EFFECT OF MICROPHONE POSITION ON VOICE QUALITY

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1. INTRODUCTION

In most recording and live amplification situations, the human voice is picked up by a microphone placed in close proximity to the subject. Various sonic problems unique to the interaction between voice and microphones can prevail due to such close placement. The most common problems in practice are popping from plosive consonants, exaggerated sibilance and biased timbral coloration.

Popping results from a brief turbulence of air exhaled from the mouth when pronouncing plosive consonants such as "b", "p", "t", "d", "k", "g"; and fricatives such as "h", "f" and "v" [1]. The microphone diaphragm becomes momentarily displaced in an extreme fashion producing an audible "thump" or "pop" sound as its output. This problem only occurs with directional pressure-gradient type microphones. The most common remedy is to place a "pop screen filter" device made of a fabric or metal mesh between the voice and microphone. This is not entirely effective however as too often some blasts of air still pass through the pop screen to the microphone.

The microphone can also translate sibilant consonants (s, sh) into distorted or whistle-like sounds - an exaggerated "flashing" of "s" sounds relative to the other accompanying consonants and vowels. These effects are further emphasized when common signal processing is applied such as electronic high-frequency equalization boosts and dynamic range compression.

It is well known that any resultant audio timbre is dependent on microphone orientation. However, this is entirely due to the directional properties of the voice which, depending on the point of microphone pickup, may have significantly different spectral characteristics. For example, some positions could result in a fuller sound, or, even impose an alias formant quality.

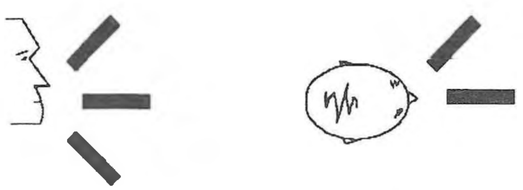
It is certain that different microphones will produce any of these problems to different degrees. In effect, the results of this investigation are influenced principally by the radiation patterns of the different voice phonemes at close range regardless of microphone characteristics. This research will attempt to establish the effect of microphone point of pickup on these 3 sonic distortions and to identify positions that might have a lower occurrence of these problems.

2. METHOD

Four different test subjects participated in this experiment - 2 females and 2 males. The subjects each sat on a chair facing a cluster of four of the same model pressure-gradient condenser type microphones. Microphones with a super-cardioid directional pattern were chosen in order to focus the range of pickup from the selected positions.

The microphones were positioned as depicted in Figure 1a and 1b. Each microphone was equally placed 10 centimetres away from the centre of the subject's mouth. (It was expected that the bass-boost "proximity-effect" would occur at such a close distance, but that it would be a given constant since all 4 positions are equidistant from the sound source). The four positions relative to the subject's mouth were: above, directly in front, below and to the left side. The first 3 positions were at 0-degrees azimuth with the above and below microphones being 40-degrees above and below the plane of reference of the mid-position microphone. Only one side microphone was set up assuming symmetry. It was placed (as in Fig. 1b) on the same horizontal plane with the subject's mouth but to the subject's left side by 40-degrees. All microphones were aimed at the subject's mouth.

Fig. 1a **Fig. 1b**



The room environment can best be described as semi-anechoic. In addition, the extreme close microphone placement to the sound source minimized the effect of room acoustics on the experiment.

The signals from all four microphones were recorded simultaneously into a desktop computer-based multitrack digital recording system.

To test for plosive consonants, the subject was scripted to speak a series of six separate sets of plosives and fricatives: b, p, t, k, h, and f. Each consonant was voiced with an attached set of vowel sounds: a (ah), e (eh), i (ee), o (oh), u (oo). For example: "Ba – Be - Bi – Bo - Bu".

The test stimuli for sibilant sounds involved the subject reciting the phrase, "many times loves lost" repeated twice.

The timbral test stimuli for the involved the subject voicing the vowel sounds, a, e, i, o, u as well as (nasal phonemes) "m" and "n". Each utterance was held at a constant pitch for about 3 seconds and repeated twice.

3. RESULTS

The plosive/vowel combinations that produced significant popping sounds from the microphone were quite apparent through listening as well as visually by the amplitude vs. time graphical waveform display. The results were tallied up in summary (Tables 1-4) with the maximum occurrences highlighted in grey:

Table 1: Consonant totals

B	P	K	T	H	F
10	29	9	25	31	21

Table 2: Vowel attachment totals

A	E	I	O	U
22	23	16	33	32

Table 3: Position totals

ABOVE	MID	BELOW	SIDE
28	62	23	12

Table 4: Detailed position totals

	B	P	K	T	H	F
above	0	5	1	6	3	13
mid	10	17	7	9	11	8
below	0	4	1	10	8	0
side	0	3	0	0	9	0

The sibilance tests were evaluated by simple listening via headphones and loudspeakers. The above microphone position gave the smoothest and most natural sibilant sound. The mid position gave the most exaggerated "s" sounds relative to the vowels and other consonants of the spoken phrase. Further validation is required through more blindfold listening evaluations from expert listeners, for example, sound engineers.

The most evident results in the timbral test were found with the nasal phonemes, "m" and "n". Here both aurally and visually (via the graphical waveform) the above position clearly had a fuller sound and higher amplitude output with the below position being the weakest.

Regarding the vowels (a,e,i,o,u), results show that the mid and side position timbres are virtually identical with the mid microphone position producing a slightly extended high-frequency content. The mid position showed the greatest proportion of high-frequency content of all 4 positions.

4. DISCUSSION

The results gathered here reveal some clear trends in the interaction between microphone position and specific voice phonemes. Many audio engineers often refer to any given microphone position as possessing a certain sonic characteristic perhaps preferable to other positions. This practice is a generalisation that may need to be further qualified dependent on the nature of what the sound source (voice, in this case) is actually producing. As a sound source, the voice challenges these oversimplifications because it is a peculiar "instrument" that changes physical form with every different phoneme it produces (not taking into account pitch). At such a close microphone position range, this change of shape results in marked differences in directional radiation. For example, it might be believed that a certain position can yield a "fuller" sound – yet this may only be true for certain phonemes as seen here with "m" and "n".

It appears (see Table 3) that the side position has the best chance of avoiding "popping". This can be an interesting option since the vowel and sibilant sounds are virtually the same here as they are for the mid position. However, the mid position (which is the most common choice for voice pickup) also provides the highest chance of "popping" from plosives. Both the above and below positions are also superior to the mid position, with the above position having the added possible benefits of producing a fuller sound (for nasal phonemes) and the smoothest sibilant sounds. It is also proven here that H and P along with the O and U vowels are the most troublesome phonemes for "popping" a microphone. These findings may also have implications towards the design of more effective pop screen filters.

The sibilant tests reveal what might be expected because the mid position would capture the highest proportion of high frequency energy causing the sibilant sounds to be most prominent. As well, the mid position may in effect produce a standing-wave reflections between the microphone itself and the face of the subject at short wavelengths (around 2 cm. and less).

REFERENCES

[1] Wuttke, J. (1992). Microphones and Wind. *Journal of the Audio Engineering Society*, Vol. 40, no. 10.

[2] Marshall, A.H., Meyer, J., (1985). The Directivity and Auditory Impression of Singers. *Acustica*, Vol. 58.