Lombard Partied in a Café … or was it at a Cocktail Party… Say What? – the Clarification of Speech-Related Concepts in Acoustics

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The interactions of human speech and noise are diverse and intriguing. Practitioners have categorized these varied speech interactions, evolving special descriptive terms. Each term is intended to treat a specific aspect of these interactions. For young and "experienced" practitioners alike, these related terms can be confusing. Four particular terms stand out: (1) the Lombard Effect, (2) the Lombard Reflex, (3) the Cocktail Party Effect, and (4) the Café Effect. It is important to recognize their meanings and differences:

Lombard Effect: The Lombard Effect is a change in uttered speech quality brought on by an increase in the ambient sound level combined with auditory feedback of the talker's voice. The modified speech is often referred to as "Lombard Speech", named after the researcher first reporting the phenomena in 1911 [1].

Lombard Reflex: The Lombard Reflex is the reactive change of articulatory movements by the talker aimed at improving communication. These changes in speech include increased loudness of the voice, increased pitch of the voice, and improved articulation of the speech. The talker instinctively strives to maintain what is perceived as a favorable signal-to-noise ratio for their speech at that listener's position in that sound environment [2]. Ambient sound level, room reverberation time, and noise quality all influence these speech modifications.

Cocktail Party Effect: The Cocktail Party Effect [3] is the ability of a listener to focus attention toward the sound from a particular talker or source among a variety of stimuli in order to increase that source's signal-to-interfering noise ratio. An important aspect is that speech sounds from others nearby function as the noise. The concept is the visual equivalent of the "figure-ground phenomenon" – perceptually assigning edges to define a shape. MacLean was one of the first to quantify this auditory phenomenon in 1959 [4]. Researchers believe the aural phenomenon is a result of the auditory system and high-level processing in perception and language.

The Café Effect: The term "Café Effect" has come into recent international use to distinguish the noise rise from the participant reactions. The first published reference we found was in 2007 by Whitlock and Dodd [6], who introduced it in reference to children competing to be heard in a New Zealand classroom. They acknowledge that the term "Cocktail Party Effect" has been previously used to include related phenomena, but they then define specifically that "*In simple terms, the café effect is the tendency, inside a reverberant space, for noise to 'breed' noise. Generally the noise is generated by conversations of separate groups of occupants, who subconsciously compete with the reverberative noise from other groups of occupants, who subconsciously compete with the reverberative noise from other groups and raise their voice such that they can be heard and understood by members of their own group.*"

As the ambient sound level in the room rises, a speaker's Lombard speech level increases to promote communication. But in turn, it adds to the noise level in the room. The 1960 study of the Cocktail Party Effect by Legget and Northwood [5] discovered that when the size of a group grows to exceed a critical number, ranging from 10 persons in a small room to 60 persons in a large hotel reception room, the conversational sound level suddenly jumps by about 15 decibels due to this regenerative competition between talkers. The resulting speech level is at least an order of magnitude greater than that required to communicate in quiet surroundings.

Considering the similarities among the terms, it is helpful to provide the following cohesive summary: The Lombard Effect focuses on an individual talker's reaction to the acoustical environment with regard to his or her speech. In a crowd that promotes conversations, because of perceived auditory response the Lombard Reflex increases one's vocal level. The ambient sound level rises to a level that satisfies all individual needs for communication. Within that crowd, each listener focuses on specific voices using the natural abilities of the auditory system, affecting selective

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attention or selective listening. This had come to be known as the Cocktail Party Effect [3, 4, 5] for public conversations, whether in pairs or in groups, in speaking or in listening arising from a universal desire for effective communication. As a collected conversing group in a room comes to contain more persons, they all speak louder to one another. On exceeding a critical number of room occupants the conversational sound level jumps about 15 decibels [5], a phenomenon now reflected in the term Café Effect [6]. For groups of persons numbering much less than or much greater than the critical number, the rate of increase of sound level vs. the number of persons conversing is the expected 3 dB per number doubled.

There are three interesting ancillary consequences relating to these communication phenomena. The first involves the Lombard Effect. When one participates in a conversation in a very noisy area requiring extensive use of Lombard speech, the voice will fatigue and on occasion fail completely in that venue. (At least one of the authors has had that occur more than once.) This troubling effect on the human voice is one of the many reasons for promoting ANSI S12.60-2002 – to avoid the need for Lombard Speech by teachers in a noisy classroom.

A second consequence deals with auditory deficiencies and the Cocktail Party Effect. A person with hearing loss or other auditory deficiency has less capability to employ cocktail party focusing sufficient for successful communication in noisy environments. Consequently, communicating in noisy venues can become embarrassingly difficult and may result in that person appearing to be, or actually becoming, reclusive.

The third issue involves the use of sound absorption and the Café Effect. When sound absorption is added to a room that experiences the Café Effect, the amount of ambient noise reduction observed is actually greater than that which is calculated. This increased reduction is because of the regenerative nature of the Café Effect – absorption reduces the background noise, so less speech effort is needed, and therefore, the overall noise level becomes even lower, especially for spaces of occupancy near and above the critical number.

Exploration of these three complex interactions should continue. Each

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is unique but with some commonality. The four terms defined deal with speech and the auditory system. Two of the effects, Lombard and Café, are directly related to each other through the influence of signal-to-noise ratio. The Café and Cocktail Party Effects both involve interactions within crowds of people while the Cocktail Party and Lombard Effects both relate to an individual's reaction to an environment.

The authors have written this article in hopes that good Mr. Lombard's influence in crowded places can be heard. Such noise can often be reduced by the efforts of NCAC consultants. Patrons should be able to speak their mind at a reasonable level in cafés and at cocktail parties.

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[2] Lane, H. and Tranel, B. (1971) "The Lombard sign and the role of hearing in speech," *J. Speech Hear. Res.* 14, 677-709.

[3] Pollack, I and Pickett, J. M., "Cocktail party effect" *J. Acoust. Soc. Am.* 29 (1), pp. 1262 (1957).

[4] MacLean, W. "On the acoustics of cocktail parties." *J. Acoust. Soc. Am.* 31 (1), pp. 79-80 (1959).

[5] Legget, R. F. and Northwood, T. D. "Noise surveys in cocktail parties." *J. Acoust. Soc. Am.* 32 (1), pp. 16-18 (1960).

[6] Whitlock, J. and Dodd, G. "Classroom Acoustics – Reverberation and the Café Effect ... Is the Lombard Effect the Key?" 19th International Congress on Acoustics, Madrid, 2-7 September, 2007. See <http://www.sea-acustica.es/WEB_ICA_07/fchrs/papers/rba-04-006.pdf.>

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