Effects of Age and Hearing Acuity on Self-Paced Listening: A Pilot Study

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ABSTRACT

Effects of Age and Hearing Acuity on Self-Paced Listening: A Pilot Study

A thesis presented to the Psychology Department

Graduate School of Arts and Sciences
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This present study investigated spoken sentence processing as a function of age and a variety of hearing acuities via a self-paced listening paradigm. Young adults and older adults with clinically normal hearing and with mild-to-moderate hearing loss, self-paced through spoken sentences using an auditory moving window technique. Sentences varied in syntactic complexity (subject-relative, objective-relative) and sound level of presentation (high, low). Accuracies and mean pause durations were recorded. An omnibus ANOVA revealed significant main effects of sound level, sentence type and segment position. These effects were moderated by a significant Sentence Type X Segment Position X Age interaction. Results were taken as support of syntactic knowledge preserved in normal aging. Furthermore, we found that a low sound level of 15 dB above individual's speech-reception threshold produced comparable pacing patterns to a conversational speaking level. However, results showed that in the low sound level condition participants increased their mean pause times. In addition, in the low sound level, comprehension accuracies suffered for older adults with poor hearing.
# Table of Contents

Acknowledgments........................................................................................................i

Abstract..........................................................................................................................ii

List of Tables....................................................................................................................iv

List of Figures....................................................................................................................v

Introduction....................................................................................................................1

Method............................................................................................................................5
  Participants....................................................................................................................5
  Stimulus Material..........................................................................................................7
  Procedure.......................................................................................................................7
  Audibility Check..........................................................................................................9

Results............................................................................................................................9
  Comprehension Accuracy.............................................................................................9
  Pause Durations..........................................................................................................11

Discussion.....................................................................................................................13

References......................................................................................................................16

Table...............................................................................................................................18

Figures...........................................................................................................................19
List of Tables

Table 1. Mean Comprehension Accuracy for Young and Older Adults
List of Figures

Figure 1. Pause durations across the six segment positions for each of the three groups on the high and low sound levels.

Figure 2. Mean reaction time at each segment position for the three groups on subject-relative and object-relative sentences.
Effects of Age and Hearing Acuity on Self-Paced Listening: A Pilot Study

Spoken language comprehension is essential for daily living and its complexity has become a growing interest in research. The way in which our sensory systems perceive the external world affects the meaning and interpretation our brains try to make. As the brain experiences language and analyzes each perceptual signal, it attempts to map the stimulus to meaning and the information that has been stored in long term memory (Federmeier, 2007). Listening to speech entails intricate processes much of which rely on how we associate the acoustics with meaning.

When listening to spoken language, in order for speech to be comprehended, two processes must be involved: bottom-up processing which is based on the physical sensory information (e.g., acoustic signal) and top-down processing which is based on cognitive processes, language comprehension, and memory (i.e., the context and expectancies). As people age, there is a higher occurrence of hearing loss, particularly in the higher frequency ranges which are critical for an accurate perception of speech (Morrell, Gordon-Salant, Pearson, Brant, & Fozard, 1996). Because of these biological changes associated with aging, sensory inputs may decline and become less lucid; and, therefore more top-down processing is involved.

Salthouse (1991) measured perceptual speed and working memory by administering a number of cognitive tasks to both young and older adults (e.g., Shipley Abstraction Test, Raven’s Advanced Progressive Matrices). Consistent with previous research (e.g., Salthouse & Babcock, 1991), results indicated that a substantial proportion of age-related differences in measures of working memory appeared to be mediated by processing speed, which was reflected by the time needed for perceptual operations. Because declines in working memory accompany natural aging, older adults show more difficulty with comprehension of spoken language,
especially when speech is more syntactically complicated (Carpenter, Miyaki, & Just, 1994; Kemper, 1992; Wingfield, Peelle, & Grossman, 2003). The more complex a sentence structure, the more demands are placed on our executive functions and other cognitive resources (e.g., working memory). Fortunately, normal aging does not affect linguistic knowledge and procedural rules for its application (Wingfield, Tun, McCoy, Stewart, & Cox, 2006). The ability and utilization of this knowledge is an important moderating factor for comprehension and memory for spoken language heard in older adulthood.

Self-paced listening is a paradigm that can be exercised using an auditory moving window (AMW) task (Ferreira, Anes, & Horine, 1996). In the AMW task, participants pace themselves through spoken sentences that have been divided into individual words or longer phrases or clauses. Participants control the flow of incoming information by initiating the subsequent segments with a key press. Waters and Caplan (2001) argued that this technique illustrates patterns of resource allotment during active linguistic processing. Longer pause durations before initiating subsequent segments are presumed to be due to listeners need for more time to process the information. That is, pause duration measures processing speed and the effort needed to understand the prior clause. Fallon, Peelle, and Wingfield (2006) also used the AMW to have listeners self-pace through spoken sentences. They found that young and older participants’ patterns of pause durations showed similar reactions to different syntactic structures. Specifically, both young and older participants paused differentially longer at clause boundaries than at points within clauses, resulting in a scalloped pattern of pause durations.

Fallon, Peelle, and Wingfield (2006) examined task demands (i.e., recall vs. comprehension) and syntactic structure in both young and older adults using the AMW task. They manipulated sentence complexity by using three types of sentences: active-conjoined
sentences (simplest type), subject-relative (medium difficulty), and object-relative (most complex). The active conjoined sentences were made up of two clauses joined by the conjunction *and* (e.g., “The author insulted the critic and hired a lawyer”). The subject-relative sentences have the main clause broken up by a relative clause (e.g., “The author that insulted the critic hired a lawyer”). The object-relative sentences have an embedded clause interrupting the main clause and the noun phrase serves as the subject of the main clause and the object of the relative clause. The object-relative sentences require an all-inclusive thematic combination which needs longer time to interpret (Gibson, 1998; Warren & Gibson, 2002) and requires more resources to process than subject-relative sentences. Because of the more resource demanding structure of the object-relative sentences, they have been shown to produce more comprehension mistakes (Just & Carpenter, 1992; Wingfield et al., 2003). Moreover, Fallon and colleagues (2006) found that object-relative sentences required significantly more processing time than did active-conjoined sentences or subject-relative sentences when using the AMW self-paced listening task.

Although research has demonstrated linguistic patterns of pause durations for younger and older adults, there is little evidence on the patterns of individuals with different levels of hearing acuity. Good hearing can be maintained in normal aging. However, many older adults have some degree of presbycusis, an age-related hearing loss (Wingfield, Tun, & McCoy, 2005). As people age, there are changes in the inner ear that can cause a loss of acuity for high-frequency sounds (sensorineural hearing loss). As mentioned, this loss for high-frequency sounds can hinder speech perception (Morrell, Gordon-Salant, Pearson, Brant, & Fozard, 1996). Given the variety of degrees in hearing acuity in older adulthood, we wanted to examine a
representative sample of the aging population. That is, to assess speech processing in both older adults with normal hearing acuity and with a mild-to-moderate range of hearing loss.

Our purpose in this present study was to examine the effects of hearing acuity and age on spoken language processing. Specifically, we wanted to observe active speech processing as a function of age, hearing acuity, syntactic complexity, and sound level. This study used a three group design: older adults with good hearing acuity, older adults with poor hearing acuity, and younger adults with good hearing acuity. For the poor hearing group we focused on participants with mild-to-moderate hearing loss. This represents the single largest group of older adults with hearing loss, a group that typically does not regularly use hearing aids (Morrell et al., 1996).

Regardless of hearing acuity, we expect to observe similar patterns using the AMW; that the more syntactically complex a sentence (i.e., object-relative sentences) the longer processing time (pause duration) we will see at the clause boundaries and at the end of the sentence. In addition, we were interested in assessing the effects of sound level presentation on self-paced listening patterns. In pursuit of this interest, we used two sound level conditions in which the sentences would be heard. The low sound level was relative to the participant’s hearing level and the high sound level was an absolute level for all participants. According Sataloff and Sataloff (1993), for SRTs, people with normal hearing can hear and repeat spoken words at a level of about 15 dB. One might speculate that 15 dB above an individual’s SRT might be low enough however, that someone would need extra effort to understand the spoken sentences. In contrast, one might expect that 15 dB above a person’s SRT might be sufficient, in that further effort would not be necessary.

Analogous to previous studies, we anticipated that there would be a main effect for sentence type (syntactic complexity) in that accuracy to true/false questions will be
disproportionately worse for object-relative (more complex type) than for subject-relative sentences. For all groups, we expected an overall "scallop" pattern illustrating longer pause durations at clause boundaries and at the sentence wrap up (i.e., after the sentence has finished). Furthermore, we expected to observe that the more syntactically complex a sentence (i.e., object-relative) the longer processing time (pause duration) at the clause boundaries and at the end of the sentence. If the low sound level condition requires listeners to use more effort to process sentences, we might expect to observe longer pause durations at major clause boundaries and sentence wrap-up because there is additional time needed to process the information.

**Method**

**Participants**

There were 14 older adults with good hearing acuity with ages ranging from 67 to 83 years ($M = 75.7$, $SD = 5.2$). The speech reception thresholds (SRTs) for the better ear for the older adult good hearing group ranged from 10 dB to 20 dB ($M = 16.07$, $SD = 4$). The group had a mean of 16.6 years of education ($SD = 1.7$) and a mean Shipley Vocabulary Test (Zachary, 1986), score of 16.4 ($SD = 2.4$).

There were 11 older adults with poor hearing acuity ranging in age from 72 to 84 years ($M = 78.7$, $SD = 3.3$) and had a group mean of 15.7 years of education. The group had a mean Shipley Vocabulary Test score of 16.6 ($SD = 1.4$). The SRTs for the better ear for the older adult poor hearing group ranged from 25 to 35 dB ($M = 29.1$, $SD = 3$). Although the two groups of older adults differed in hearing profiles, they did not differ in age, $t(23) = 1.77$, $ns$. The two groups of older adults also did not differ in education, $t(23) = 1.18$, $ns$, or verbal ability, $t(21.3) = .23$, $ns$. 

5
The young participants were 23 university undergraduates and staff ranging in age from 18 to 25 years ($M = 20.1$, $SD = 1.6$). At the time of testing, the young adult group had a mean of 13.7 years of education ($SD = 1.2$) and a mean Shipley Vocabulary score of 14.7 ($SD = 1.8$). The young adults and both of the older adults with good and poor hearing acuity differed in education, with the older adults having more years of formal education, $t(35) = 6.16, p < .05$, $t(32) = 3.46, p < .05$, respectively. There was a significant difference of verbal ability between the young adults and the older adults with good and poor hearing acuity, with the two groups of older adults $t(35) = 2.59, p < .05$, $t(32) = 3.21, p < .05$, respectively. The younger participants were good hearing adults whose speech range and SRTs approximate those of the older adults with good hearing. The SRTs for the better ear for the young adult group ranged from 5 dB to 15 dB ($M = 10.7$, $SD = 3.3$).

All participants were native English speakers. In addition to assessing participants’ verbal ability by the Shipley Vocabulary Test, participants were administered Trails A and B, Digit Symbol (baseline and test), and Letter-number sequencing. There were no significant difference between the two groups of older adults on Trails B [good hearing, $M = 71.5$, $SD = 12.5$; poor hearing, $M = 90.2$, $SD = 29.2$; $t(12.9) = 1.99$, ns] and on Digit Symbol baseline task [good hearing, $M = 121.1$, $SD=4.6$; poor hearing, $M = 110.1$, $SD = 27.1$; $t(16.1) = 1.17$, ns]. The two groups of older adults differed significantly on Trails A [good hearing, $M = 33.5$, $SD = 7.2$; poor hearing, $M = 43.1$, $SD = 13.2$; $t(23) = 2.33, p < .05$], Letter-number sequencing task [good hearing, $M = 12.6$, $SD = 3.1$; poor hearing, $M = 9.9$, $SD = 3.3$; $t(23) = 2.08, p = .05$], and Digit Symbol test [good hearing, $M = 62.2$, $SD = 10.2$; poor hearing, $M = 46.4$, $SD = 7.4$; $t(23) = 4.34, p < .05$]. The older adults with good hearing were significantly different than the young adults on Trails A [young, $M = 28.2$, $SD = 6.1$; $t(35) = 2.47, p < .05$], Trails B [young, $M = 54.9$, $SD =
9.0; \( t(35) = 4.67, p < .05 \), Digit Symbol baseline [young, \( M = 140.5, SD = 21.6; t(35) = 2.85, p < .05 \)] and Digit Symbol test [young, \( M = 77.2, SD = 7.4; t(35) = 5.16, p < .05 \]. There was no statistical differences between young adults and older adults with good hearing on the Letter-number sequencing task [young, \( M = 12.7, SD = 1.8, t(18.8) < 1 \]. The young adults and the older adults with poor hearing differed significantly on Trails A \( t(12.1) = 3.61, p < .05 \), Trails B \( t(11) = 3.91, p < .05 \), Letter-number sequencing \( t(13) = 2.56, p < .05 \), Digit Symbol baseline \( t(32) = 3.53, p < .05 \) and Digit Symbol test \( t(32) = 11.33, p < .05 \).

**Stimulus Materials**

All sentences were nine words long and were recorded by a female American English speaker onto a computer sound file (SoundEdit software; Macromedia, Inc., San Francisco, CA) at a natural speaking rate. There were two sentence types: subject-relative sentences (e.g., “The gambler that signaled the dealer revealed the card”) and object-relative sentences (e.g., “The gambler that the dealer signaled revealed the card”). The sentences were selected from Fallon and colleagues 2006 study. Each sentence type were equated for length and made use of the same words, but in different orders.

The sentences were first recorded in full, and then markers were placed after a word or two. This results in the spoken sentence maintaining the overall intonation and relative temporal patterns of the original sentence. There were six segments in each sentence; the segments consisted of noun phrases (e.g., _the gambler_), verbs (e.g., _signaled_), or other functional elements (e.g., _that_).

**Procedure**

Participants were tested individually in a sound-attenuated room. A brief hearing exam was given first to record participants’ pure-tone averages (PTAs) and SRTs. Participants heard
spoken sentences in which they controlled the rate the speech was presented by key press. They were told that as they listened to a sentence it would periodically stop. When this happened they were to press the space bar on the keyboard to hear the next segment. Once the sentence had ended, participants were told to press the space bar and that would present a true/false comprehension question (e.g., “The gambler revealed the card.” True/False). They were told to press the key when they felt ready for the question. The true/false comprehension query appeared visually on the computer monitor. Participants answered the comprehension questions by pressing keys labeled “true” or “false” on the keyboard. A computer program recorded the duration of the pauses from the end of each segment until they pressed the key to receiving the next segment and the pause between the end of the sentence and the key press to initiate the question. The participants were told that they would be tested for comprehension accuracy; however, they were unaware that key pressing latencies were being recorded.

The experimenter informed the participants that there were going to be two types of sentences varying in complexity (i.e., syntax). They were given examples of each type of sentence prior to the actual test. A participant heard an equal amount of each syntactic sentence (subject-relative, object-relative) and there were an equal number of “true” and “false” responses.

Each participant heard a total of 96 sentences presented binaurally over ear inserts: 48 sentences were heard in a low sound level condition and, 48 sentences were heard in a high sound level condition. The low sound level condition was 15 dB higher than the individual’s SRT threshold for the best ear. The high sound level condition for all participants was 70 dB. This is an intensity equivalent to normal conversational speech. Sound levels were blocked, and presentation order of each sound-level condition was counterbalanced between subjects.
Audibility Check

For an extra precautionary measure that listeners could hear the sentences at each sound level, following the main experiment participants was asked to repeat each segment of six sentences at each sound level. That is, participants repeated back each segment of six sentences (three subject-relative, three object-relative) at the low sound level (15 dB higher than SRT) and each segment of six sentences (three subject-relative, three object-relative) at the high sound level (70 dB). All participants were able to repeat the sentences with at least 99% accuracy; which confirmed that the sentences in the each sound level were audible.

Results

Comprehension Accuracy

The comprehension accuracy was the percentage of true/false questions answered correctly. Table 1 shows the mean comprehension accuracy for the young adults, older adults with good hearing and older adults with poor hearing acuity. The older adults with poor hearing acuity had the lowest average percent correct in the low sound level condition, with the object-relative sentences \( (M = 72.0, SD = 14.3) \). The older adults with good hearing had the highest group average of percent correct in the high sound level condition with the subject relative sentences \( (M = 96.1, SD = 3.8) \).

For the accuracy data, we used a 2 X 2 X 2 X 2 mixed-design analysis of variance (ANOVA), with age (young, older) and hearing acuity (good, poor) as between subject variables and sound level (high, low) and sentence type (subject-relative, object relative) as within-subject variables. There was a significant main effect of sentence type (subject-relative, object-relative), reflecting that accuracy to true/false questions was differentially worse for object-relative sentences (more complex type) than for subject-relative sentences \( F(1, 45) = 33.20, p < .05, \)
partial $\eta^2 = .43$. This effect of sentence type was greater for the older adults than for the young adults, which was supported by a significant Age X Sentence Type interaction, $F(1, 45) = 4.32, p < .05$, partial $\eta^2 = .09$. There was a significant main effect of hearing acuity on comprehension accuracy, $F(1, 45) = 9.17, p < .05$, partial $\eta^2 = .17$. There was also a significant main effect of sound level condition, in which the low sound level condition had an overall lower percentage of correct responses compared to the accuracy in the high sound level condition, $F(1, 45) = 26.86, p < .05$, partial $\eta^2 = .37$. In addition to these main effects, there was a significant Sound Level X Hearing Acuity interaction, reflecting the finding that sound level condition differentially affected the poor hearing participants’ accuracy, compared to the good hearing participants, $F(1, 45) = 4.27, p < .05$, partial $\eta^2 = .09$. There was only a marginal Sentence Type X Hearing Acuity interaction $F(1, 45) = 2.95, p = .09$, and a Sound Level X Age interaction, $F(1, 45) = 3.13, p = .08$. No three-way interactions achieved significance, in all cases $p > .05$.

An independent samples test revealed that the older adult with good hearing had a significantly higher percent correct than the older adults with poor hearing in the low sound level condition for both the subject-relative and object-relative sentences ($t(23) = 2.05, p = .05$; $t(23) = 2.45, p < .05$, respectively); however, this was not true in the higher sound level condition (in each case, $p > .09$). The young adults performed significantly better on the comprehension questions, on average, then the older adults with poor hearing on the subject-relative and object-relative in the low sound level, $t(12.38) = 2.69, p < .05$; $t(12.28) = 4.57, p < .05$, and the object-relative sentences in the high sound level, $t(12.46) = 2.28, p < .05$. However, there was no difference between the young and older adults with poor hearing in the high sound level, subject-relative sentences $t(23) = 1.04, ns$. 
It is important to note that participants were required to get a minimum of 50% correct on the true/false questions. The data for an older adult with poor hearing who scored less than 50% was excluded. Thus, the accuracies were constrained by a floor level of 50% and a ceiling level of 100%. These effects should be interpreted with caution as accuracy was at or near ceiling in some conditions.

**Pause Durations**

Data were first analyzed using a 2 X 2 X 2 X 2 X 6 mixed-design omnibus ANOVA, with age (young, older) and hearing acuity (good, poor) as between-subjects variables and sound level (high, low), sentence type (subject-relative, object relative), and segment position (1, 2, 3, clause, 5, wrap-up) within-subjects. We used the Greenhouse-Geisser correction to adjust all \( F \) values to correct for heterogeneity of variance. Following Waters and Caplan (2001) and Fallon, Peelle & Wingfield (2006) we only included trials on which participants provided correct answers to the true/false questions. Figure 1 shows the older and young adults’ mean pause durations for each segment of the subject-relative and object-relative sentences for each sound level condition (i.e., high and low). The sixth position is the sentence wrap up: the phase from the end of the sentence and the key press to initiate the question.

As can be seen in Figure 1, for all groups of participants, pause times varied across the segments, producing a significant main effect of segment position, \( F(1.96, 88.30) = 31.19, p < .001 \). There was also a significant main of sentence type, \( F(1, 45) = 36.73, p < .001 \). The observation that the effect of sentence type depended on the segment position was confirmed by a significant Sentence Type X Segment Position interaction, \( F(2.20, 98.80) = 25.28, p < .001 \). Pause duration did not show a main effect of age, \( F(1, 45) = 1.38, ns \), nor was there a significant Age X Sentence Type interaction, \( F(1, 45) < 1 \). However, there was a significant Sentence Type
X Segment Position X Age interaction, $F(2.20, 98.80) = 3.11, p < .05$. Thus, the older and young adult participants did not have comparable responses to variations in syntactic structure. There was a significant main effect of sound level, $F(1, 45) = 6.26, p < .05$. There was no significant main effect of hearing acuity, and no interactions with hearing acuity achieved significance.

To assess each group’s processing times and to verify the impression in Figure 1, we conducted three subsidiary two-way ANOVAs for each sound level condition. Starting with the high sound level condition, for older adults with good hearing, there was a significant main effect of segment position, $F(5, 156) = 7.27, p < .001$. There was no significant main effect of sentence type, $F(1, 156) = 1.45, ns$, nor was there a significant Sentence Type X Segment Position interaction, $F(5, 156) < 1$. For the older adults with poor hearing, there was also a significant main effect of segment position, $F(5, 120) = 4.92, p < .001$. For this group, in the high sound level, there was no significant main effect of sentence type, $F(1, 120) < 1$, nor was there a significant Sentence Type X Segment Position interaction, $F(5, 120) < 1$. For the young adults, there was a significant main effect of segment position on pause durations, $F(5, 264) = 17.98, p < .001$, and a main effect of sentence type, $F(1, 264) = 4.75, p < .05$. These effects were moderated by a significant Sentence Type X Segment Position interaction, $F(5, 264) = 2.41, p < .05$.

In the low sound level condition, for older adults with good hearing, there was a significant main effect of segment position on reaction times, $F(5, 156) = 8.34, p < .001$. There was only a marginal main effect of sentence type, $F(1, 156) = 3.07, p = .08$. There was no significant Sentence Type X Segment Position interaction, $F(5, 156) = .30, ns$. For the older adults with poor hearing there was a significant main effect of segment position, $F(5, 120) =$
4.02, \( p < .01 \). There was no significant main effect of sentence type, \( F(1, 120) = .77, \) \( ns \), nor was there a significant Sentence Type X Segment Position interaction, \( F(5, 120) = .21, \) \( ns \). For the young adults, there was a significant main effect for segment position \( F(5, 264) = 27.88, \) \( p < .001 \), and a main effect for sentence type, \( F(1, 264) = 6.82, \) \( p < .01 \). These main effects were moderated by a statistically significant Sentence Type X Segment Position interaction, \( F(5, 264) = 3.78, \) \( p < .01 \).

Figure 2 shows the three groups of participants' mean pause durations on subject-relative and object-relative sentence types collapsed across the sound level conditions. As Figure 2 depicts, the young adults, on average, had shorter reaction times on the subject-relative sentences across each segment position than both groups of older adults. In other words, the young adults were going faster with the easier syntactic sentences. For the more syntactically complex sentences, the young adults took longer to facilitate the subsequent segment at the clause boundaries compared to their older counterparts. The older adults with poor hearing had the longest pause duration for both sentence types at the sentence wrap-up than any other group and segment position. It appeared that the older adults with good and poor hearing generally maintained slower, more consistent, pacing patterns. Therefore, there was not a significant difference of pause durations at the clause-boundaries and sentence wrap-up for these groups.

**Discussion**

Pause durations showed the typical scalloping pattern of longer reactions times following the clause boundaries and increased reaction times at the ends of sentences. These patterns were consistent with previous self-pacing patterns in AMW listening studies (Waters & Caplan, 2001; Fallon, Peelle & Wingfield, 2006). For the young adults, the reactions times varied across the
segment position, with the pause durations generally increasing when the sentences were more syntactically complex.

Another salient finding was that older adults maintained syntactic and procedural knowledge. In all conditions, syntax was not lost, providing further support that linguistic knowledge remains stable in normal aging. For both groups of older adults, there was only a significant effect of segment position, with longer pause times at the clause boundaries and after the sentence had finished. The older adults did not have comparable responses to variations in syntactic structure to the young adults. One could speculate that older adults had concerns for their accurate comprehension and memory of the sentences, resulting in faster reaction times at the clause boundary positions for the object-relative sentences. The adopted strategy for this sample of older adults hindered their accuracy for the more syntactically complicated sentences (object-relative). Whereas, for the young adults, taking longer to process at the clause boundaries for challenging syntactic structure was beneficial to their comprehension and accuracy.

For young adults, and older adults with both good and with poor hearing, a presentation level of 15 dB above SRTs sound level produced linguistic processing patterns comparable to conversational speech levels (70 dB). The only difference was the low sound level resulted in a small, but significant overall increase in mean pause times. The lower sound level also affected comprehension accuracy for the older adults with mild-to-moderate hearing loss. In the low sound level, the older adults with poor hearing acuity had lower mean accuracies on the true/false questions compared to the young and older adults with good hearing. Therefore, even though each segment of the sentences was audible, a low presentation level affected older adults with poor hearing acuity's comprehension.
This present study added two important factors to the growing body of literature on
spoken sentence processing. It is essential when studying speech comprehension to consider
hearing acuity, as it is dependent on understanding spoken language. This is especially
impetrate when investigating the aging population. This present study was able to add a more
broad and representative sample of older adults.
References


Table 1

*Mean Comprehension Accuracy (% correct) for Young and Older Adults*

<table>
<thead>
<tr>
<th>Sound Level</th>
<th>Young Adults</th>
<th></th>
<th>Older Adults</th>
<th></th>
<th></th>
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<td>Object Relative</td>
<td>Subject Relative</td>
<td>Object Relative</td>
<td>Subject Relative</td>
<td>Object Relative</td>
</tr>
<tr>
<td>High</td>
<td>94.9 (4.5)</td>
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<td>96.1 (3.8)</td>
<td>89.9 (6.9)</td>
<td>93.2 (4.7)</td>
<td>82.6 (15.5)</td>
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<td>Low</td>
<td>94.6 (5.8)</td>
<td>92.8 (6.9)</td>
<td>92.0 (6.2)</td>
<td>85.1 (12.5)</td>
<td>84.5 (11.8)</td>
<td>72.0 (14.3)</td>
</tr>
</tbody>
</table>

*Note.* Standard deviations are shown in parentheses.
Figure 1. Pause durations across the six segment positions for each of the three groups on the high and low sound levels. CL = clause boundary; WP = wrap up.
Figure 2. Mean reaction time at each segment position for the three groups on subject-relative (SR) and object-relative (OR) sentences. CL = clause boundary; WP = wrap up.