Charlotte A. Sust[1], Hans Lazarus[2], Rita Steckel[2] & Marko Kulka[2]
ABoVe GmbH[1], Wettenberg

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin[2], Dortmund

Evaluation of traffic noise by quality of speech communication

The fact that high noise levels can lead to hearing damage and other forms of health impairment is general knowledge. Noise beneath levels of 75 dB(A) does not mean necessarily that there are no effects. It might lead health impairment, but what seems to be more obvious is the day-to-day experienced fact that it disturbs: concentration, regeneration, and last but not least communication. This not only reduces our quality of life, but the interference of (traffic) noise with spoken communication reduces speech intelligibility and speech quality. Misunderstandings and mistakes are more probable, that might indeed lead to reduction of performance efficiency or even higher probality of accidents. Interference-free speech communication is a major prerequisite of troublefree working and humanely designed work activity. In dwellings, in the leisure domain and at school a high quality of speech communication is taken for granted, otherwise it would not be possible or at least difficult to learn language, to exchange (personal) information or to conduct a relaxed conversation.

With the standards to be set in the new version of ISO 9921 it is intended to ensure the minimum degree of necessary speech intelligibility in different communication situations. Speech intelligibility – in other words the percentage of correctly recognised speech items with defined speech material – is a necessary, but not a sufficient criterion for describing the quality of speech, in particular in cases of high speech intelligibility. Because of the so-called ceiling effects, it appears meaningful to describe the quality of spoken communication additionally in terms of further features, f.e.:

- hearer-side: hearer satisfaction and effort
- transmission-side: interference form background noises, communication of other persons
- speaker-side: volume and natural character of the language, dialect, accent (Cox et al. 1987).

To rate communication situations quickly and simply with respect to their speech quality, a scale had been developed which imposes rating criteria going beyond that of speech intelligibility (Purdy & Pavlovic 1992), namely concentration, coping, annoyance and subjective speech intelligibility (Sust et al. 2003). In cases of high speech intelligibility the scale differentiates significantly between different levels of SNR and different speakers. In developing the rating scale only pink noise was used. Within the framework of the “Quiet Traffic”-project now the scale is used for assessing different traffic noises in terms of frequency and time patterns. If there are differences, which feature influence the ratings and also of interest is the speakers’ influence.

Experimental Study

Partly repeating, partly expanding the original experiments (Sust et al. 2003), the communication situations were broken down: that is, first the speech material was spoken on tape by different, non-professional speakers. These recordings were played to the test subjects, who had to repeat and assess the speech material according to various criteria. Specifically the test plan contained the following features:

- Participation of 4 speakers (all untrained, two native speakers and two non-native speakers, in each as male/female)
- As speech materials grammatically correct, but semantically nearly unpredictable sentences were used
- 6 signal-to-noise ratios (SNR_A = -15 to + 20 dB, in steps of 7)
- 3 different noise conditions: road traffic noise, railroad traffic noise, pink noise
- Rating questionnaire with the features of subjectively felt speech intelligibility, coping, concentration, annoyance (evaluation on a five-stage scale after presenting three speech items)

24 subjects with an average of 24.8 years (between 19 and 31 years) took part in the test (1 training, 1 test session). The subjects were paid for taking part.

Results and Discussion

The proportion of correctly recognised sentences was registered. In the case of the sentences both the percentage (proportion of correctly recognised words in the sentence) and the absolute proportion of completely understood sentences were determined, as were the scale ratings of the evaluation questionnaire.

The percentage of speech items as a function of the signal-to-noise ratio exhibits as expected a rise with the increase in the signal-to-noise ratio. There is a significant difference between the different noise conditions, but it is superposed by the differential effects of the speakers (Fig. 1).

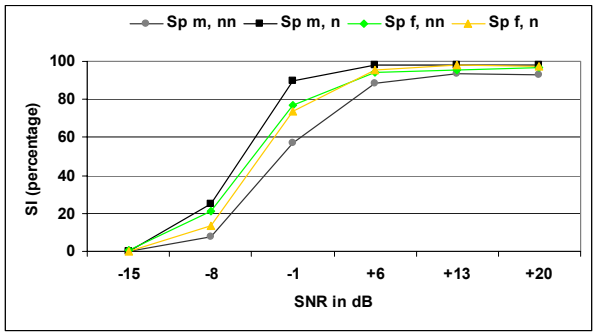

Fig.1: Speech intelligibility (SI) for four speakers (m: male; f: female; n: native speaker; nn: non-native Speaker)

After the presentation of 3 speech items in each case – under constant conditions with respect to signal-to-noise ratio, speaker, speech material and hearing situation – the subjects answered four questions on their rating of the preceding situation. The scales for subjective intelligibility (sSI), coping (CP), concentration (CC) and annyoance (NS) included the following steps:

sSI, CP: 5 “excellent” to 1 “bad”
CC, NS: 1 “not” to 5 “very”

The differing speech intelligibility is reflected in the judgement of the test subjects. The more positive subjective evaluation corresponds to a higher speech intelligibility (fig.2).

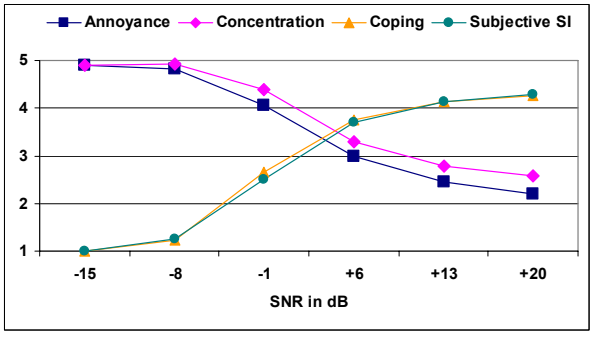

Fig 2: Quality ratings of communication for “Annoyance”; “Concentration”; “Coping”, “subjective Speech Intelligibility”

There was also clear evidence of speaker effects in the ratings, but no differences between noise conditions (fig. 3)

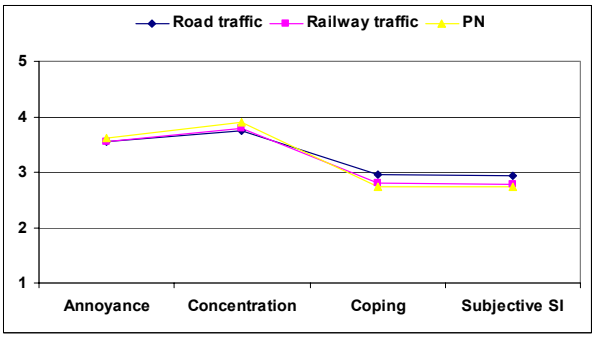

Fig 3: Quality ratings of communication for “Annoyance”; “Concentration”; “Coping”, “Subjective Speech Intelligibility” for different noise conditions

In the judgement of the test subjects better speech intelligibility makes it easier for them to cope with their task (hearing, understanding, reproducing). On the other hand, a poor speech intelligibility forces them to concentrate more and they feel exposed to greater interference. This holds true for similar noise conditions, we presented in our first experiment. Conclusion seems to be as far as communication are concerned, any noise condition interfering with communication is rated more annoying, need more coping strategies or force subjects to concentrate more to understand what a speaker has said. What is also important, even with high speech intelligibility scores there is still room for different evaluations at high s-n-levels.

In the next experiment the effects of different time patterns in understanding and rating communication quality are going to be examined.

Literature

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