

Relationship Between Automatic Behavior of Directional Microphone and Listening Effort

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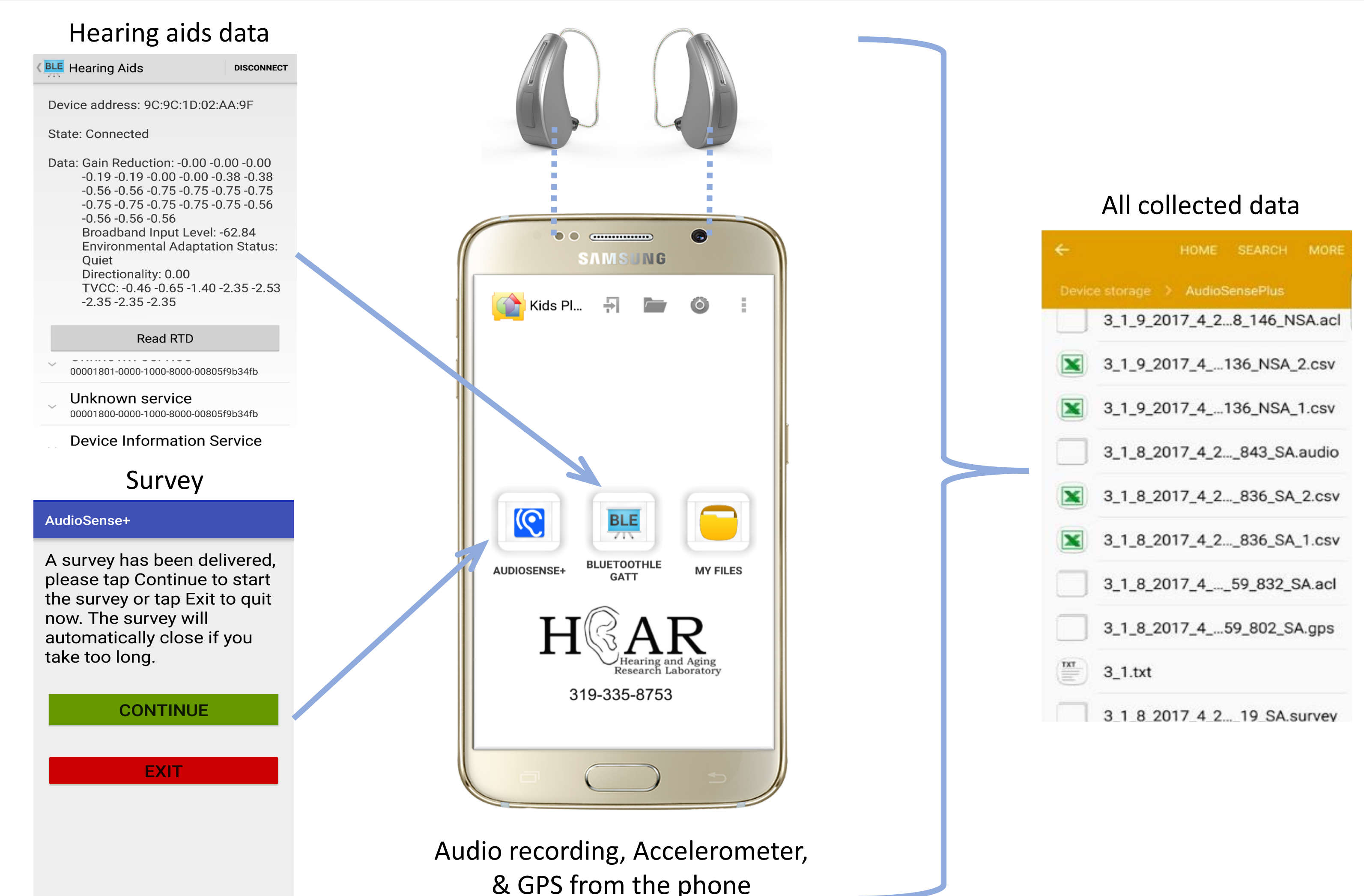


INTRODUCTION

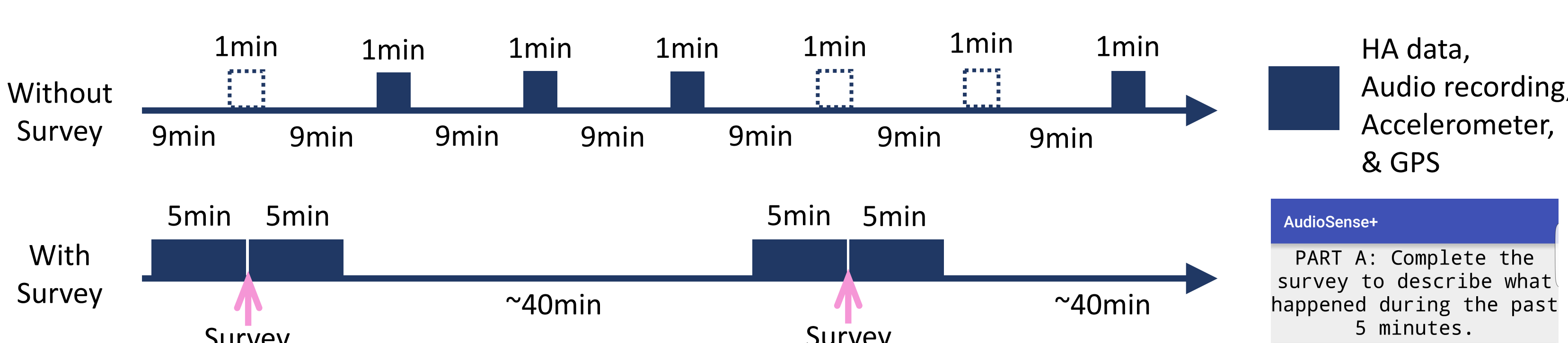
- ❖ Modern hearing aids implement automatic directional microphone technology, which switches between omnidirectional microphone (OMNI) with all-around sensitivity and directional microphone (DIR) with spatial sensitivity.
- ❖ Although laboratory studies have consistently shown that DIR improves signal-to-noise ratio (SNR), evidence supporting DIR benefit in the real world is limited.
- ❖ Because the extent to which DIR can provide its benefit is highly dependent on environmental context (i.e., auditory ecology), one possible reason for the limited DIR benefit in the real world is that automatic switching algorithms of the hearing aids do not activate DIR in the right situation at the right time.
 - Banerjee (2011) reported that DIR was activated only 10% of the time over a period of 4-5 week long field study. When the sound level was moderate to high, DIR was activated about 50% of the time.
 - Ricketts et al. (2017) observed that DIR could be beneficial over OMNI in 42% of the communication situations in the school environment. However, the automatic switching algorithms did not always select DIR in these situations.
- ❖ This study explores the relationship between the automatic behavior of DIR and the hearing aid users' perceived communication difficulty in the real world.

METHODS

- ❖ Eighteen participants
 - One week long field trial
 - 46-79 years, eight females
 - Native English speakers
 - Experienced hearing aid users
 - Bilaterally symmetrical sensorineural hearing loss with pure-tone thresholds not exceeding 75 dB HL from 250 to 4000 Hz
- ❖ Two-site data collection (The University of Iowa, Iowa City, IA & Starkey Hearing Aid Research Center, Berkeley, CA)
- ❖ Subjects were fit with behind-the-ear style hearing aids bilaterally.
- ❖ Hearing aid / smartphone-based Ecological Momentary Assessment (EMA) was used to collect data. Subjects completed electronic surveys delivered through a smartphone. Via wireless streaming, real-time data-logging information of the hearing aids was saved to the smartphone.

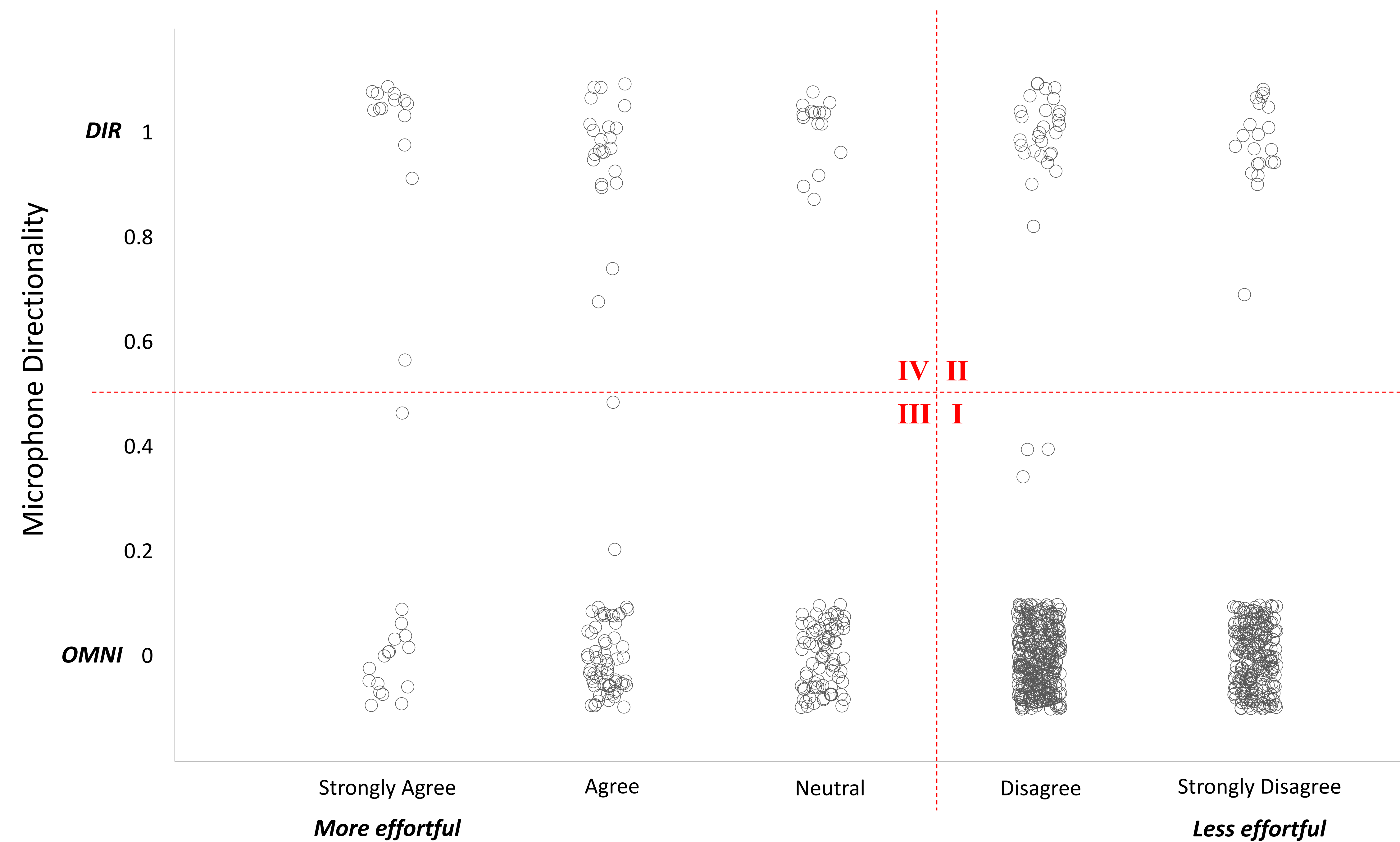


EMA Data Collection Schedule

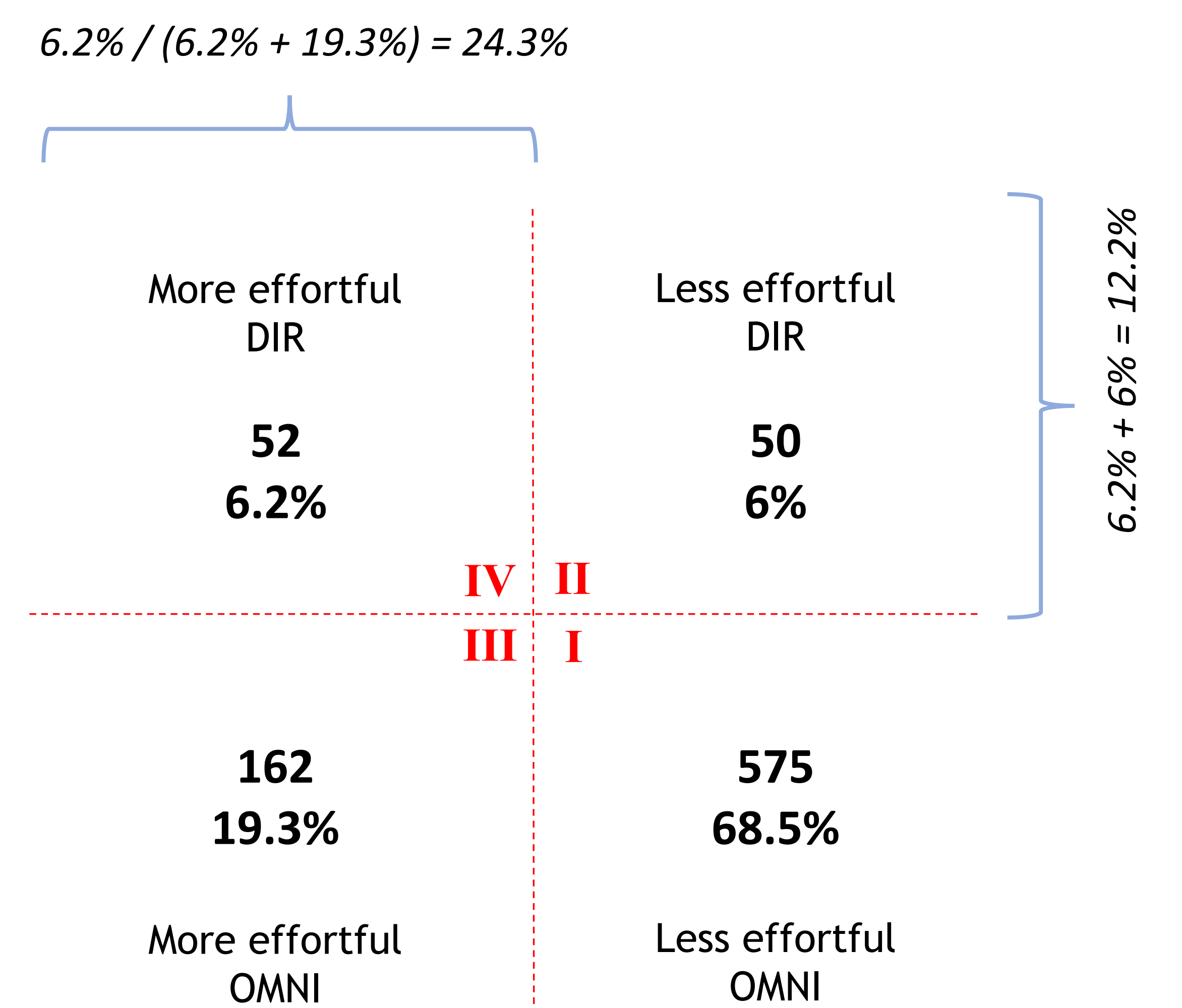


RESULTS

Listening Effort vs. Microphone Directionality



of Surveys (total 839) & % of Surveys of each quadrant



Listening Effort Question: "You had to strain to understand the conversation/speech"

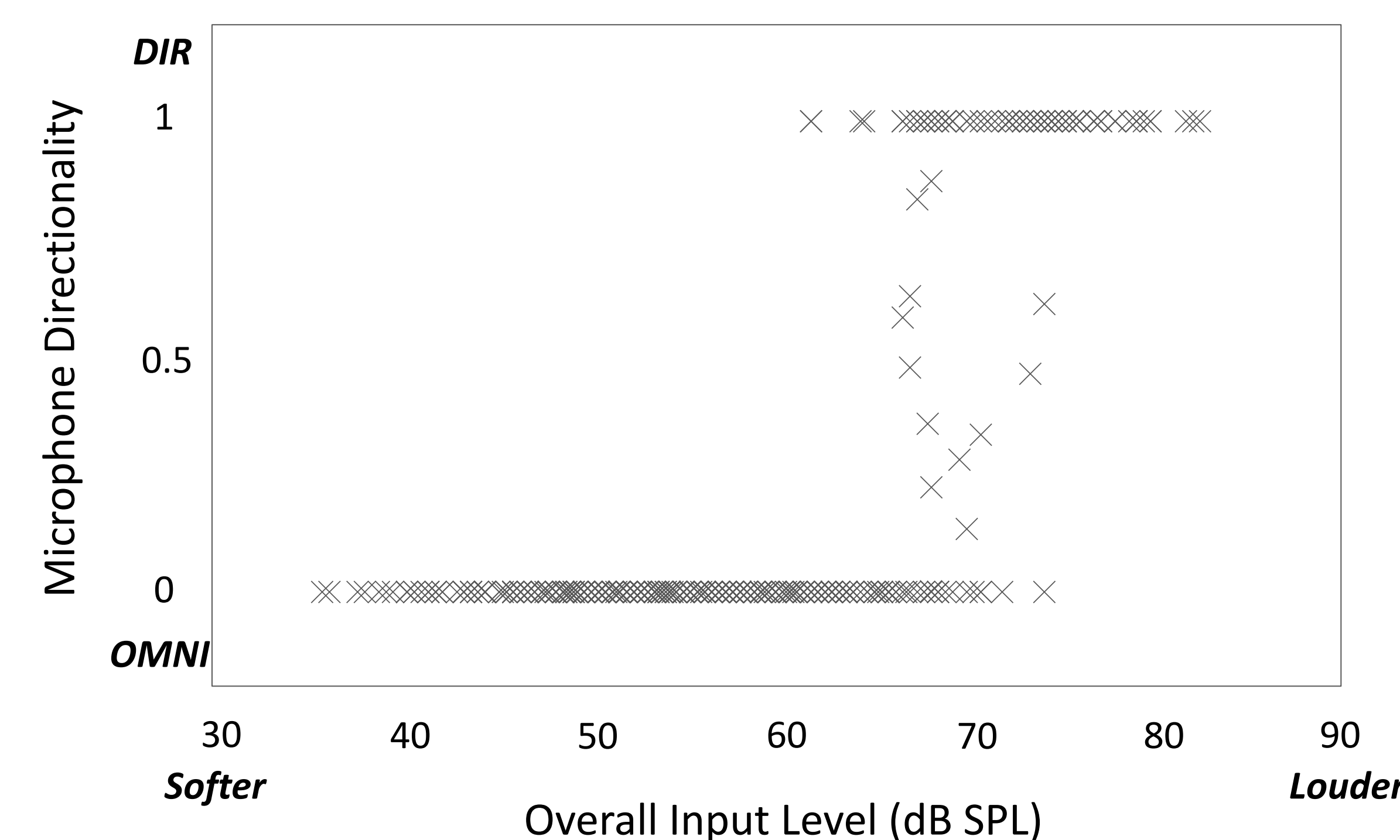
- ❖ DIR is activated 12.2% of the time during conversational situations
- ❖ When listeners report effortful listening (25.5%), DIR is activated 24.3% of the time

DISCUSSION & CONCLUSION

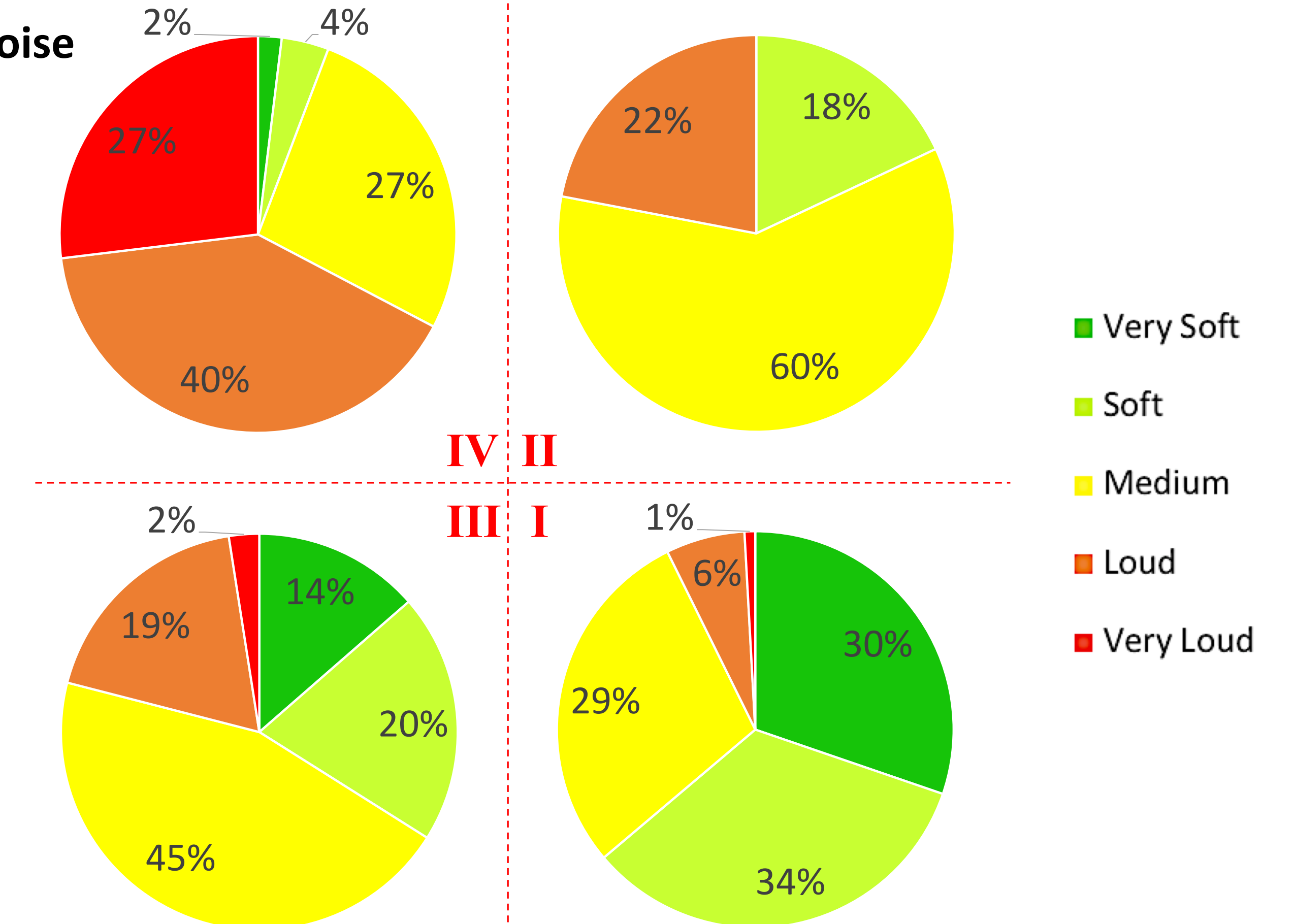
- ❖ **Q-II & Q-IV:** DIR was activated about 12.2% of the time during conversational situations, which is consistent with previous literature findings (Banerjee, 2011).
- ❖ **Q-I:** Listening was not effortful, even with OMNI (68.5%).
- ❖ **Q-II:** Hearing aid users might obtain benefit from DIR in these situations. However, Q-II situations did not occur very often (6%).
- ❖ **Q-III:** When hearing aid users needed help to reduce listening effort (19.3%), DIR was not available to them.
- ❖ **Q-IV:** DIR was activated, but the listening was still effortful (6.2%).
- ❖ The results of this study may explain why hearing aid users often do not notice the benefit of DIR in the real world.
- ❖ Clinical Implication: It could be beneficial to provide a manual directional program and train patients to use this program in appropriate situations.
- ❖ Future Research Questions:
 - What are the characteristics of the situations in which users have difficulty understanding speech (Q-III and Q-IV)? Why is DIR not activated in most of these situations (Q-III)?
 - If DIR is activated in these difficult situations, would users perceive benefit or notice any difference? What are the characteristics of the situations wherein DIR should be, but actually is not, activated (Q-III)?

When hearing aid users need help (25.5%), DIR is not available to them most of the time (activated 24.3%; not activated 75.7% of the time)

Overall Input Level vs. Microphone Directionality



Background Noise



REFERENCES

- Banerjee, S. (2011). "Hearing aids in the real world: Typical automatic behavior of expansion, directionality, and noise management," *J Am Acad Audiol*. 22, 34-48.
- Ricketts, T. A., Picou, E. M., & Galster, J. (2017). "Directional microphone hearing aids in school environments: Working toward optimization," *J Speech Lang Hear Res*. 60, 263-275.

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for further information