An Introduction to Speech Privacy: Can You Hear Me Now?

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What Is Speech Privacy?

Did you ever have a nearby conversation interrupt your focus? Have you ever heard the doctor/patient conversations in the next examination room? Do you discuss sensitive or personal information in private conversations? These are just some of the examples where speech privacy is required in the built environment. This article is intended to provide a basic introduction to and understanding of speech privacy in architectural spaces.

In most architectural spaces, good speech intelligibility is an important aspect of aural communication. This is especially true for classrooms and meeting rooms. However, it is also important that some types of aural communication are limited to those for whom it is intended and that all reasonable safeguards are taken to ensure that these conversations are not heard by an unintended listener(s). Speech privacy is defined in Acoustical Society of America (ASA)/American National Standards Institute (ANSI) S12.70 (1996) as (the) "*Measure of the degree to which speech is both audible and can be understood by casual unintended listener(s).*" Speech privacy is required by the Health Insurance Portability and Accountability Act of 1996 (HIPAA) for health care spaces and the Gramm-Leach-Bliley Act of 1999 (GLBA; also known as the Financial Modernization Act) for spaces conducting financial communication.

Expectations for Speech Privacy

The focus of the ASA Technical Committee on Architectural Acoustics (TCAA) is the acoustical environment within buildings. Because speech privacy is an expectation and sometimes a legal requirement, the TCAA formed a subcommittee to specially focus on speech privacy within the built environment. The term "speech privacy" is ultimately an umbrella term for several similar, but yet different, occupant concerns.

During the first speech privacy subcommittee meeting, the members discussed the needs and expectations for speech privacy. However, it was immediately clear that there was a fundamental disagreement among members as to the general expectations for speech privacy. After further discussion, it also became clear that various members were talking about different kinds of architectural spaces and thus had different expectations for speech privacy. For example, one member based his expectations from a recent visit to a doctor's examination room. Another member based her expectations on an open-plan office project. Other members were describing the speech isolation needs for classrooms.

Finally, after much discussion, it was clear that all of the experiences were correct but also very different. It was agreed that there are subcategories of speech privacy, and the "kind" of speech privacy is dependent on the application and occupant expectation. Perhaps this was best presented by Cavanaugh et al. (1962, p. 480):

"*The degree of speech privacy required by the occupant of a room depends on his activity. As an example, consider the case of an engineer or other technical person. During most of his work day, his desire for speech isolation is set by his wish for freedom from distraction. We have called this "normal" privacy. However, if he should be called into the office of his supervisor or employer to discuss salary or personal matters, the need for speech isolation is different. It no longer is the freedom from distraction, but now becomes the assurance of not being overheard. This kind of privacy we have called 'confidential.' Let us further imagine that a part of his work concerns a highly classified project. Conferences he may have in this connection may need to be truly secret.*"

Thus, the Cavanaugh et al. paper identified three "kinds," or categories, of privacy needed.

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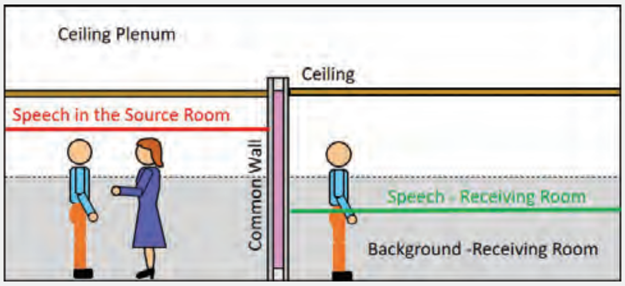


Figure 1. *Speech privacy between two adjacent offices.* ***Red line****, voice level;* ***gray area****, background noise level;* ***green line****, intruding voice level that has been reduced by the architectural path (through the wall and the ceiling) due to appropriate design choices. See text for details.*

Speech Distraction

Speech distraction, also called "freedom from distraction," is from the perspective of the listener whose desire is to be free from the distraction of other talkers that could impede focus, worker productivity, and/or overall comfort. The paper called this "normal privacy." However, many ASA members believe the term "normal" is insufficient for practical use because when working with the architectural community (e.g., architects, building specifiers, general contractors, and building owners), terms must be clear and have legal meaning. Thus, the term normal would be bad practice for legal documents such as building specifications. Speech distraction is the term whereby the occupant expects that speech can be both audible (heard) and intelligible (understood) by unintended listeners but minimally distracting.

Confidential Speech Privacy

This kind of privacy is from the perspective of the talker whose desire is to limit the information shared via speech. One might argue that the typical occupant within a closed room has a reasonable expectation that the information shared (spoken) will be contained within the boundaries of the room. Consider how your expectation for "confidential speech privacy" changes with the door open versus with the door closed. For confidential speech privacy, a talker's speech may be heard by unintended listeners in adjacent rooms but not understood by them.

Speech Security

This kind of privacy is once again from the perspective of the talker who requires limitations to information shared aurally. In this case, the desire is that speech must be infrequently heard, if at all, and not understood by unintended listeners outside the source room.

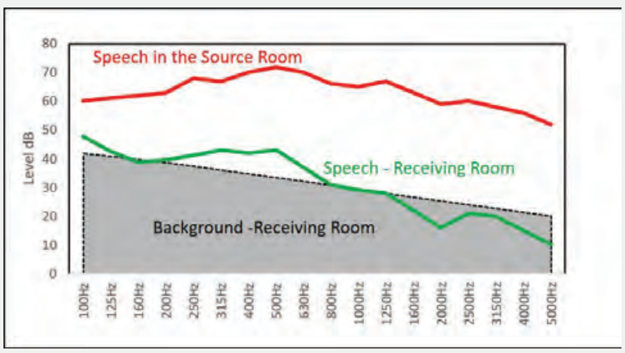
Fundamentals of Speech Privacy

Speech privacy depends on the signal-to-noise ratio of the intruding speech level (signal) and the background noise at the listener's location. The intruding speech level in the listener's location is determined by the source talker's effort (how loud) and the noise reduction provided by the architectural design (walls, ceilings, etc.) that might lower the sound level before it gets to the listener's location.

The overall principals are illustrated in **Figure 1**. These rooms could be medical treatment/examination rooms or adjacent enclosed private offices. **Figure 1**, *left*, shows the source room with two people having a conversation. The voice is well above the background noise because it needs to be to achieve clear intelligible speech within the room. **Figure 1**, *right*, shows the receiving room occupied by an unintended listener. Note that the intruding voice (**Figure 1**, *green line*) is within the background noise (**Figure 1**, *gray area*); thus, the intruding voice is "masked" by the background noise.

Speech privacy is a complex problem that involves the frequency content of the source voice, the wall and ceiling attenuation, and the background sound level and spectrum. **Figure 2** shows a plot of frequency versus amplitude level (in decibels). In this plot, the relative

Figure 2. *Room-to-room speech privacy is plotted as frequency versus amplitude level.* ***Red line****, source voice;* ***green line****, intruding voice level into the listener's space (receiving room);* ***gray area****, background noise level. See text for details.*



levels (signal-to-noise ratio) by frequency are seen and illustrate which parts of speech are significantly masked and which parts of speech may be heard and understood.

The three key considerations from **Figures 1** and **2** are the background noise, architectural sound blocking, and the source voice.

Background Noise

If we were to lower the background noise, the intruding voice would be unmasked and speech privacy would be compromised. If we raised the background noise, then the intruding speech would be masked even more.

Architecture

Changing the architecture affects the intruding voice. Less robust wall and ceiling choices will attenuate the source voice less, resulting in unmasking of the intruding voice (**Figure 2**, *green line* goes up). More robust wall and ceiling choices will better attenuate the source voice so that the intruding voice will be better masked (**Figure 2**, *green line* goes down).

Source Voice

The source talker's effort is a design condition, not a design choice, and will depend on many demographics, but also on the situation. We must consider the use of the space and the experiences within the space. When in a library, many voices may be at a casual or soft effort (lower sound level), but a counseling space may experience emotionally charged and louder conversations (higher sound levels). This, along with speech privacy expectations, dictates the architectural design choices.

If the anticipated source voice is casual and the speech privacy expectation is simply to minimize distraction, then perhaps a furniture partition such as an open office cubical design is sufficient. In a medical office, the vocal effort can be expected to be more conversational, meaning a higher effort than a casual voice. Also, the speech privacy expectations are increased due to the sharing of personal, private, and potentially embarrassing information. This requires completely different architectural solutions. Rooms must now be fully enclosed as in **Figure 1**. The wall, ceilings, and door design must sufficiently contain the speech within the room so that speech cannot be understood by listeners in adjacent rooms. Voices may be heard, but speech may not be understood.

Designing for Speech Privacy

By considering the expectations and fundamentals of speech privacy, we can put them together with a knowledge of privacy architecture and make good design choices. The following are some examples for achieving good speech privacy design in various situations.

Open-Plan Office Spaces

Previously, we touched on open-plan office spaces. These are general larger open spaces with multiple occupant work stations. Because these are shared spaces, it would be unreasonable to expect confidential speech privacy. At the same time, productivity, focus, and overall comfort are very important. Therefore, freedom from speech distraction is the expectation. Generally, in such situations, vocal effort is more casual (quieter) but can occasionally increase to normal conversational levels. There can be just a few occupants or many occupants, so the collection of voices and activity can contribute to overall "chatter."

In open-plan office spaces, good speech privacy design will minimize the radius of distraction. This means that speech will be heard at adjacent workstations, but will an occupant in more distant workstations be distracted by a conversation? If the work requires a higher degree of focus, then furniture partitions at least five feet high will help block sound between workstations. If the occupants need continuous interaction with coworkers, then a partition may be lower or not necessary at all. This will enhance interactive communication but will also increase distraction, which negatively impacts worker productivity.

Architectural acoustics practitioners teach architects the "ABCs of good acoustic design": *A*bsorb sound in the space, *B*lock sound between spaces, and *C*over unwanted sound with the appropriate background noise. The appropriate background noise is always essential for speech privacy, and levels can be elevated in open plan space to reduce speech distraction.

Over the past 20 to 30 years, the architectural trend has been to lower or eliminate partitions between workstations. This trend was primarily driven by the visual design and occupant density. It will be interesting to see if this trend reverses due to recent health concerns. Future partitions may be transparent elements, such as glass or Plexiglas-type materials, to maintain the visual "openness" while maintain social distancing practices.

Of special consideration for open spaces are those in the medical industry that includes pharmacies, reception areas, and call centers. These are currently the most difficult applications simply because the expectations are unknown. Personal private information protected by HIPAA will be discussed at a pharmacy, but is it reasonable to expect confidential speech privacy in these open spaces? If not, what is an appropriate and reasonable speech privacy expectation? The ASA Committee on Standards, Working Group 44 is currently working on these issues.

Enclosed Rooms

"Come in and close the door, we need to talk." If you have ever heard or made that statement, then you know that enclosed rooms, such as the one in **Figure 1**, have completely different speech privacy expectations. At a minimum, the expectation is confidential speech privacy. Listeners outside the room can hear voices but can not understand what is being said inside the room.

In these spaces, voice effort will typically be conversational but can be raised depending on the occupants and situation. In medical examination rooms, caregivers may need to raise their voices for elderly patients with diminished hearing. Conversations may get heated in a manager's office with the news of a job loss. The foundation for meeting these expectations will depend on the appropriate wall and ceiling choices.

The architectural acoustic community has developed several single-number metrics that describe the sound-isolation performance of building components. Examples are the sound transmission class (STC) to evaluate the performance of wall assemblies, and the ceiling attenuation class (CAC) to evaluate the performance of suspended ceiling systems. The STC and CAC are single-number ratings calculated in accordance with the American Society for Testing and Materials (ASTM) classification E413 for sound transmission loss by a partition such as wall (STC) and suspended-ceiling systems (CAC).

As a consequence of having these metrics, good design practice closely matches wall and ceiling performance because the resulting room-to-room sound transmission will be limited by the lowest performing element. A typical enclosed room design will have a wall assembly of gypsum board on each side of 3½-inch-wide studs, with an empty cavity and a mineral-fiber suspended ceiling closely match the wall sound isolation. This room will typically need a 40 dB background sound to achieve confidential speech privacy. If the occupant desired a lower background noise, then more a robust architectural design is required, such as adding fiberglass insulation in the wall cavity and, again, a closely matching suspended ceiling.

Any sound that travels from room to room other than directly through the wall or ceiling is called acoustic leakage and can significantly compromise the sound isolation and, therefore, speech privacy. Most common examples include door sills and fixtures such as electrical outlets (see Schnitta, 2016). These are easily accounted for with proper placement. For example, it is important to ensure that electrical outlets are never back-to-back in the common wall and that doors are placed at least four feet from the common wall. When the design requires compromised placement, then accommodations such as better doors and door seals may be required.

The focus of this article is commercial spaces. Schnitta (2016) discussed sound isolation for residential applications. In that article, the author points out that residential sound isolation goes beyond speech privacy because the intent is to also minimize, if not eliminate, disturbance from any unwanted sound source.

Classrooms, Boardrooms, and Patient Rooms

In a classroom, executive board-room, or some government facilities, confidential speech privacy is not sufficient. The desire is for conversation to not be heard at all.

Executive boardrooms and classrooms have similar needs. Classroom acoustics, as discussed by Brill et al. (2018), have many demands to ensure proper learning. If a student can hear the teacher in the adjacent classroom, that would be a distraction and it would compromise learning. In addition, the teacher's voice is elevated and the background noise must be low to maintain clear speech intelligibility within the classroom (e.g., Liebold et al., 2019). The combination of high speech privacy expectation, high voice effort, and low background noise requires very robust architectural choices. A higher performing wall is needed, and in most cases, the wall will extend to the structure.

At the same time, we must keep in mind that most mechanical, electrical, plumbing, heating/cooling, and other building systems are delivered through the ceiling space. These systems require penetrations through the wall above the ceiling. Because this section of wall is above the ceiling and not seen, little care for fit and finish is taken by building contractors, resulting in acoustical leakage. Therefore, the sound isolation of the suspended ceiling may not need to match that of the wall but is still important and must be factored into the design.

Due to cost and building schedule, more and more schools want to end the walls at, or just above, the ceiling. For this design, a high-performance ceiling must match the wall design, and care must be taken when selecting lighting and other ceiling fixtures to minimize leakage. An insulated enclosure or muffler (sometimes called an acoustical boot) will typically be required on the backside of all open fixtures that are placed within four feet of any common wall.

Patient rooms in hospitals require the same high-performance sound isolation. The ability to rest, sleep, and heal without interruption is discussed by Busch-Vishniac and Ryherd (2019). Sleep disturbance is a topic of study all of its own, but the fundamentals of architectural sound isolation remain the same. Hospitals face a financial penalty/reward incentive. The Hospital Consumer Assessment of Healthcare Providers and System (HCAHPS; see go.cms.gov/2Ybr9p9) is a standardized survey to collect patient perspective on hospital care. The survey includes questions related to acoustic quality. Medicare and Medicaid compensation are adjusted based on HCAHPS results.

Conclusion

We all desire speech privacy at times, and our expectations of the types of privacy are not the same from space to space or from situation to situation. By understanding the fundamental principles to achieving speech privacy, the appropriate architecture can be identified in building specifications, designs, and, in some cases, building regulations to meet expectations. As stated at the beginning, this article is intended to provide a basic introduction to and understanding of speech privacy in architectural spaces. We hope we have increased your awareness of this critical issue.

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