

Spring 5-2016

## List Equivalency of the AzBio Sentence Test

Lauren C. Bush  
*University of Southern Mississippi*

Follow this and additional works at: [https://aquila.usm.edu/honors\\_theses](https://aquila.usm.edu/honors_theses)



Part of the [Speech Pathology and Audiology Commons](#)

---

### Recommended Citation

Bush, Lauren C., "List Equivalency of the AzBio Sentence Test" (2016). *Honors Theses*. 419.  
[https://aquila.usm.edu/honors\\_theses/419](https://aquila.usm.edu/honors_theses/419)

This Honors College Thesis is brought to you for free and open access by the Honors College at The Aquila Digital Community. It has been accepted for inclusion in Honors Theses by an authorized administrator of The Aquila Digital Community. For more information, please contact [Joshua.Cromwell@usm.edu](mailto:Joshua.Cromwell@usm.edu).

Running Head: AZBIO LIST EQUIVALENCY

The University of Southern Mississippi

List Equivalency of the AzBio Sentence Test

by

Lauren Bush

A Thesis  
Submitted to the Honors College of  
The University of Southern Mississippi  
in Partial Fulfillment  
of the Requirements of the Degree of  
Bachelor of Arts  
in the Department of Speech and Hearing Sciences

May 2016

# AZBIO LIST EQUIVALENCY

# AZBIO LIST EQUIVALENCY

Approved by

---

Kimberly Ward, Au.D., Thesis Advisor  
Assistant Professor of Audiology

---

Edward Goshorn, Ph.D., Chair  
Department of Speech and Hearing  
Sciences

---

Ellen Weinauer, Ph.D., Dean  
Honors College

# AZBIO LIST EQUIVALENCY

## Abstract

The AzBio Sentence Test was developed as a measure of speech perception abilities and intended to be more reliable and closer to real life conditions than the previous speech perception measures commonly used. The purpose of speech perception measures is to partially determine cochlear implant candidacy as well as pre- and post-outcomes of cochlear implantation. The AzBio Sentence test is composed of 15 lists of 20 sentences each. There is limited research conducted on the equivalency of each of these lists. Of the previous limited research conducted, one study found that only 10 of the 15 lists were equivalent. The authors proposed the 15 lists included in the test were not equivalent. To evaluate the list equivalency, this study examined listening abilities of 30 normal hearing subjects in quiet and a difficult noise condition. Results from this study found that these lists are in fact not equivalent.

*Keywords:* AzBio, cochlear implants, speech perception, candidacy, BKB-SIN

# AZBIO LIST EQUIVALENCY

## Table of Contents

List of Tables and Figures.....	vi
List of Abbreviations .....	vii
Introduction.....	1
Literature Review.....	6
Speech Perception Tests .....	6
Development of the AzBio .....	7
Methodology.....	10
Sample.....	10
Procedure .....	10
Instrumentation .....	10
Results.....	12
Discussion and Conclusion.....	15
References.....	19
Appendices.....	22
A. IRB Approval Letter .....	22
B. Participant Consent Form.....	23

# AZBIO LIST EQUIVALENCY

## List of Tables and Figures

### **TABLES**

Table 1: Significant Differences Among Lists .....	14
--	----

### **FIGURES**

Figure 1: Average percent correct across all sentences in quiet and noise .....	12
---	----

Figure 2: Percent correct for lists in quiet condition.....	13
---	----

Figure 3: Percent correct for lists in noise condition .....	13
--	----

# AZBIO LIST EQUIVALENCY

## List of Abbreviations

AAA	American Academy of Audiology
AAO-HNS	American Academy of Otolaryngology – Head and Neck Surgery
ANOVA	Analysis of Variance
BKB-SIN	Bamford-Kowal-Bench Speech-in-Noise
CST	Connected Speech Test
HINT	Hearing in Noise Test
MSTB	Minimum Speech Test Battery
SNR	Signal to Noise Ratio
QuickSIN	Quick Speech-in-Noise Test
WHO	World Health Organization



## **Introduction**

According to the World Health Organization (WHO) (2012), 360 million people, or 5.3% of the world's population, suffer from a disabling hearing loss. The American Academy of Audiology (2013) estimates that 35 million of those people reside in the United States of America. As a solution to this hearing loss, the National Institute on Deafness and Other Communication Disorders (2013) notes that 324,200 individuals throughout the world have received cochlear implants, with 96,000 of those being Americans.

Cochlear implants are utilized when there is an extensive “loss of hair cell receptors in the inner ear, limiting the cochlea’s ability to transduce sound information from the environment to neural transmissions that can be interpreted by the central nervous system’s auditory sensations” (Copeland & Pillsbury, 2004). Cochlear implants are used to restore stimulation to the inner ear, and these devices have revolutionized the treatment of debilitating sensorineural hearing loss for many individuals (Copeland & Pillsbury, 2004). Furthermore, without the device, individuals with hearing loss struggle with speech perception, particularly in the presence of noise (Schafer, Pogue, & Milrany, 2012). Dorman, Loizou, Spahr, & Maloff (2002) explain that cochlear implants can aid in speech perception abilities. Because of this assistance, cochlear implants can immensely improve the quality of life for a person with hearing loss. Numerous studies have shown that the use of cochlear implants can increase communication skills, frequency of conversation with others, telephone usage, and self-confidence while reducing the impact of hearing loss on family life (Faber & Grøntved, 2000).

## AZBIO LIST EQUIVALENCY

The primary reason cochlear implants are able to improve quality of life is that they are expected to increase speech intelligibility, which is crucial for effective communication. In the *International Journal of Language and Communication Disorders*, Dr. Miller notes that “intelligibility is sine qua non for successful spoken communication” (Miller, 2013). Naturally, “when speech cannot be heard, it cannot be understood” (Ching & Dillon, 2013). The authors then assert that the most common complaint for someone with hearing loss relates to difficulty understanding speech, especially when that speech occurs in a noisy environment (Wilson & McArdle, 2005). Despite the obvious importance of intelligibility in matters of communication, there is still debate over how to properly define and measure intelligibility, and when necessary, provide intervention (Miller, 2013). Much of this debate is due to the complex nature of speech intelligibility. Speech intelligibility is comprised of two aspects: signal-dependent intelligibility and signal-independent intelligibility. First, there is signal-dependent intelligibility where retrieving the spoken message is based solely on the sound signal (Miller, 2013). Second, there is a signal-independent intelligibility where retrieving the message is based on verbal and nonverbal clues – such as syntax, semantics, facial expression, gesture, and contextual setting – in addition to the signal itself (Miller, 2013). Signal-independent intelligibility is crucial to those individuals with hearing loss who express difficulties in noise.

Understanding speech, particularly in the presence of background noise, is a difficult task which improves from childhood into adulthood (Vance, Rosen, & Coleman, 2009). When a hearing loss is present, speech perception becomes even more complicated: “People with hearing impairment have more difficulty than people with

## AZBIO LIST EQUIVALENCY

normal hearing in understanding speech, especially but not limited to speech in the presence of background noise” (Ching & Dillon, 2013). Wilson and McArdle (2005) found that individuals with hearing loss perform fairly well with speech perception in quiet; the difficulty lies mostly when one encounters background noise. Of course, this obstacle of hearing in the presence of noise affects hearing-impaired individuals’ ability to communicate: “the communication handicap imposed by sensorineural hearing loss was not only characterized by a hearing loss in the threshold for speech and a ‘discrimination’ loss in listening to speech in quiet, but also in ‘the masking efficiency of competing speech and other background sounds that plague the patient when he is in complex listening environments [22, p. 279]’ i.e., the ability of the listener to understand speech in background noise (Wilson & McArdle, 2005).

Multiple factors contribute to causing difficulty with speech intelligibility for people with hearing loss. First is the fact that one suffers from reduced audibility in general (Ching & Dillon, 2013). However, this alone does not explain the great difficulty many individuals experience in noisy listening conditions. Therefore, another factor is reduced frequency selectivity (Ching & Dillon, 2013). Individuals with hearing loss have broader auditory filters than their normal-hearing counterparts (Ching & Dillon, 2013). The broader filters “reduce these individuals’ ability to resolve the spectral shape of speech sounds and to separate components of speech from back-ground noise” (Ching & Dillon, 2013). A third factor is the presence of dead regions. Dead regions are parts of the cochlea where there are no surviving inner hair cells, meaning there is no transduction of basilar membrane vibration (Ching & Dillon, 2013). The presence of dead regions affect speech perception because “people with dead regions in the cochlea may extract little to

## AZBIO LIST EQUIVALENCY

no information from frequency components of speech that fall within a dead region, even when sounds are amplified sufficiently to make them audible” (Ching & Dillon, 2013).

Another contributing factor in the proficiency of listening in noise is reduced cognitive ability. Speech perception in noise requires a listener “to attend to some stimuli and disregard others, process two or more sources of information that may come from different spatial locations, and maintain concentration on the task at hand. At the same time, the listener has to decipher the acoustic signal, hold the information in short-term memory, decipher subsequent incoming signals, keep track of the information, fill in missing gaps, and ignore irrelevant information” (Ching & Dillon, 2013). Clearly, speech perception is complex task that requires extensive cognitive skills, which may prove difficult for those with hearing loss.

Just as there are many causes for difficulty with speech intelligibility for those persons who experience hearing loss, there are also many ways to measure speech perception. The most common way to measure speech perception is to measure the listener’s ability to reproduce speech correctly (Hilkhuisen, Gaubitch, & Huckvale, 2012). Some of these measures include a wide array of rating scales and word recognition tests (Miller, 2013). With rating scales, the “listener marks on a visual analogue, equal appearing interval or labeled ordinal scale where they feel the person’s level of intelligibility falls” (Miller, 2013). While this method boasts speed and ease, it suffers from poor, or less than ideal, inter-rater reliability (Miller, 2013). Word recognition tests are an alternative method. With these tests, a speaker produces a set of words while the listener indicates what word he/she believes he/she heard and are given a score based on the number of words correct (Miller, 2013). Other types of tests include full sentences in

## AZBIO LIST EQUIVALENCY

order to provide insight into speech perception abilities for connected speech with factors of stress, rhythm, and intonation (Miller, 2013).

One such speech perception test, the AzBio Sentence Test, has become the gold standard for measuring the speech perception abilities of those with cochlear implants since 2012 (Schafer, Pogue, & Milrany, 2012). This test is comprised of fifteen lists containing twenty sentences each. These sentences were chosen by the creators of the AzBio Sentence Test from a large pool of sentences. The method in which this test is delivered is by a recording of four speakers reading the sentences being played, and the listener is scored on his or her ability to repeat what is said on the test. The test was created with the intention that the fifteen lists would be equally difficult for listeners to understand. As the new standard of speech perception testing, the AzBio holds great power in the field of audiology and the life of someone who has undergone cochlear implantation. However, a minimal amount of literature has been published on this test, especially the list equivalency. One of the few studies completed did in fact reveal that the fifteen sentence lists included in the test were not of equivalent difficulty when compared to each other (Schafer, Pogue, & Milrany, 2012). This study found only ten of the fifteen lists to be equivalent (Schafer, Pogue, & Milrany, 2012). However, to date, no further studies have been published and the test is continuously being used in clinics across the nation. Therefore, it is this researchers' intention to replicate the study in order to determine whether the AzBio Sentence Test lists are indeed equivalent.

## **Literature Review**

### **Speech Perception Tests**

To determine candidates' eligibility to receive cochlear implants, speech perception test measures are used. These measures evaluate candidacy and are performed both before and after implantation in order to measure the effectiveness of cochlear implants. Audiologists "must have access to sensitive speech recognition materials in noise with multiple, equally intelligible lists" (Schafer, Pogue, & Milrany, 2012). The noise makes the test conditions as realistic as possible and multiple equally intelligible lists allow for a patient's performance to be assessed over time. Until 2012, there were four tests that were proven to have list equivalency in noise: the Bamford-Kowal-Bench Speech-in-Noise test (BKB-SIN), Connected Speech Test (CST), the Hearing in Noise Test (HINT), and the Quick Speech-in-Noise test (QuickSIN) (Schafer, Pogue, & Milrany, 2012). Of those four, only one – the HINT – was commonly used in cochlear implants clinics and research (Schafer, Pogue, & Milrany 2012). Unfortunately, the HINT has several shortcomings when being used to evaluate speech perception abilities of people with cochlear implants. For example, it is often only given in quiet at a fixed-level or sometimes may be used in an adaptive mode. This is not ideal "when attempting to predict performance at typical levels for conversational or soft speech" (Schafer, Pogue, & Milrany 2012). Literature suggests it may be best to test in noise using fixed-signal levels for adults with cochlear implants while determining cochlear implant candidacy.

In addition to using speech perception tests for cochlear implant candidacy, a common use of such tests is to measure outcomes of patients with cochlear implants. Outcomes are measured by completing pre- and post-implantation measures. Simply, the

## AZBIO LIST EQUIVALENCY

clinician acquires this data by administering tests of speech perception prior to implantation and then again after implantation and comparing the scores. Measuring outcomes with speech perception tests may be seen as an easy task; however, literature has stated that evaluating speech perception “has proven to be a difficult as well as an evolutionary process” (Gifford, Shallop, & Peterson 2008).

### **Development of the AzBio**

Researchers have found that the ideal speech perception test is “reliable, highly sensitive to differences between testing conditions, and having a high degree of correlation with real-world speech perception” (Gifford, Shallop, & Peterson 2008). Despite the many speech perception tests already available, such as the HINT, researchers are continuing to develop new tests, hoping to create the ideal test. It is in this interest that the AzBio Sentence Test was developed. The lists were created by the Department of Speech and Hearing Sciences at Arizona State University as part of an experiment by Spahr and Dorman to compare the speech understanding abilities of high-performing individuals with cochlear implants (Spahr et al. 2012). The goals for the test were “to (i) provide an unbiased evaluation of individuals with extensive exposure to traditional sentence materials, (ii) allow for evaluation of performance in a large number of test conditions, (iii) create lists of sentences with similar levels of difficulty for within-subject comparisons, and (iv) provide an estimate of performance that was consistent with the patient’s perception of their performance in everyday listening environments” (Spahr et al. 2012). A grant from the Arizona Biomedical Institute at Arizona State University made the development of these lists possible. As a result, the speech materials were called the AzBio Sentence Test.

## AZBIO LIST EQUIVALENCY

1500 sentences were originally created for the AzBio Sentence Test. Each sentence was between three and twelve words, and proper nouns were avoided. The sentences focused on “up-to-date, adult topics and current social issues” (Spahr et al. 2012). After process of elimination by the researchers, only 1000 of the original 1500 sentences were recorded using two male and two female speakers. Each speaker recorded two hundred fifty sentences in a sound-treated booth, speaking at a normal conversational pace and volume. After being processed through a five-channel cochlear implant simulation software, all 1000 sentences were presented to fifteen normal-hearing listeners. The individual tests were then scored based on the number of words each person could repeat correctly. Based on the research which has shown that “a minimum of twenty sentences was necessary to significantly reduce list variability”, the researchers decided upon twenty sentences per list (Spahr et al. 2012). Each list, consisting of 20 sentences, contained 5 sentences read by each of the four speakers. To determine the make-up of lists, the researchers ranked all 1000 sentences in order of difficulty and evenly distributed the sentences to create thirty-three lists. After a study to attempt to validate each of the lists, the researchers chose fifteen of the lists and these lists were compiled to ultimately create the final product of the AzBio Sentence Test.

Since the development, the AzBio Sentence Test has become part of a standard test battery of speech perception measurement in cochlear implant patients (Schafer, Pogue, & Milrany, 2012). However, the test is less than three years old and has limited studies completed to verify its list equivalency. Schafer, Pogue, and Milrany (2012) found that only ten of the fifteen lists included in the AzBio Sentence Test were



## AZBIO LIST EQUIVALENCY

equivalent in levels of difficulty, which proposes concerns regarding its use in cochlear implant candidacy and outcomes measures (Schafer, Pogue, & Milrany, 2012).

The idea that the lists of the AzBio may not be equivalent is particularly noteworthy considering these lists are assumed to be equivalent so that they can be compared against each other and among multiple listeners. In fact, a committee of representatives from the American Academy of Audiology (AAA), the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), and cochlear implant manufacturers convened in 2011 to create a minimum battery of speech tests that would be used to evaluate the performance of post-lingually deafened adult cochlear implant patients (Luxford et al., 2001). Thus, they created the Minimum Speech Test Battery (MSTB). By having such a test battery, the hope is that comparisons could be made between individuals and groups (Luxford et al., 2001). The AzBio is now part of that test battery; however, the lists included in it may not be equivalent. Therefore, comparisons of the results could be skewed and the underlying assumption of the AzBio Sentence Test as an integral part of the MSTB could be invalid.

There are limited published manuscripts on this test because it is relatively new. Therefore, the literature review is limited due to lack of research on the equivalency. However, this lack of research supports the need for this project.

## **Methodology**

### **Sample**

32 participants initially enrolled in this study, and 30 participants completed the study. The two participants who did not complete the study did not pass the hearing screening. Participants were adults over the age of 18 years who expressed voluntary consent to participate and possessed normal hearing.

### **Procedure**

Participants were recruited through The University of Southern Mississippi Mailout, flyers distributed throughout buildings on campus, and word of mouth. To ensure that participants had normal hearing, each was screened by performing otoscopy, tympanometry, and pure tone audiometry. Participants that passed the hearing screening were eligible to participate in this study. Following the screening, each participant completed all fifteen AzBio sentence lists in quiet and at a signal to noise ratio (SNR) level of 0dB, with lists presented in randomized order. Sentences were scored by the number of words correctly repeated by each listener, as directed by the manufacturer's guidelines. Speech and noise were always be presented from the same speaker. The sentences were at a presentation level of 60dBSPL. Testing occurred during one session; however, the participants were given a break between the list sets. All testing was conducted by the authors.

### **Instrumentation**

The pure tone hearing screening was performed in a double wall sound treated booth that was provided by the Speech and Hearing Sciences Department using an Otometrics Madsen Astera audiometer and K66 stereo headphones. Tympanometry was

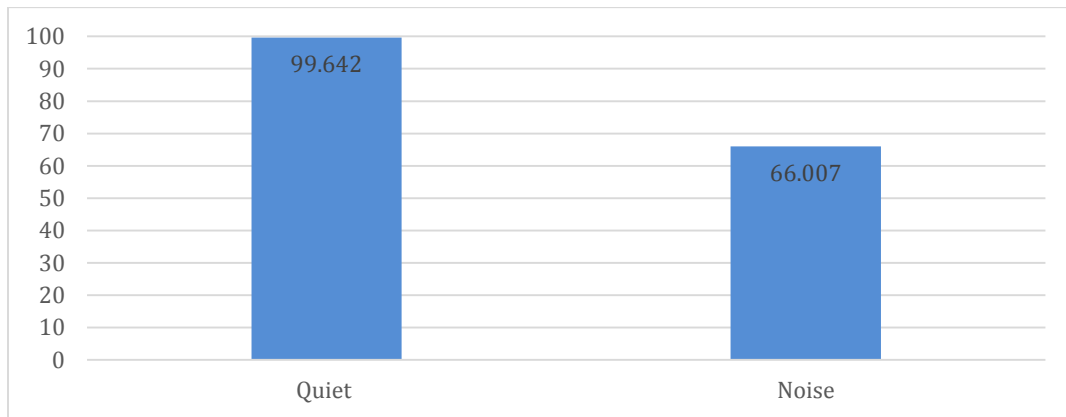
## AZBIO LIST EQUIVALENCY

performed using a Welch Allyn GSI 33 tympanometer. The AzBio Sentence Test was administered using the same sound-treated booth using a Lenovo compact disc player and Logitech IHX speakers.

**Results**

Results were analyzed using a two-way repeated measures analysis of variance (ANOVA) with the independent variables of lists (1-15) and SNR (quiet and 0dB SPL). 105 paired sample t tests were used to compare each list and condition to another list and condition. Each list in each condition was compared individually to every list in every condition. The Bonferroni correction was not used to adjust for p value due to its conservative nature and the possibility of missing significant differences which truly are in the data. A 95% confidence interval was used to analyze data ( $p < .05$ ).

When given in quiet, listeners achieved an average score of 99.64% correct, but when given in noise, listeners achieved an average score of 66.00% correct. This is illustrated in Figure 1.

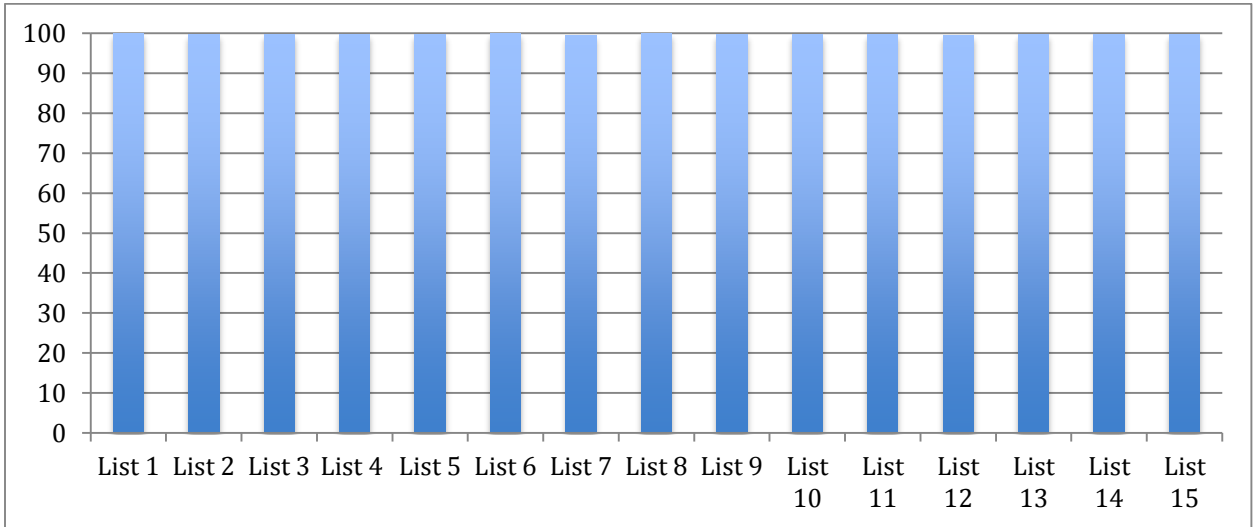


*Figure 1.* Average percent correct across all sentences in the quiet and the noisy condition.

The scores of the lists when given in quiet are found in Figure 2. The scores of all lists when given in quiet varied less than 1% with the lowest being 99.33% and highest

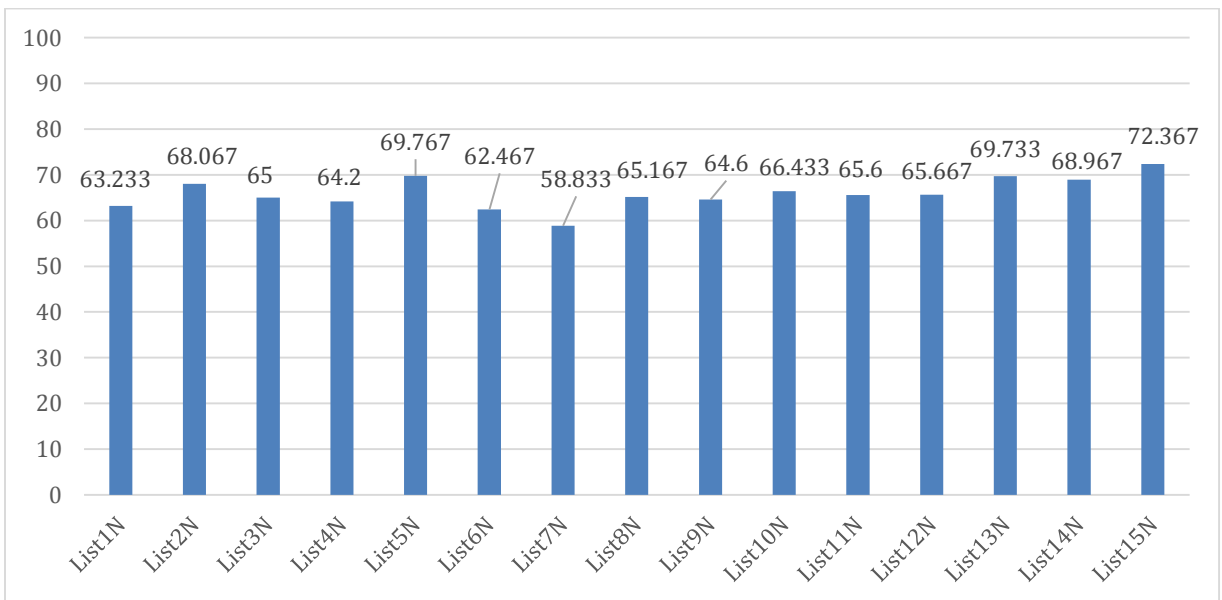
## AZBIO LIST EQUIVALENCY

being 99.80%. On the lower end were lists 7 and 12. On the higher end were lists 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, and 15.



*Figure 2.* Percent correct for lists in quiet condition.

The scores of the lists when given in noise are found in Figure 3. These scores ranged from 58.83% to 72.36%.



*Figure 3.* Percent correct for lists in noise condition.

## AZBIO LIST EQUIVALENCY

Analysis outcomes of this data can be seen in Table 1.1 below. Results revealed all lists were not equivalent with at least one other list in the AzBio Speech Perception Test.

Table 1.1

### *Significant Differences Among Lists*

<b>List Number</b>	<b>Significantly Different Lists (p&lt;.05)</b>	<b>Total Number</b>
1	2, 5, 7, 13, 14, 15	6
2	1, 3, 6, 7	4
3	2, 5, 7, 13, 14, 15	6
4	5, 7, 13, 14, 15	5
5	1, 3, 4, 6, 7, 8, 9, 11	8
6	2, 5, 10, 13, 14, 15	6
7	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15	13
8	5, 7, 13, 14, 15	5
9	5, 7, 13, 14, 15	5
10	6, 7, 15	3
11	5, 7, 13, 14, 15	5
12	7, 15	2
13	1, 3, 4, 6, 7, 8, 9, 11	8
14	1, 3, 4, 6, 7, 8, 9, 11	8
15	1, 3, 4, 6, 7, 8, 9, 10, 11, 12	10

### **Discussion and Conclusion**

Normal hearing listeners were used in this study due to the availability of such listeners in the researchers' environment. As such, participants possessed a typically functioning auditory system. However, individuals with hearing loss have a degraded auditory system, making it more difficult for them to understand speech than an individual with normal hearing. By using a SNR of 0dB SPL, the listening situation of the normal hearing participants was more comparable to that of those with hearing impairment; however, the subjects were still using a normal auditory system. Therefore, it is easily assumed that this test would be even more difficult for those with hearing loss because of a degraded auditory system. The results from this study prove to be beneficial in determining list equivalency of the AzBio Sentence Test.

The first finding from this study was that listeners scored better when the tests were administered in the quiet condition than when tests were administered in the noisy condition. This is to be expected and was not a surprising finding due to the fact that normal hearing listeners are able to understand better in quiet than in noise. In addition, the results of the study confirmed that there were no significant differences in the levels of difficulty among the lists when given in quiet. This outcome is also to be expected when using normal hearing listeners in a quiet situation.

The significant finding of this study was the significant differences in subjects' scores for every list contained in the AzBio Sentence Test when compared to other lists presented in the noisy condition. The subjects' scores on the lists presented in noise ranged from 58.83% correct (List 7) to 72.36% correct (List 15). There was not a single list which was not significantly different from at least two other lists ( $p < .05$ ). It is

## AZBIO LIST EQUIVALENCY

interesting to note that there were a few lists which were significantly different than a large majority of the other lists. List 7 was the most significantly different of all the lists, being significantly different from ten of the other lists. List 15 was also significantly different from ten of the other lists. The most equivalent list was list 12 which was only significantly different from lists 7 and 15. These findings are in agreement with the previous study by Schafer, Pogue, and Milrany (2012) which also reported non-equivalency among the lists. This study confirms a significant lack of list equivalency when the lists are presented in noise. These new findings in addition to previous limited research on this speech perception test may prove to be useful in multiple clinical applications.

These findings may be advantageous for practitioners when conducting candidacy evaluations and/or pre- or post-candidacy outcomes. Because none of the lists are truly equivalent, a client could score significantly different scores when multiple lists are administered, reducing the test-retest reliability which is crucial in clinical applications. Furthermore, if a patient is given one of the easier lists in the sequence during a candidacy evaluation, one may not be considered a candidate for a cochlear implant. On the other hand, if one of the harder lists were administered to the client, one may in fact qualify for a cochlear implant. This poor test-retest reliability and poor list equivalency confuses the true cochlear implant candidacy criteria. This finding is worrisome to the researchers as a person's ability to meet candidacy for a cochlear implant may ultimately depend on the clinician's list selection rather than an individual's actual speech perception abilities. As a result, someone who is a candidate for a cochlear implant may be denied or, even worse, may undergo unnecessary surgery and rehabilitation. In addition to pre-



## AZBIO LIST EQUIVALENCY

and post-candidacy evaluation findings and concerns, the lack of equivalency may also affect outcomes measures for those individuals who have received a cochlear implant.

The AzBio is typically given as part of a speech test battery prior to implantation as well as during routine intervals post-implantation to individuals who have received cochlear implants. The use of non-equivalent lists in pre-and post-implantation outcome measures may skew the scores which are intended to measure true outcomes for the clients. For example, if a person is given one of the easier lists pre-implantation and then given a more difficult list for the first post-implantation measure, the score may be significantly different, which may not necessarily reflect the true performance of the client, rather it may reflect the non-equivalency of the lists within the AzBio Sentence Test. This may result in small or decreased expected post-implantation outcomes rather than a true reflection of the client's improvement in speech perception abilities. Similarly, if the patient is given a one of the more difficult lists at the pre-implantation candidacy determination appointment, and is then given an easier list at the post-implantation appointment the client's score may inaccurately improve. Based on the findings of this research, it would be difficult to determine if this was a less than expected outcome for the client based on actual ability or simply a result of the administration of a non-equivalent list. The AzBio Sentence Test is given routinely at specified intervals to clients at multiple post-implantation appointments throughout an individual's life. These measured outcomes are commonly used to assist in adjusting the cochlear implant's programming features which ultimately affect function of the cochlear implant. It is fair to assume when using the AzBio Sentence Test, some adjustments may be made in programming and cochlear implant function unnecessarily or worse, even not made at all.

## AZBIO LIST EQUIVALENCY

This is a concern to the researchers as this test may be affecting the clinical management, as well as success, of the cochlear implant recipients. In the AzBio's current condition, it is impossible to know which is responsible for the client's fluctuation in scores – the list or the client's actual speech perception abilities. For best outcomes and evidenced-based clinical practice, clients need to be accurately assessed for candidacy as well as outcomes; both of which based on the findings of this study, may not be available with the use of the AzBio Sentence Test in its current state.

Further research should be done to determine how to appropriately use the AzBio Sentence Test to evaluate candidacy and outcomes of cochlear implant patients. In addition, further research should also be completed on how clinicians select which AzBio list they choose – whether it be systematically randomized, a designated order, or personal preference – and be aware of what effects may occur as a result. Additional research should be conducted to determine why the non-equivalencies in the lists exist.

## References

- American Academy of Audiology. (2013). Incidence of severe and profound hearing loss in the United States and United Kingdom. Retrieved from <http://www.audiology.org/news/incidence-severe-and-profound-hearing-loss-united-states-and-united-kingdom>.
- Ching, T. Y. C. & Dillion, H. (2013). A brief overview of factors affecting speech intelligibility of people with hearing loss: implications for amplification. *American Journal of Audiology*, 22, 306-309.
- Copeland, B. J. & Pillsbury, H. C. (2004). Cochlear implantation for the treatment of deafness. *Annual Review of Medicine*, 55(1), 157-167.
- Dorman, M. F., Loizou, P. C., Sparh, A. J. & Maloff, E. (2002). Factors that allow a high level of speech understanding by patients fit with cochlear implants. *American Journal of Audiology*, 11, 119-123.
- Faber, C. E. & Grøntved A. M. (2000). Cochlear implantation and change in quality of life. *Acta Otolaryngol*, 543, 151-153.
- Gifford, R. H., Shallop, J. K., & Peterson, A. M. (2008). Speech recognition materials and ceiling effects: considerations for cochlear implant programs. *Audiology Neurotology*, 38, 193-205.
- Hilkuysen, G. L. M., Gaubitch, N. & Hackvale, M. (2013). Effects of noise suppression on intelligibility: experts' opinions and naïve normal-hearing listeners' performance. *Journal of Speech, Language, and Hearing Research*, 56, 404-415.

## AZBIO LIST EQUIVALENCY

- Luxford, W. M., Allum, D., Balkany, T., Brimacombe, J., Cohen, N., Waltzman, S. (2001). Minimum speech test battery for postlingually deafened adult cochlear implant patients. *Otolaryngology-Head and Neck Surgery*, 124, 125-126.
- Miller, N. (2013). Measuring up to speech intelligibility. *International Journal of Language and Communication Disorders*, 48(6), 601-612.
- National Institute on Deafness and Other Communication Disorders. (2013). *Cochlear Implants* (Data file). Retrieved from <http://www.nidcd.nih.gov/health/hearing/pages/coch.aspx>
- Schafer, E. C., Pogue, J., & Milrany, T. (2012). List equivalency of the AzBio sentence test in noise for listeners with normal-hearing sensitivity or cochlear implants. *Journal of the American Academy of Audiology*, 23 (7), 501-509.
- Sladen, D. P. & Sappler, A. (2014). Older and younger adult cochlear implant users: speech recognition in quiet and noise, quality of life, and music perception. *American Journal of Audiology*, 1-9.
- Spahr, A. J., Dorman, M. F., Litvak, L. M., Wie, S. V., Gifford, R. H., Loizou, P. C., Cook, S. (2012). Development and validation of the AzBio sentence lists. *Hearing and Ear*, 33 (1), 112-117.
- Vance, M., Rosen, S. & Coleman, M. (2009). Assessing speech perception in young children and relationships with language skills. *International Journal of Audiology*, 48, 708-717.
- World Health Organization. (2012). *WHO global estimates on prevalence of hearing loss* (Data file). Retrieved from [http://www.who.int/pbd/deafness/WHO\\_GE\\_HL.pdf](http://www.who.int/pbd/deafness/WHO_GE_HL.pdf)

## AZBIO LIST EQUIVALENCY

Wilson, R. H. & McArdle R. (2005). Speech signals used to evaluate functional status of the auditory system. *Journal of Rehabilitation Research and Development*, 42(4), 79-94.

## Appendices

### Appendix A: IRB Approval Letter



#### INSTITUTIONAL REVIEW BOARD

118 College Drive #5147 | Hattiesburg, MS 39406-0001

Phone: 601.266.5997 | Fax: 601.266.4377 | [www.usm.edu/research/institutional.review.board](http://www.usm.edu/research/institutional.review.board)

#### NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.  
Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 15080601

PROJECT TITLE: List Equivalency of the AzBio Speech Perception Test

PROJECT TYPE: New Project

RESEARCHER(S): Lauren Bush

COLLEGE/DIVISION: College of Health

DEPARTMENT: Speech and Hearing Sciences

FUNDING AGENCY/SPONSOR: Eagle SPUR

IRB COMMITTEE ACTION: Expedited Review Approval

PERIOD OF APPROVAL: 08/12/2015 to 08/11/2016

**Lawrence A. Hosman, Ph.D.**

**Institutional Review Board**

**Appendix B:  
Participant Consent Form**

**Consent Form**

**Title of Study: List Equivalency of the AzBio Speech Perception Test**

**Introduction I,** \_\_\_\_\_, have been asked to participate in this study. Dr. Kimberly Ward, Dr. Edward Goshorn, Dr. C. G. Marx, Lauren Bush, and Stephen Williams, researchers at the University of Southern Mississippi who are conducting this research. This study has been explained to me and I certify that I am 18 years or older.

**Purpose of the Study:** The purpose of this study is to determine whether the lists included in the AzBio Sentence Test are equivalent levels of difficulty, when given to normal hearing listeners.

**Description of Procedures:** This study will be conducted in the J.B. George Building in the Department of Speech & Hearing Sciences. I will be asked to listen to and repeat 30 lists of sentences at 2 different noise levels.

**Risks and Discomforts:** There are no known or expected risks from participating in this study.

**Benefits:** I understand that if I complete this entire study I will be given a \$10 gift card to Starbucks. No other expected benefits are known.

**Contact Persons:** For more information about this research, I can contact Lauren Bush at 256-783-9719 or Dr. Kimberly Ward at 601-266-5232. For information regarding my rights as a research participant, I may contact the Chair of the Institutional Review Board at 601-266-6820.

**Confidentiality:** I understand that any information obtained as a result of my participation in this research will be kept as confidential as legally possible. I understand that these research records, just like hospital records, may be subpoenaed by court order or may be inspected by federal authorities. In any publications that result from this research, neither my name nor any information from which I might be identified will be published without my consent.

**Voluntary Participation:** Participation in this study is voluntary. I understand that I may withdraw from this study at any time. Refusal to participate or withdrawal will involve no penalty or loss of benefits for me. I have been given the opportunity to ask questions about the research, and I have received answers concerning areas I did not understand. Upon signing this form, I will receive a copy. I willingly consent to my participation in this study.

\_\_\_\_\_  
**Signature of Participant**

\_\_\_\_\_  
**Date**

AZBIO LIST EQUIVALENCY

\_\_\_\_\_  
**Signature of Investigator**

\_\_\_\_\_  
**Date**

**This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.**