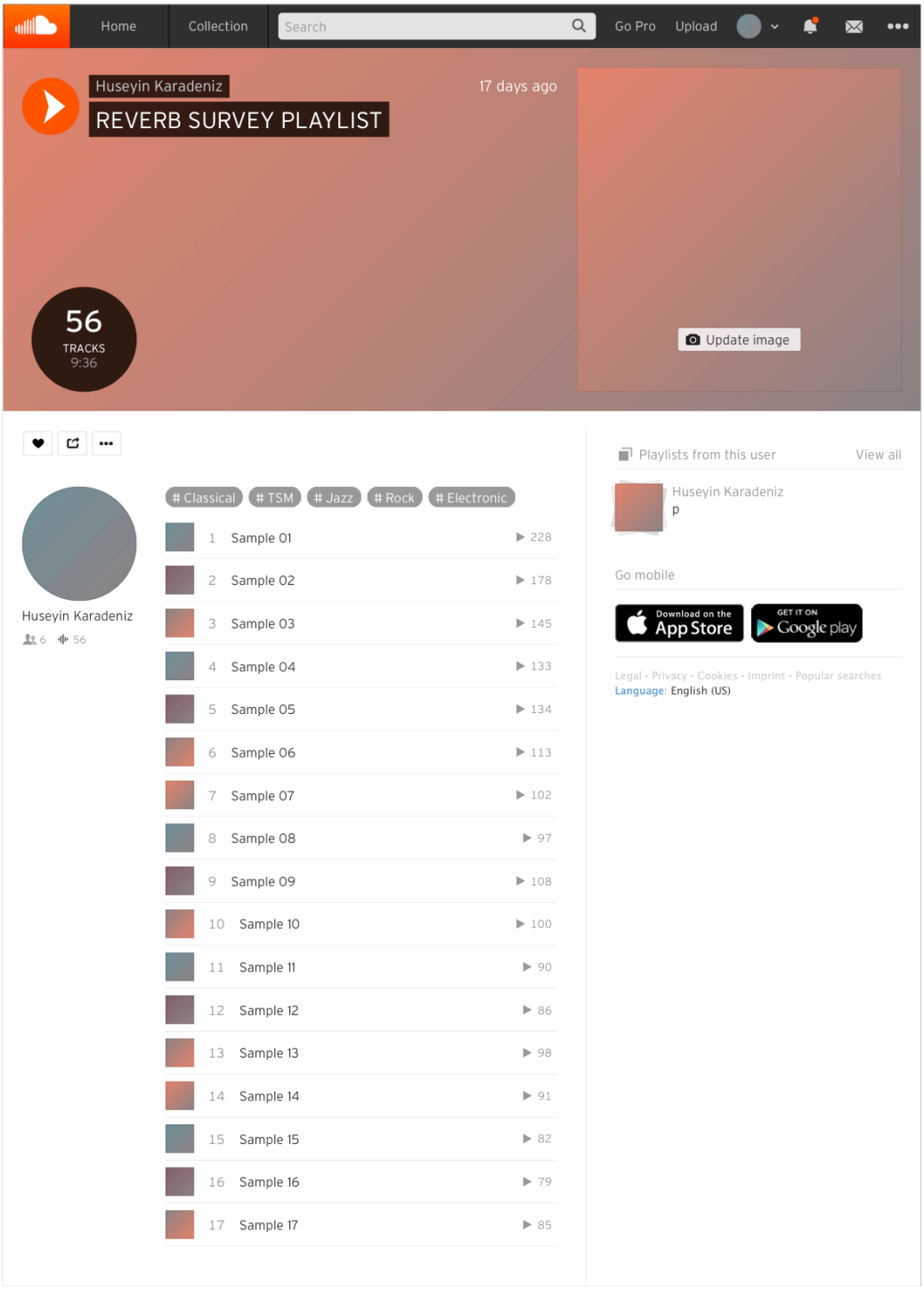
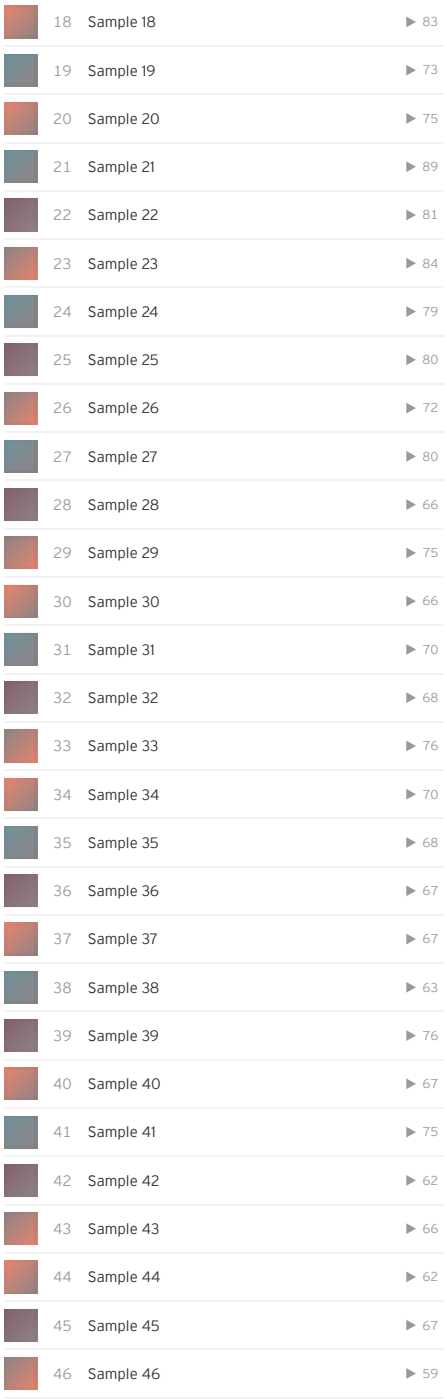
APPENDICES

APPENDIX A: PLAYLIST OF SAMPLES ON SOUNDCLOUD

APPENDIX B: SURVEY QUESTIONS AND ANSWERS

APPENDIX A: PLAYLIST OF SAMPLES ON SOUNDCLOUD




18 Sample 18 ▶ 83
19 Sample 19 ▶ 73
20 Sample 20 ▶ 75
21 Sample 21 ▶ 89
22 Sample 22 ▶ 81
23 Sample 23 ▶ 84
24 Sample 24 ▶ 79
25 Sample 25 ▶ 80
26 Sample 26 ▶ 72
27 Sample 27 ▶ 80
28 Sample 28 ▶ 66
29 Sample 29 ▶ 75
30 Sample 30 ▶ 66
31 Sample 31 ▶ 70
32 Sample 32 ▶ 68
33 Sample 33 ▶ 76
34 Sample 34 ▶ 70
35 Sample 35 ▶ 68
36 Sample 36 ▶ 67
37 Sample 37 ▶ 67
38 Sample 38 ▶ 63
39 Sample 39 ▶ 76
40 Sample 40 ▶ 67
41 Sample 41 ▶ 75
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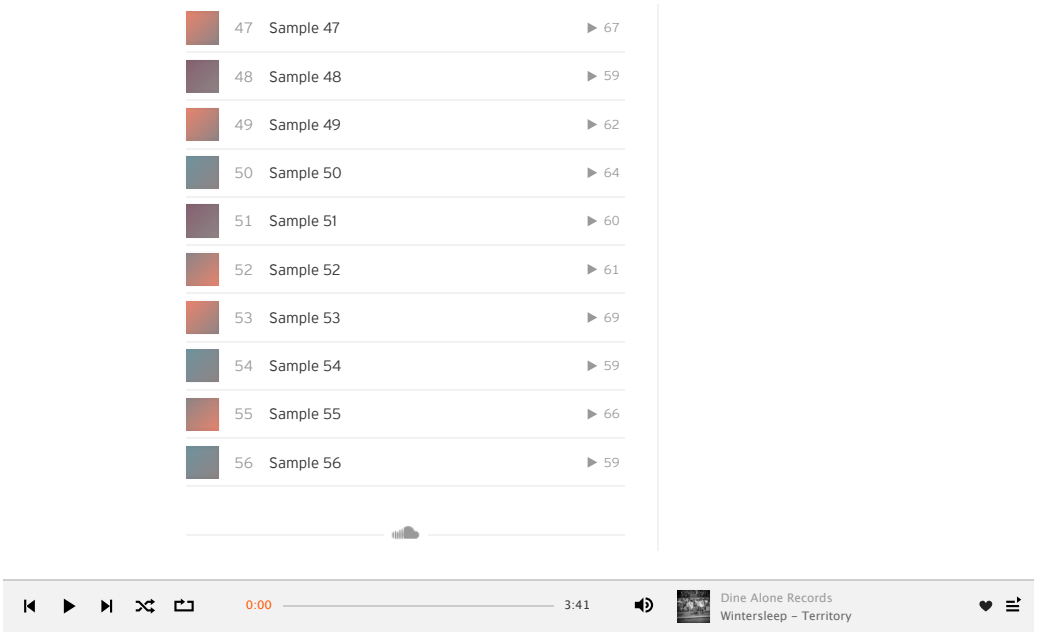
43 Sample 43 ▶ 66
44 Sample 44 ▶ 62
45 Sample 45 ▶ 67
46 Sample 46 ▶ 59

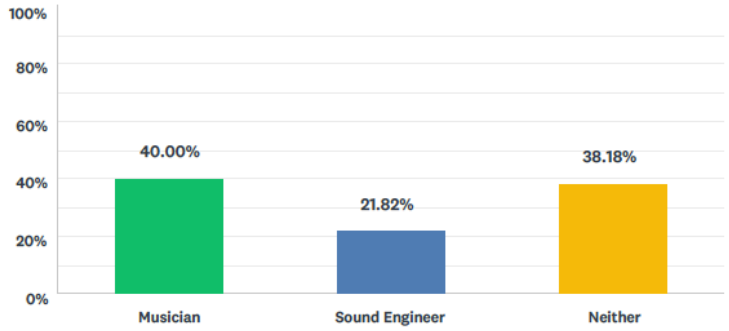

47 Sample 47 ▶ 67
48 Sample 48 ▶ 59
49 Sample 49 ▶ 62
50 Sample 50 ▶ 64
51 Sample 51 ▶ 60
52 Sample 52 ▶ 61
53 Sample 53 ▶ 69
54 Sample 54 ▶ 59
55 Sample 55 ▶ 66
56 Sample 56 ▶ 59
0:00
3:41
Dine Alone Records
Wintersleep – Territory

APPENDIX B: SURVEY QUESTIONS AND ANSWERS

REVERB SURVEY SurveyMonkey

Q1 Please choose your occupation.

Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Musician	40.00%	22
Sound Engineer	21.82%	12
Neither	38.18%	21
TOTAL		55

REVERB SURVEY SurveyMonkey

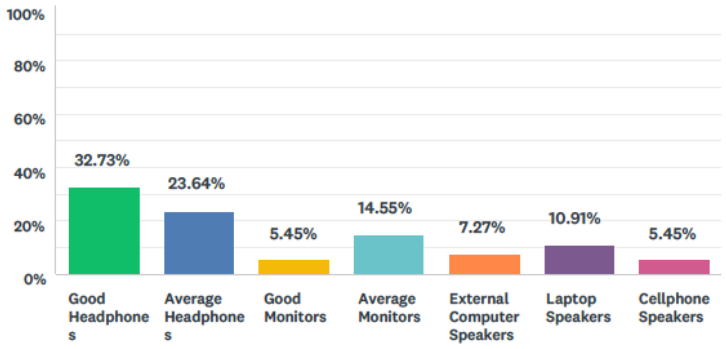
Q2 Please write your info.

Answered: 55 Skipped: 0

ANSWER CHOICES	RESPONSES	
Name/Surname	100.00%	55
Şirket	0.00%	0
Adres	0.00%	0
Adres 2	0.00%	0
Şehir/İlçe	0.00%	0
Eyalet/İl	0.00%	0
Posta Kodu	0.00%	0
Ülke	0.00%	0
E-posta Adresi	0.00%	0
Telefon Numarası	0.00%	0

Q3 Please choose the playback system you will use for the survey.

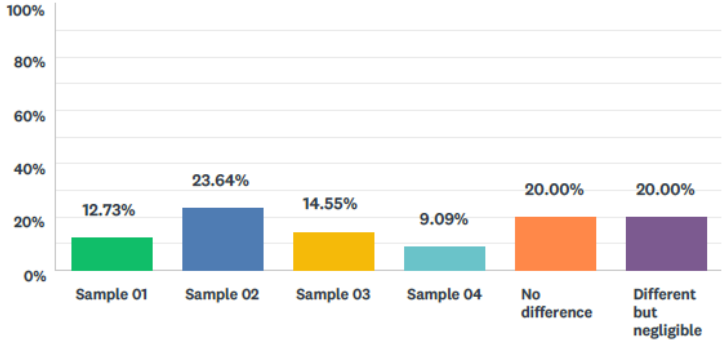
Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Good Headphones	32.73%	18
Average Headphones	23.64%	13
Good Monitors	5.45%	3
Average Monitors	14.55%	8
External Computer Speakers	7.27%	4
Laptop Speakers	10.91%	6
Cellphone Speakers	5.45%	3
TOTAL		55

Q4 Listen to SAMPLE 01, SAMPLE 02, SAMPLE 03, and SAMPLE 04. Which one sounds better?

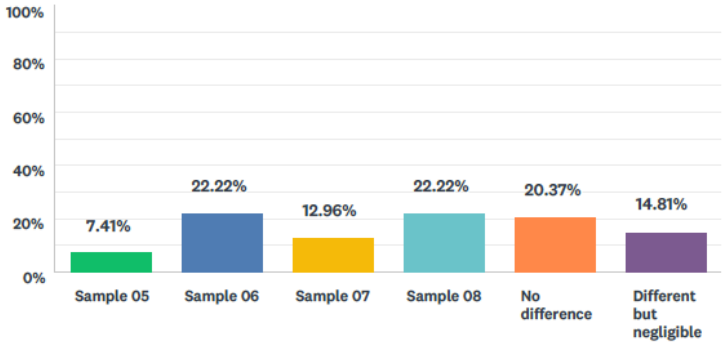
Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Sample 01	12.73%	7
Sample 02	23.64%	13
Sample 03	14.55%	8
Sample 04	9.09%	5
No difference	20.00%	11
Different but negligible	20.00%	11
TOTAL		55

Q5 Listen to SAMPLE 05, SAMPLE 06, SAMPLE 07, and SAMPLE 08. Which one sounds better?

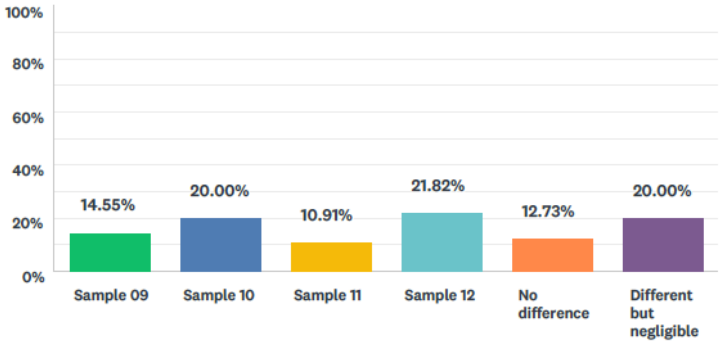
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 05	7.41%	4
Sample 06	22.22%	12
Sample 07	12.96%	7
Sample 08	22.22%	12
No difference	20.37%	11
Different but negligible	14.81%	8
TOTAL		54

Q6 Listen to SAMPLE 09, SAMPLE 10, SAMPLE 11, and SAMPLE 12. Which one sounds better?

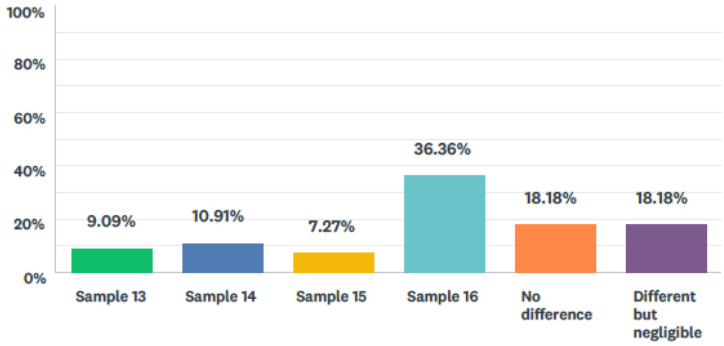
Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Sample 09	14.55%	8
Sample 10	20.00%	11
Sample 11	10.91%	6
Sample 12	21.82%	12
No difference	12.73%	7
Different but negligible	20.00%	11
TOTAL		55

Q7 Listen to SAMPLE 13, SAMPLE 14, SAMPLE 15, and SAMPLE 16. Which one sounds better?

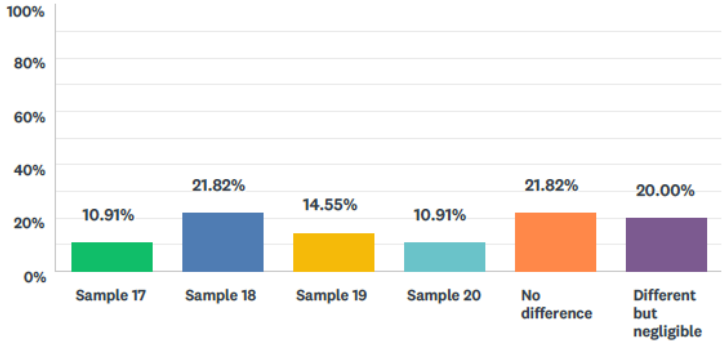
Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Sample 13	9.09%	5
Sample 14	10.91%	6
Sample 15	7.27%	4
Sample 16	36.36%	20
No difference	18.18%	10
Different but negligible	18.18%	10
TOTAL		55

Q8 Listen to SAMPLE 17, SAMPLE 18, SAMPLE 19, and SAMPLE 20. Which one sounds better?

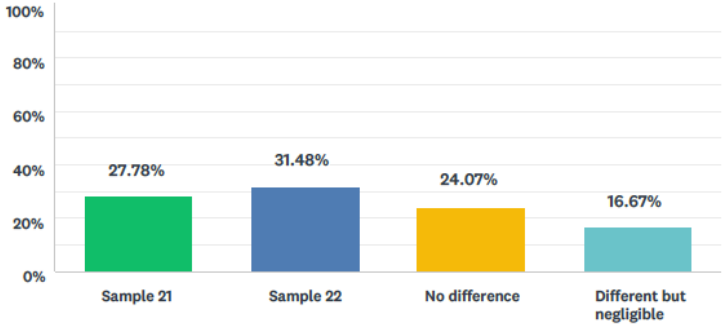
Answered: 55 Skipped: 0



ANSWER CHOICES	RESPONSES	
Sample 17	10.91%	6
Sample 18	21.82%	12
Sample 19	14.55%	8
Sample 20	10.91%	6
No difference	21.82%	12
Different but negligible	20.00%	11
TOTAL		55

Q9 Listen to SAMPLE 21 and SAMPLE 22. Which one sounds better?

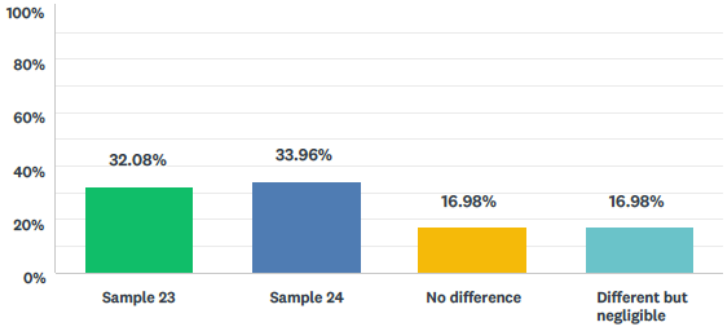
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 21	27.78%	15
Sample 22	31.48%	17
No difference	24.07%	13
Different but negligible	16.67%	9
TOTAL		54

Q10 Listen to SAMPLE 23 and SAMPLE 24. Which one sounds better?

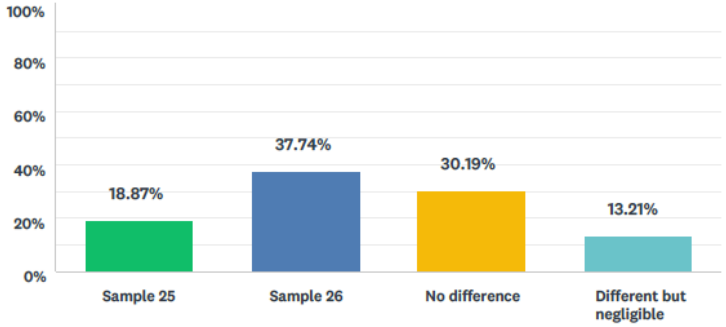
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 23	32.08%	17
Sample 24	33.96%	18
No difference	16.98%	9
Different but negligible	16.98%	9
TOTAL		53

Q11 Listen to SAMPLE 25 and SAMPLE 26. Which one sounds better?

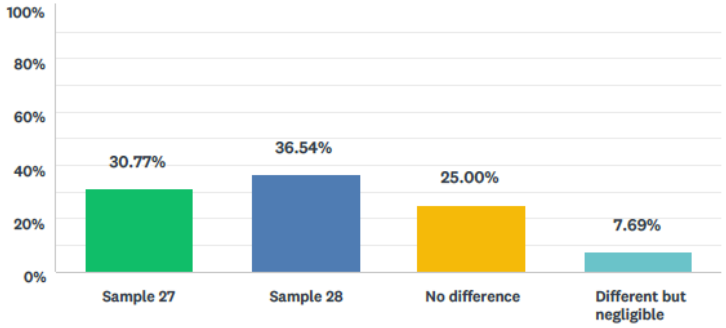
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 25	18.87%	10
Sample 26	37.74%	20
No difference	30.19%	16
Different but negligible	13.21%	7
TOTAL		53

Q12 Listen to SAMPLE 27 and SAMPLE 28. Which one sounds better?

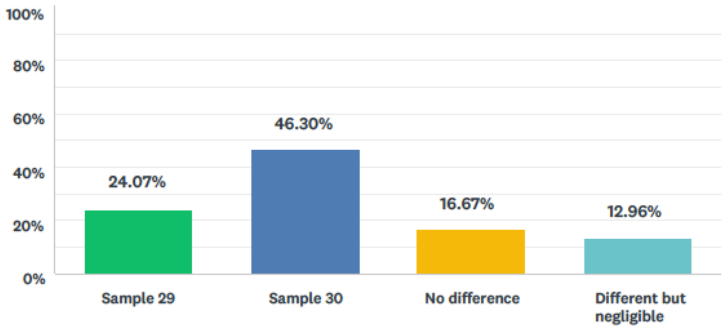
Answered: 52 Skipped: 3



ANSWER CHOICES	RESPONSES	
Sample 27	30.77%	16
Sample 28	36.54%	19
No difference	25.00%	13
Different but negligible	7.69%	4
TOTAL		52

Q13 Listen to SAMPLE 29 and SAMPLE 30. Which one sounds better?

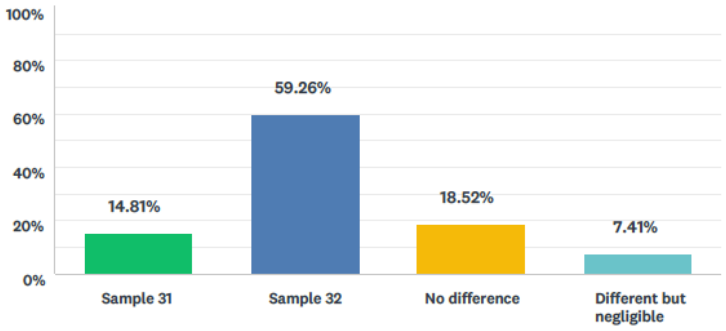
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 29	24.07%	13
Sample 30	46.30%	25
No difference	16.67%	9
Different but negligible	12.96%	7
TOTAL		54

Q14 Listen to SAMPLE 31 and SAMPLE 32. Which one sounds better?

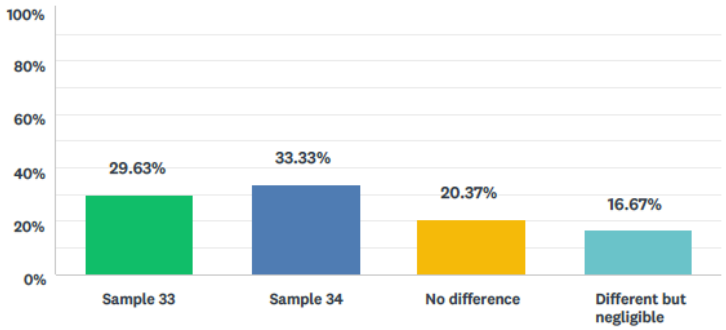
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 31	14.81%	8
Sample 32	59.26%	32
No difference	18.52%	10
Different but negligible	7.41%	4
TOTAL		54

Q15 Listen to SAMPLE 33 and SAMPLE 34. Which one sounds better?

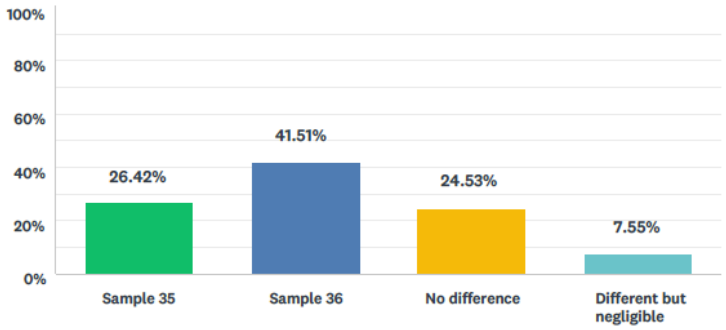
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 33	29.63%	16
Sample 34	33.33%	18
No difference	20.37%	11
Different but negligible	16.67%	9
TOTAL		54

Q16 Listen to SAMPLE 35 and SAMPLE 36. Which one sounds better?

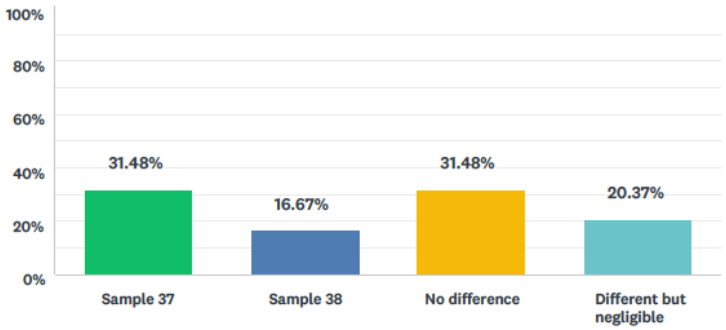
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 35	26.42%	14
Sample 36	41.51%	22
No difference	24.53%	13
Different but negligible	7.55%	4
TOTAL		53

Q17 Listen to SAMPLE 37 and SAMPLE 38. Which one sounds better?

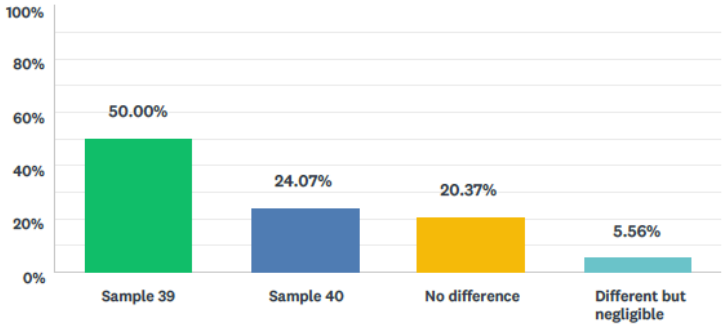
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 37	31.48%	17
Sample 38	16.67%	9
No difference	31.48%	17
Different but negligible	20.37%	11
TOTAL		54

Q18 Listen to SAMPLE 39 and SAMPLE 40. Which one has more noticeable (or louder) reverb?

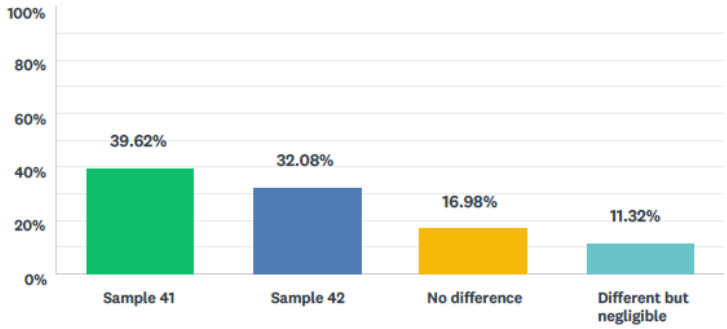
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 39	50.00%	27
Sample 40	24.07%	13
No difference	20.37%	11
Different but negligible	5.56%	3
TOTAL		54

Q19 Listen to SAMPLE 41 and SAMPLE 42. Which one has more noticeable (or louder) reverb?

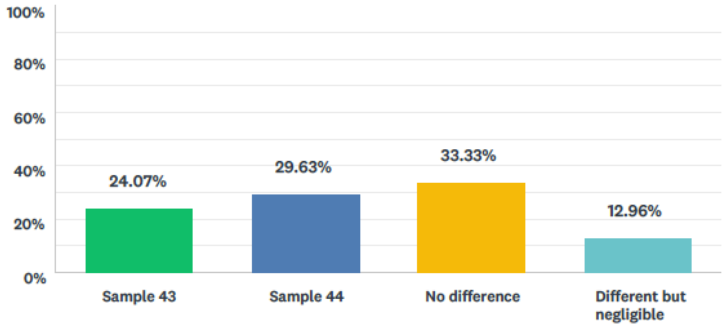
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 41	39.62%	21
Sample 42	32.08%	17
No difference	16.98%	9
Different but negligible	11.32%	6
TOTAL		53

Q20 Listen to SAMPLE 43 and SAMPLE 44. Which one has more noticeable (or louder) reverb?

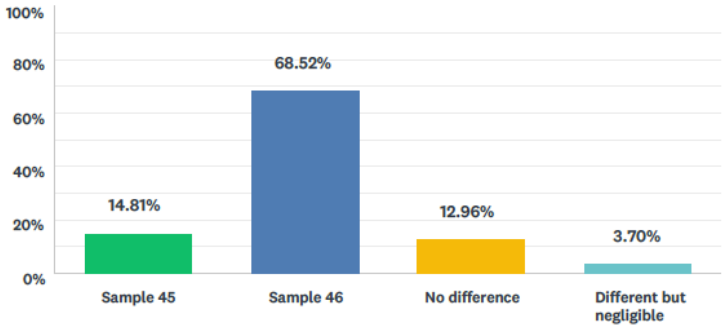
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 43	24.07%	13
Sample 44	29.63%	16
No difference	33.33%	18
Different but negligible	12.96%	7
TOTAL		54

Q21 Listen to SAMPLE 45 and SAMPLE 46. Which one has more noticeable (or louder) reverb?

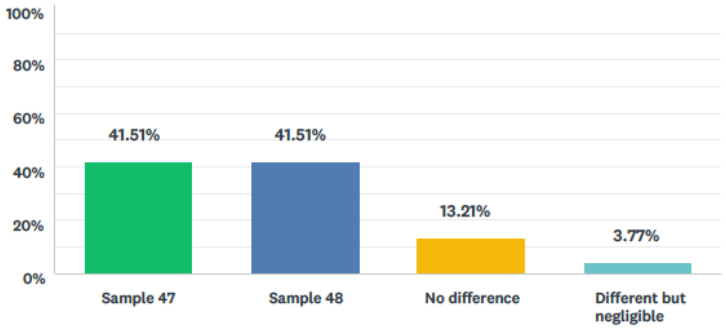
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 45	14.81%	8
Sample 46	68.52%	37
No difference	12.96%	7
Different but negligible	3.70%	2
TOTAL		54

Q22 Listen to SAMPLE 47 and SAMPLE 48. Which one sounds better?

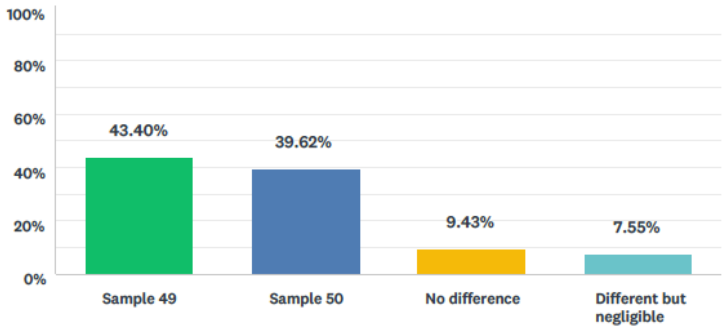
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 47	41.51%	22
Sample 48	41.51%	22
No difference	13.21%	7
Different but negligible	3.77%	2
TOTAL		53

Q23 Listen to SAMPLE 49 and SAMPLE 50. Which one sounds better?

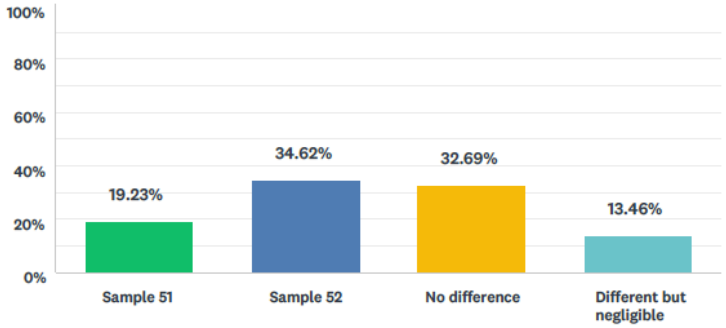
Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 49	43.40%	23
Sample 50	39.62%	21
No difference	9.43%	5
Different but negligible	7.55%	4
TOTAL		53

Q24 Listen to SAMPLE 51 and SAMPLE 52. Which one sounds better?

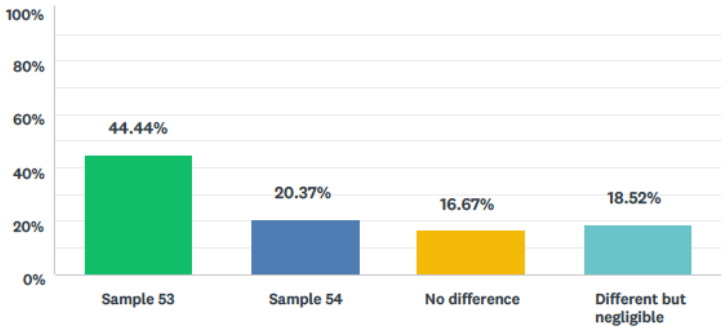
Answered: 52 Skipped: 3



ANSWER CHOICES	RESPONSES	
Sample 51	19.23%	10
Sample 52	34.62%	18
No difference	32.69%	17
Different but negligible	13.46%	7
TOTAL		52

Q25 Listen to SAMPLE 53 and SAMPLE 54. Which one sounds better?

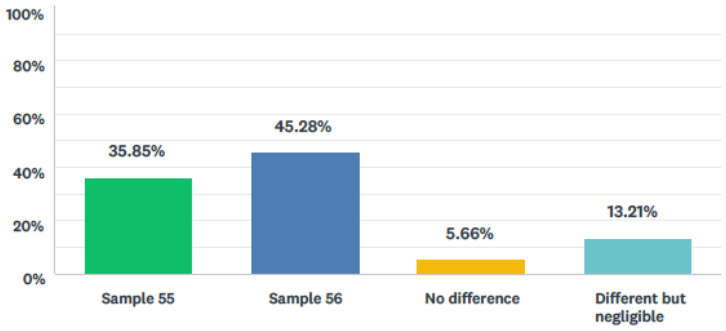
Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Sample 53	44.44%	24
Sample 54	20.37%	11
No difference	16.67%	9
Different but negligible	18.52%	10
TOTAL		54

Q26 Listen to SAMPLE 55 and SAMPLE 56. Which one sounds better?

Answered: 53 Skipped: 2



ANSWER CHOICES	RESPONSES	
Sample 55	35.85%	19
Sample 56	45.28%	24
No difference	5.66%	3
Different but negligible	13.21%	7
TOTAL		53