The haas effect – echoes and location essay sample

The aim of this project is to research into Helmut Haas's observations about the way a human brain deals with the sounds it hears in every day life and thus learn how to fool a person into believing something is or isn't as it really is. To begin with its important to realise how the brain finds the location of sounds it hears, once this has been clarified more research can be done into the different discoveries which Haas made and how they can be used in modern life.

The actual effects which Haas discovered can be simply written down as three separate findings. These three effects are commonly known as the Haas effect even though they are a plural. The official findings of Haas are as follows: I

1. Signals which arrive at the same time but from different sources are heard as one sound from a fictitious or phantom source that is localized between the two sources at a place dependent upon the relative intensities of the two sources. This is the basics of volume panning.

2. Signals from the same source arriving at different times are heard essentially as one sound, with the delayed signal adding to the original sound but, when audible, being heard much more weakly.

3. Signals incoherent in both time and direction are heard as not localized, neither from source nor from a large range of angles in space, i. e. as a diffused sound. This diffused sound can be adjusted so as to come from a far more believable phantom source. To do this, more information of how the human brain interprets sound is required.

Basics of Human sound location.

The human brain has a very clever method for locating the source of sounds that are heard. A sharp sound in the middle of silence can be easily picked up and a person can instantly ‘ feel’ where the sound came from, be it in front, behind, or to the side. However the brain can also pickup the location of individual sounds among many other sounds, like picking exactly where different voices are originating from in a crowd. This ability to quickly and instinctively locate sounds is a very important one in early human survival, and it may well have developed from the survival of the fittest area of evolution.

It is quite easy to see that if somebody could hear exactly where the sounds of animals which they wanted to catch were coming from, they would be able to catch more of them and thus have more food to live on. For example being able to stalk deer by their sound greatly increases somebody’s chances of catching them, and thus the people who did not develop this skill would not have survived as long and thus produced fewer offspring. Also an instinctive reaction of running in the opposite direction as to where you heard a predator will also help to secure human survival. However once you understand that sound can be located, there is still a huge mountain of information on how the brain actually works out direction and position and also clarifies the sounds and uses echoes to amplify any sound in a crowd.

To take the most extreme example of sound location, imagine a door is slammed, creating a sound which originates directly to the right of someone’s head 5 feet away. Due to sound travelling at a finite speed of

1130 feet per second in air, it takes time for it to travel across the room from the door, to their head. The first object which the sound will come in contact with is their right ear. The sound will be heard many times through echoes and other abnormalities; however the very first sound they hear is always the shortest path difference to the source. This ear will then detect the sound and process it through the brain.

As stated above, sound travels at 1130 feet per second in air. By using the equation of distance = speed x time the distance an object (or sound) has travelled can be calculated if the time taken from start to finish is known. In the case of the sound coming from the right, the path difference between the sound going to the right ear and the left ear is about 1 foot with a spongy barrier between (a human head) This causes the two path differences to be more apparent as the sounds travelling directly from one ear to the other are absorbed a great deal. If they were not absorbed there would be a problem with sound travelling faster though the more solid head than the air.

Therefore the formula shows that the time difference will be 1 ï¿½ 1130 which is 0. 889 milliseconds or approximately 0. 9 ms. This number will be useful later as it is also the time taken for sound to travel one foot, so when multiplied by the path difference in feet it gives the delay time. The reason for using feet per second in this report rather than the standard SI units of meters per second is that due to the human ears being very close to 1 foot apart it makes all of the calculations far more simple and seeing as what is required is simply the time delay, the unit of distance is not important as they both give answers in seconds.

Therefore 0. 9 milliseconds later the left ear starts to pick up the sound. This sound get processed too and goes to the brain, where without thinking about it the human brain automatically measure the time delay between the sound from right and left ears. In this case the sound has taken the longest possible time difference between the two ears, because the sound was directly to the side. However, had the sound come from the left, the time delay would have been of the same magnitude but in the opposite direction, because the right ear would have heard the sound last rather than before the left ear.

Also, if the sound was either directly in front or directly behind, the time delay between the two sounds would have been zero. Therefore as a sound travels around the head in a circle, the delays, gradually get longer and then shorter and then reverse in a sine wave like pattern. This wave is relevant because you can use the sine wave along with trigonometry to actually calculate the angle at which the sound must have come from originally, and this is exactly what your brain is doing all the time.

From a very early age, the human brain learns the maximum time delay between its ears and adjusts the senses to that limit. As the head grows with age, sound location does not suffer, therefore the human brain must be capable of adjusting these limits over time.

This simple phenomenon uses basic mathematical instinct to find sound direction. As it was stated earlier, all that is required is some simple trigonometry. The human brain knows the distance between its ears and the time delay between hearing each sound and thus the path difference of the sound to each ear. A simple drawing below will help to explain how the angle of the source of the sound can be established using trigonometry.