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Assessing word recognition in infants with a history of chronic otitis media

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Assessing Word Recognition in Infants with a History of Chronic Otitis Media

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Abstract

Otitis media (OM) is a common ear-related disorder diagnosed in children that can cause a temporary conductive hearing loss. The fluctuating hearing loss may alter auditory processing which may interfere with language development while impacting quality of life for infants and their caregivers (Homøe et al., 2019). In several languages, eleven-month-old infants have shown a preference for familiar words over unfamiliar words using the head-turn preference paradigm. This study examines the effect of chronic OM on the preference for familiar or unfamiliar words in eleven-month-old infants. Fourteen eleven-month-old infants (mean age 344 days) with three or more diagnosed ear infections before the test date were tested using a familiar word list and unfamiliar word list adapted from Vihman et al. (2004). Infants with a history of chronic OM did not show a preference to either the familiar or unfamiliar word lists ($t(13)=1.05$, $p=0.3$), whereas their peers without a history of chronic OM showed a preference to the familiar word list over the unfamiliar word list from research previously conducted in the lab ($t(11)=2.94$, $p=0.013$). When combined with other high-risk factors such as pre-existing cognitive or language deficit and a compromised environment including smoking, overcrowding, poor nutrition, and non-compliance with medical management, more routine monitoring and additional support may be needed.

Introduction

The scope of practice of an audiologist includes identification, diagnosis, and evidence-based intervention and treatment of hearing loss in children. It is widely accepted in the field that early identification of hearing loss and early intervention results in better language development in children (Yoshinaga-Itano et al., 1998). However, early word form recognition has not been studied in infants with a history of chronic otitis media. If a history of chronic otitis media affects word form recognition and the ability of children to meet language milestone goals, then audiologists and other interdisciplinary team members need to re-evaluate how children with chronic otitis media are referred for early intervention.

Otitis Media

Otitis media (OM) is a common ear-related disorder diagnosed in children. By three years old, seventy five percent of children have had at least one episode of OM and half of these children will have had three or more episodes of OM (National Institute of Health, 2000). Different types of OM exist and present differently clinically. Acute otitis media (AOM) is acute inflammation caused by bacteria or viruses. AOM typically presents with otalgia and fever. A subtype of AOM is acute suppurative OM which is AOM with pus in the middle ear. Another type of OM is otitis media with effusion (OME) and is characterized by presence of fluid without inflammation (Querishi et al., 2014). Current medical management strategies of AOM include both immediate treatment of antibiotics and initial observation with delayed initiation of antibiotics while current medical management strategies of OME include watchful waiting and myringotomy with tympanostomy tube placement. Choice of intervention for AOM and OME depend on several factors including risk level for severe infection, complication, recurrent episodes of OM, risk for speech, language, or learning issues, and hearing thresholds (Lieberthal et al., 2013; American Academy of Physicians, American Academy of

Otolaryngology-Head and Neck Surgery, & American Academy of Pediatrics Subcommittee on Otitis Media with Effusion, 2004; American Academy of Pediatrics, 2013). In this paper, OM will be used to incorporate both forms of the middle ear disorder and chronic otitis media (COM) is defined as three or more bouts of OM.

OM has an impact on the child and caregiver's health-related quality of life (Homøe et al., 2019). Health is defined by the World Health Organization (WHO) as "a state of complete physical, mental and social well-being and not merely the absence of disease" (WHO, 2020). Health-related quality of life encompasses the physical, functional, mental, and social health (Testa & Simonson, 1996). Caregiver reports of interrupted sleep, worry, altered daily schedule, and less leisure time negatively impacted quality of life in varying degrees proportional to severity, number of episodes, and younger age of child. Additionally, OM can cause chronic ear discharge, discomfort, disturbed sleep, and frequent doctor visits which impacts the quality of life of a child and their caregivers. These negative impacts on quality of life may impact interactions between the child and their caregiver when the child is experiencing an episode of OM (Homøe et al., 2019).

Audiologically, OM can result in a fluctuating conductive hearing loss ranging in severity from mild to moderate (Roberts et al., 2004a). The fluctuating hearing loss may alter auditory processing, which may interfere with language development (Homøe et al., 2019). Foundations for language development occur during the first two years of life, also known as the sensitive period. The fluctuating hearing loss caused by OM can affect a child's ability to recognize speech patterns which is a foundational step to language learning (Zumach et al., 2010). There has been debate regarding whether a history of OM is related to a delay in speech and language development and ultimately academic performance (Roberts et al., 2004a; Roberts et al., 2004b). Numerous studies indicate a connection between OM and language deficits while others do not show a difference in language outcomes when comparing pre-school and school aged children with and without a history of OM (Roberts et al., 2004a; Zumach et al., 2010).

Proposed reasons for children with a history of OM to perform similarly to their peers without a history of OM are the overlap and redundancy of language. The additional time and exposure to language allows the children with a history of OM to overcome the temporary processing inefficiencies and perform similarly to their peers (Roberts et al., 2004a). Overall, there is not sufficient evidence documenting that chronic OM early in life alone is a significant risk factor for children reaching speech-language milestones once they are preschool aged. Other factors such as children from a low socioeconomic status, at-risk birth, neurological problems, or other coexisting disabilities in children with chronic OM have not been evaluated for language development (Zumach et al., 2010). It is not known how children with chronic OM develop their language lexicon compared to children who do not experience chronic OM.

Auditory Head-Turn Preference Paradigm

The auditory head-turn preference paradigm (AHPP) uses an infant's attention to stimuli to determine if an infant has developed a receptive lexicon (Hallé & Boysson-Bardies, 1994). The AHPP involves an infant sitting on their caregiver's lap in a dark, three-sided booth with stimuli, either a familiar or unfamiliar word list, presented from a random speaker positioned on either the right or left side in conjunction with light stimuli. The infant's attention is blindly coded by the experimenter. The word list with longer attention is the preferred stimuli. Infants with a receptive lexicon will have longer attention to the familiar word list because infants look longer to words they recognize compared to words they do not recognize (Hallé & Boysson-Bardies, 1994). A novel stimulus is a stimulus that is expected to be unknown to the participant. A familiar stimulus is one that the participant has been exposed to and would be expected to recognize. A familiar word is a word that the infant would recognize, but not necessarily understand. Infants generally prefer familiar stimuli and as they mature and words become overly familiar, begin to prefer novel stimuli. This change in preference is influenced by the age of the infant, the complexity of the stimuli, and how the infant is familiarized (Hunter & Ames,

1988; Vihman et al., 2004; DePaolis et al., 2016). In this study, novelty is carefully controlled by matching the lists for phonetics, phonotactics, and acoustics. Thus, if the infant prefers the familiar word list, it is due to familiarity and indicates the likely onset of a lexicon (DePaolis et al., 2016).

Boysson-Bardies (1994) tested French eleven and twelve-month old infants and determined twelve-month-olds had a distinct preference for familiar words that was just emerging in eleven-month-olds. Vihman et al. (2004) replicated the French study in British-English with nine- and eleven-month-olds. Results indicated eleven-month-old infants had a group preference for familiar words and nine-month-old infants not. Another study evaluated ten-month old British infants and found the infants did not have a preference for familiar words (DePaolis et al., 2016). Eleven-months is the youngest age infants are shown to exhibit word form recognition (Boysson-Bardies, 1994; Vihman et al., 2004; DePaolis et al., 2016; Segal et al., 2015; Swingley, 2005).

The AHPP has been successfully used to demonstrate eleven-month-old infants show a preference for familiar stimuli over unfamiliar stimuli in French, Hebrew, Dutch, and British-English (Hallé & Boysson-Bardies, 1994; Segal et al., 2015; Swingley, 2005; Vihman et al., 2004). This study aims to determine if eleven-month-old infants with a history of chronic OM show a preference to familiar or unfamiliar words.

Hypothesis

We hypothesized that infants with a history of chronic OM will show no preference for familiar or unfamiliar words suggesting that infants with a history of chronic OM are delayed in their ability to recognize words independent of context as compared to a cohort without a history of chronic OM.

Methods

All study protocols were approved by James Madison University's Institutional Review Board (Protocol #20-1513).

Participants

As determined by an a priori power analysis using G*Power 3.1 (Faul et al., 2007) for a large effect (d=0.8) and 80% power at an alpha level of 0.05, a sample size of 15 is required. A total of 14 participants (six females and eight males, mean age 344 days) were included in the research. The first seven of the participants were tested as the pilot study using the same criteria and set-up but without the pure tone audiometry screening process detailed below. Two additional infants were tested but were removed from the dataset due to confounding factors including experimenter error (n=1) and inability to complete the task due to excessive fussiness (n=1).

Eleven-month-old infants were recruited in the local community through university-wide emails and posters displayed at local daycares, pediatrician offices, otolaryngology offices, and public bulletin boards. Inclusion criteria included at least three diagnosed bouts of OM prior to test date and at learning English. Three bouts of OM were chosen based on American Academy of Pediatrics (2013) guidelines that recommend pressure equalization tubes for recurrent AOM defined as three episodes within six months. Disorders of the eye or inability to move their head would also exclude an infant from participating.

Stimuli

The word lists used in this study were based on the words from Vihman et al. (2004) that were presented to infants in Britain. The word "nappy" was replaced with "cookie" as American infants are unlikely to recognize the word "nappy", British word for "diaper". The word list remains phonetically and phonotactically balanced with this change, which is important to

ensure infants are responding based on familiarity instead of novelty (Vinyard, 2018). The American-English words are as follows:

Table 1: Familiar and Unfamiliar Word Lists

Familiar Words	**Unfamiliar Words**
Apple	Bridle
Baby	Cycle
Button	Fog Light
Mommy	Maiden
Cookie	Manna
Sleepy	Mortar
Thank You	Through
A Ball	A Bine
Away	A Noose
Balloon	Compare
Fall Down	Disturb
Tonight	Taboo

The American English word lists were recorded by a female with a general American dialect. The sound pressure level was set at a peak amplitude of 60dB(A) using a Quest 1700 (Type 1) Impulse Sound Level Meter.

Procedures

Each participant's caregiver gave written informed consent prior to the start of the study. Participant's caregivers were compensated $20 for their time.

The study was conducted in the Infant and Toddler Language Laboratory at James Madison University and is a continuation of a dissertation project completed in 2021 by Allison Schmidt, Au.D. titled *Assessing Word Recognition through Head Turn Preference in Infants with*

Chronic Otitis Media. The current project included an additional five participants, expanded context in the introduction, and the addition of potential clinical applications to the discussion.

Infants sat on their caregiver's lap in a black, three-sided booth in a room separate from the researcher (Figure 1). The researcher monitored and coded the infant's looking times via a video camera mounted on Side A of the three-sided booth and a monitor on the researcher's side of the wall. Lighting in the three-sided booth included two lamps dimmed to an appropriate level to allow the infant to be seen on the video camera yet dark enough for the light stimuli to be visible to the infant. The brightness of the light was consistent across participants. The caregiver and researcher wore supra-aural headphones with speech masking noise. The masking level presented to the caregiver was determined by having three unfamiliar normal hearing listeners attempt to identify familiar or unfamiliar word lists. The masking level was increased until the listener's response was at chance or 50%. The level presented to the researcher was increased until the researcher could not hear the words presented via the speakers through the wall. The presentation level of the speech masking noise was consistent across test sessions.

The study consisted of four conditioning trials and 12 test trials. A trial consisted of an attention getting light blinking on Side A of the test booth to center the look of the infant. Once the infant was centered, a word list was presented by the computer based on the protocol (described below) from a speaker mounted on Side B or Side C of the three-sided booth. Lights were mounted on top of the speaker on Side B and Side C and a solid light was presented in conjunction with the word list on the same side. When the infant looked to Side B or Side C, the researcher coded the look as a head turn. A trial ended after the infant was no longer looking at Side B or Side C for a period of three seconds in the conditioning trials and two seconds in the test trials. This was timed by the computer for consistency. The centering light was presented to begin the next trial. Figure 1 provides a visual representation of the study set-up.

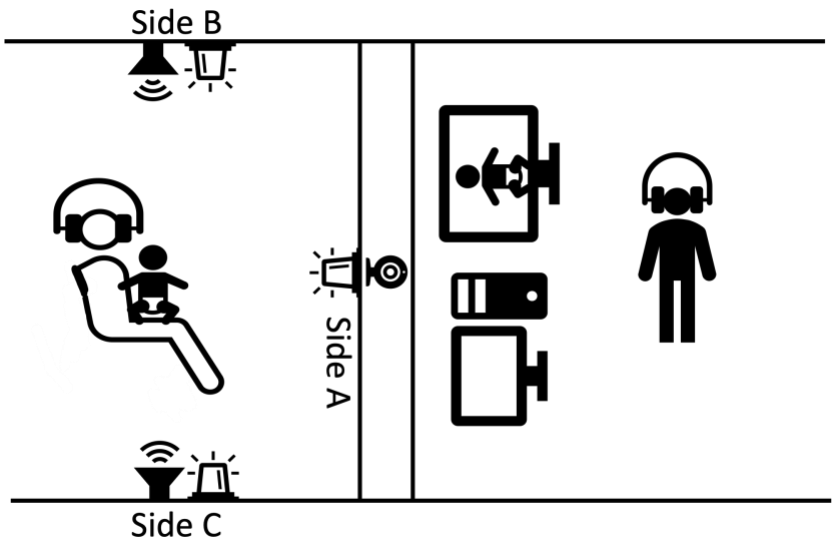

Figure 1: Visual representation of study set-up including three-sided booth.

The four conditioning trials included two trials where the familiar word list was presented and two trials where the unfamiliar word list was presented. The conditioning trials were not used in the analysis.

The twelve test trials consisted of six trials where the familiar word list was presented and six trials where the unfamiliar word list was presented. The 12 test trials were split into two sections, the first four were counterbalanced because infant looking times at the beginning of the test are very long, therefore we ensured two familiar and two unfamiliar word lists were presented in the first four trials. The order of the familiar (f) and unfamiliar (u) word lists in the first four trials were ufuf, fufu, uuff, and ffuu creating test blocks of four. The final eight trials were pseudo-randomized so that no more than two of the same type of word list were presented in a row. In addition, the order of the words in the familiar and unfamiliar word lists were pseudo-randomized so each word occurred in the first or second position to ensure each infant heard each word at least once during the test trials. Each list was approximately 25 seconds long and had a 1.5 second pause between each word. All twelve word lists combined lasts 4 minutes and 56 seconds.

Additionally, on the day of testing, all 14 participants underwent tympanometry testing to test tympanic membrane functioning. All participants were required to have at least one normal functioning tympanic membrane on the day of testing. A normal functioning tympanic membrane was defined as Type A, Type As, Type Ad, and a large volume tympanogram if pressure equalizing tubes (PE tubes) were present, determined by caregiver report and otoscopy. The most recent seven participants also underwent a hearing screening completed in the James Madison University Audiology Clinic. Testing was performed in the soundfield via visual reinforcement audiometry (VRA) between octave frequencies of 500 to 4,000Hz at 20dB HL based on hearing screening guidelines from the American Speech-Language Hearing Association (ASHA). A present response in the soundfield indicates hearing within the normal range for at least one ear. No participants were eliminated from the dataset due tympanometry results or a failed hearing screening.

Results

A total of 14 participants with a history of chronic OM were included in the dataset with a mean age of 344 days (SD = 9.68) and an age range of 330 to 363 days. Six females and eight male infants were included. Seven of the included infants were tested as part of the pilot study. Two babies were tested and not included in the dataset, one due to experimenter error and one due to the excessive fussiness and movement causing the infant not to complete testing.

Twelve infants without a history of chronic OM were previously tested using the same American-English word lists are included for comparison. The mean age of infants without a history of chronic OM was 338 days (SD = 3.94) and an age range of 334 to 348 days. Three females and nine males were included. All infants tested were included in the dataset, none were eliminated due to confounding factors.

Infants with a History of Chronic Otitis Media

Fourteen participants were included in the infants with a history of OM group. Seven of the participants were tested during the pilot study and did not undergo a hearing screening. The most recent seven participants all passed a hearing screening. The average looking times for both familiar and unfamiliar word lists were evaluated for each subgroup. The initial seven participants had an average looking time of 7.87 seconds (SD = 3.17) to familiar words and 6.65 seconds (SD = 2.5) to unfamiliar words. A paired sample means two-tailed t-test revealed no significant group effect between word lists, $t(6)=0.88$, $p=0.41$. The most recent seven participants had an average looking time of 7.36 seconds (SD = 2.53) to familiar words and 6.95 seconds (SD = 3.65) to unfamiliar words. A paired sample means two-tailed t-test revealed no significant group effect between word lists, $t(6)=0.54$, $p=0.61$. The average looking times to familiar and unfamiliar words for the initial seven and most recent seven participants can be seen in Figure 2. The statistical results comparing the initial seven and most recent seven

participants can be seen in Table 2. Since both groups did not differ, the groups were combined into one OM group, the results are presented below.

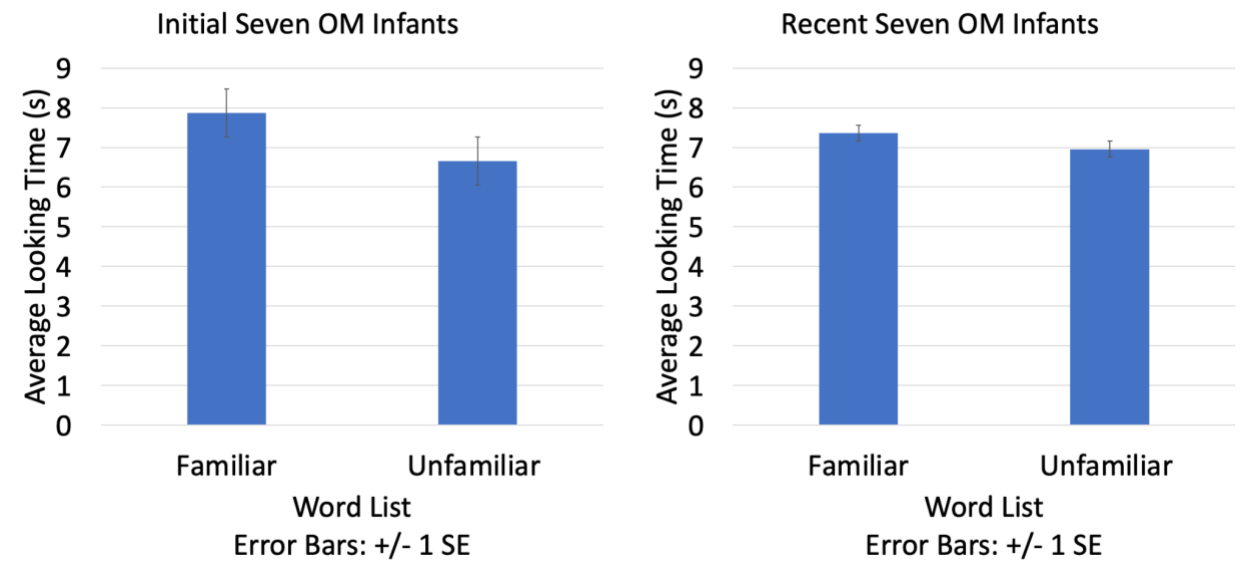

Figure 2: Average looking times for the initial seven infants with a history of OM and recent seven infants with a history of OM to familiar and unfamiliar word lists.

Table 2: Mean looking times, SDs, and paired sample means two-tailed t-test results of initial seven participants and recent seven participants in the group with a history of OM.

Group	Familiar Word List Mean (SD)	Unfamiliar Word List Mean (SD)	Comparison
Initial Seven	7.87s (3.17)	6.65s (2.5)	$t(6)=0.88$, $p=0.41$
Recent Seven	7.36s (2.53)	6.95s (3.65)	$t(6)=0.54$, $p=0.61$

Table 3: Mean looking times, SDs, and paired sample means two-tailed t-test results of participants with a history of OM and participants without a history of OM.

Group	Familiar Word List Mean (SD)	Unfamiliar Word List Mean (SD)	Comparison
OM	7.61s (2.77)	6.81s (2.99)	$t(13)=1.06$, $p=0.31$
Non-OM	5.13s (2.53)	3.74s (1.29)	$t(11)=2.94$, $p=0.013$*

Infants with a history of chronic OM had a combined average looking time of 7.61 seconds (SD = 2.77) to familiar words and 6.8 seconds (SD = 2.99) to unfamiliar words. The average looking time for infants with a history of chronic OM to familiar words and unfamiliar words can be seen in Figure 3. A paired sample means two-tailed t-test revealed no significant group effect between word lists, $t(13)=1.06$, $p= 0.31$ (See Table 3). The individual data for infants with a history of chronic OM can be seen in Figure 4.

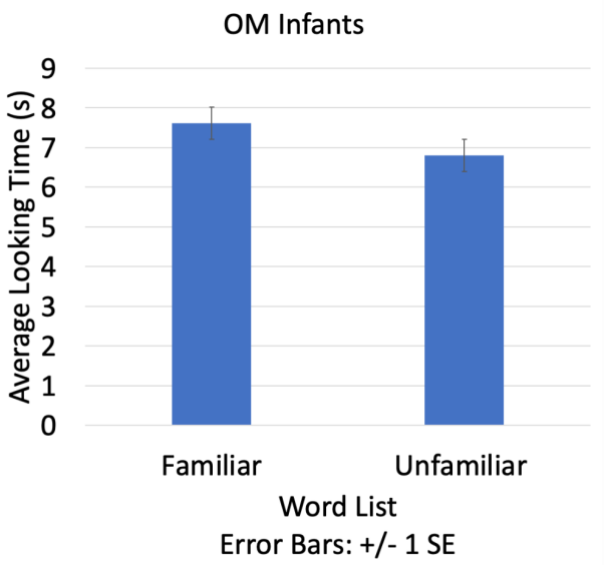

Figure 3: Average looking times for infants with a history of OM to familiar and unfamiliar word lists.

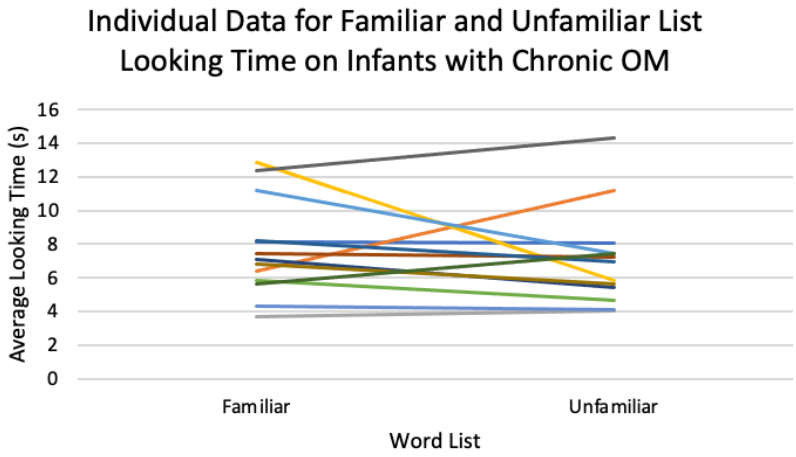

Figure 4: Individual mean looking times of infants with a history of chronic OM to familiar and unfamiliar word lists.

The results of the tympanometry testing revealed combinations of Type A, Type As, Type B, Type C, and large volume tympanograms when pressure equalizing tubes were present. A preference ratio was calculated for each participant. A preference ratio greater than 0.5 indicates a preference for the familiar wordlist, a preference ratio equal to 0.5 indicates no preference to either word list, and a preference ratio less than 0.5 indicates a preference to the unfamiliar wordlist. The tympanogram type and preference ratio can be seen in Table 4.

Table 4: Tympanogram type and preference ratio for each participant in participants with a history of chronic otitis media.

Participant	**Right Ear Tympanogram Type**	**Left Ear Tympanogram Type**	**Preference Ratio**
Participant 14	B	As	0.69
Participant 4	Open PE Tube	As	0.68
Participant 5	B	A	0.60
Participant 7	As	C	0.57
Participant 6	A	A	0.55
Participant 12	C	B	0.55
Participant 9	B	A	0.54
Participant 13	A	As	0.51
Participant 8	A	A	0.50
Participant 1	A	A	0.50
Participant 3	Open PE Tube	Open PE Tube	0.48
Participant 10	Open PE Tube	Open PE Tube	0.46
Participant 11	A	A	0.43
Participant 2	B	As	0.36

Infants Without a History of Chronic Otitis Media

The eleven-month-old infants without a history of chronic OM had an average looking time of 5.13 seconds (SD = 2.31) to familiar words and 3.74 seconds (SD = 1.31) to unfamiliar words, as seen in Figure 5. A paired sample means two-tailed t-test showed a significant group effect between word lists, $t(11)=2.94$, $p=0.01$, with the familiar word list receiving longer looking times than the unfamiliar word list (see Table 3). Individual looking times for infants without a history of chronic OM can be seen in Figure 6.

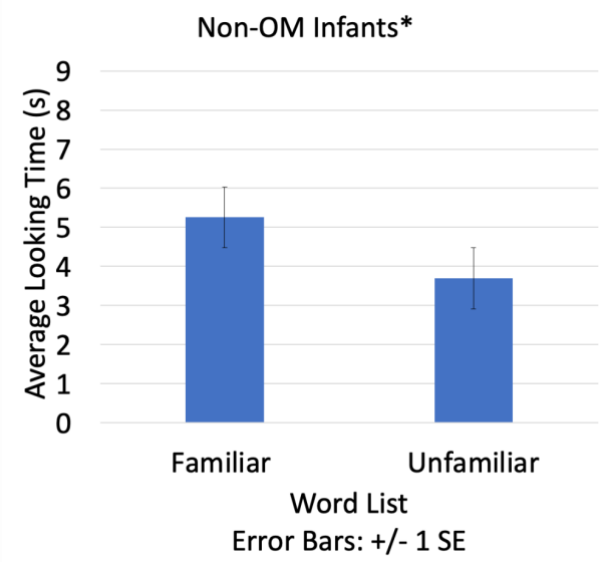

Figure 5: Average looking times for infants without a history of OM to familiar and unfamiliar word lists.

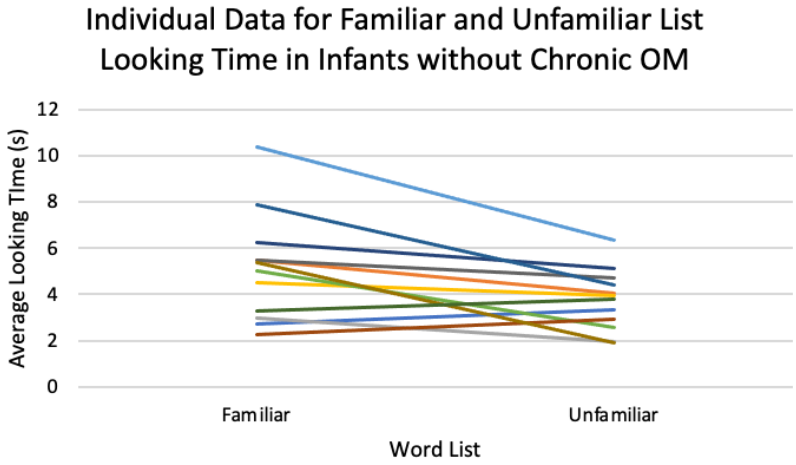

Figure 6: Individual mean looking times of infants without a history of chronic OM to familiar and unfamiliar word lists.

Discussion

The results of this study indicate that infants with a history of chronic otitis media are delayed in their word form recognition abilities.

Comparison of Initial Seven and Recent Seven Participants in History of Chronic Otitis Media Group

In the group of infants with a history of OM, the initial seven participants did not undergo the same hearing screening that the most recent seven participants completed. All fourteen infants with a history of chronic OM can be combined into one group for analysis because all infants underwent tympanometry testing to be included in the study. The hearing screening was added as a cross-check measure to ensure infants with unknown hearing loss were not included in the study. Based on reports from caregivers, all participants passed a newborn hearing screening.

Tympanometry Results of Infants with a History of Chronic Otitis Media

All infants underwent tympanometry testing in the group of infants with a history of chronic OM and had at least one normal functioning tympanic membrane on the day of testing. A normal functioning tympanic membrane was defined as Type A, Type As, Type Ad, and a large volume tympanogram if pressure equalizing tubes were present, determined by caregiver report and otoscopy. There is no clear trend between tympanogram type and preference shown. For example, the infants with a Type A tympanogram did not all show a preference for familiar words and infants with a Type B tympanogram did not all show a preference for unfamiliar words.

The Effect of Otitis Media on Word Form Recognition

The findings of this study indicate that eleven-month-old American-English infants with a history of chronic OM do not show a preference for familiar or unfamiliar word lists, suggesting a delay in word form recognition compared to eleven-month-old American-English infants without

a history of chronic OM. Some infants do exhibit word form recognition based on their preference for familiar words, but this was not the group trend. Word form recognition means that the infant is able to recognize words independent of context but does not require or imply understanding of the word. Both groups of infants were tested using the same methods and equipment and were recruited from the same geographic area, indicating that the reason for the difference in preference is the history of chronic OM.

OM has been shown to cause a temporary mild to moderate conductive hearing loss which is likely the cause of the delay in word form recognition. Episodes of OM of varying severity would result in different degrees of hearing loss. AOM can be medically treated with antibiotic therapy which would clear the infection and effusion in the middle ear. OME cannot be treated with antibiotic therapy and is typically treated by medical clinicians using a watchful waiting approach which consists of regular visits to the medical clinician where OME is monitored using pneumatic otoscopy and/or tympanometry. A majority of cases of OME resolve spontaneously within three months (American Academy of Physicians, American Academy of Otolaryngology-Head and Neck Surgery, & American Academy of Pediatrics Subcommittee on Otitis Media with Effusion, 2004).

If a child experienced chronic episodes of OME, they could experience up to nine months of reduced access to speech and language. Children are exposed to approximately 1,344 words per hour in a typical day (Sperry, Sperry, & Miller, 2019). If a temporary hearing loss is present even for one month, a child could hear over 900,000 words with reduced access to speech cues. Although a child experiencing OME for a combined time of nine months may be an extreme example, it is important to recognize the effect of reduced access to speech cues can have on speech and language learning. It is likely that the reduced access to speech and language is the reason the data suggests no preference between familiar and unfamiliar wordlists for children with a history of chronic OM.

Potential Clinical Applications

The language abilities of children with a history of chronic OM vary with some children performing equal to their peers and other children with delayed language acquisition. Factors that increase the risk of children having long-term speech and language deficits due to OM include onset of OM younger than 12 months of age, more than one episode of OM younger than 12 months of age, long periods of infection, limited access to medical management, degree of hearing loss, pre-existing cognitive or language deficit, and/or a compromised environment including smoking, overcrowding, poor nutrition, and non-compliance with medical management (Williams & Jacobs, 2009). Therefore, closer monitoring of OM and hearing status in children with these risk factors is warranted.

Audiologists should be included in the interdisciplinary team to monitor presence of middle ear effusion and hearing status to assist the medical team in making treatment decisions. Children can be tested with tympanometry and pure tone testing to determine if fluid is present in the middle ear and if the child has any degree of hearing loss on the day of testing. The results are shared with the medical team, which can be comprised of a child's pediatrician and otolaryngologist, to assist in developing a treatment plan. The interdisciplinary team can also determine if a child with chronic OM is experiencing any risk factors and if so can refer the child to early intervention services. Early intervention services can include speech therapy where a speech-language pathologist would work with a family to reach their goals by encouraging parental involvement and working together to facilitate early language development.

Limitations of Research and Potential Future Research

The target sample determined by the power analysis was unable to be reached. The recruitment of this study was affected by the COVID-19 pandemic and difficulty recruiting participants from the Harrisonburg/Rockingham geographic area. Ideally, this project would be

continued to recruit participants from a larger geographical range to reach the target sample size and be appropriately counterbalanced.

Future research could compare the eleven-month-old infants with a history of chronic OM to typically developing ten-month old infants with regard to word form recognition. Another study could evaluate word form recognition abilities in twelve-month old infants with a history of chronic OM. A longitudinal study could also be performed to determine how children with OM and high-risk factors develop language and progress throughout childhood. Future research could improve the care provided to children experiencing OM.

References

American Academy of Pediatrics (2013). The diagnosis and management of acute otitis media. *American Academy of Pediatrics, 131*(3), e964-e999. https://doi.org/10.1542/peds.2012-3488

American Academy of Physicians, American Academy of Otolaryngology-Head and Neck Surgery, & American Academy of Pediatrics Subcommittee on Otitis Media with Effusion (2004). Otitis media with effusion. *American Academy of Pediatrics, 113*(5), 1412-1429. https://doi.org/10.1542/peds.113.5.1412

DePaolis, R. A., Keren-Portnoy, T., & Vihman, M. (2016). Making sense of infant familiarity and novelty responses to words at lexical onset. *Frontiers in Psychology, 7*(715), 1-12. https://doi.org/10.3389/fpsyg.2016.00715

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.

Hallé, P. A., & Boysson-Bardies, B. (1994). Emergence of an early receptive lexicon: Infants' recognition of words. *Infant Behavior and Development, 17*(2), 119-129. https://doi.org/10.1016/0163-6383(94)90047-7

Homøe, P., Heidemann, C. H., Damoiseaux, R. A., Lailach, S., Lieu, J. E., Phillips, J. S., & Venekamp, R. P. (2020). Panel 5: impact of otitis media on quality of life and development. *International Journal of Pediatric Otorhinolaryngology, 130*(1), https://doi.org/10.1016/j.ijporl.2019.109837

Hunter, M. A., & Ames, E. W. (1988). A multifactor model of infant preferences for novel and familiar stimuli. *Advances in Infancy Research*, *5*(Generic), 69–95.

Lieberthal, A. S., Carroll, A. E., Chonmaitree, T., Ganiats, T. G., Hoberman, A., Jackson, M. A., Joffe, M. D., Miller, D. T., Rosenfeld, R. M., Sevilla, X. D., Schwartz, R. H., Thomas, P. A., Tunkel, D. E. (2013). The diagnosis and management of acute otitis media. *American Academy of Pediatrics, 131*(3), e964-e999. https://doi.org/10.1542/peds.2012-3488

National Institute of Health. (2000, October). *Otitis Media.* https://www.nidcd.nih.gov/sites/default/files/Content%20Images/otitismedia.pdf

Qureishi, A., Lee, Y., Belfield, K., Birchall, J. P., Daniel, M. (2014). Update on otitis media - prevention and treatment. *Infection and Drug Resistance, 7*, 15-24. https://doi.org/10.2147/IDR.S39637

Roberts. J., Hunter, L., Gravel, J., Rosenfeld, R., Berman, S., Haggard, M., Hall, J., Lannon, C., Moore, D., Vernon-Geagans, L., & Wallace, I. (2004a). Otitis media, hearing loss, and language learning: Controversies and current research. *Developmental and Behavioral Pediatrics, 25*(2), 110-122. https://doi.org/10.1097/00004703-200404000-00007 .

Roberts, J. E., Rosenfeld, R. M., & Zeisel, S. A. (2004b). Otitis media and speech and language: a meta-analysis of prospective studies. *Pediatrics, 113*(3), e238-e248. https://doi.org/10.1542/peds.113.3.e238

Schmidt, Allison Elizabeth, "Assessing word recognition through head turn preference in infants with chronic otitis media" (2021). Dissertations, 2020-current. 55. https://commons.lib.jmu.edu/diss202029/55

Segal, O., Keren-Portnoy, T., & Vihman, M. (2015). Infant recognition of Hebrew vocalic word patterns. *Infancy, 20*(2), 208-236. https://doi.org/10.1111/infa.12072

Sperry, D. E., Sperry, L. L., & Miller, P. J., (2019). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development, 90*(4), 1303-1318. https://doi.org/10.1111/cdev.13072

Swingley, D. (2005). 11-month-olds' knowledge of how familiar words sound. *Developmental Science*, 8(5), 432-443. https://doi.org/10.1111/j.1467-7687.2005.00432.x

Testa, M. A. & Simonson, D. C. (1996). Assessment of quality-of-life outcomes. *New England Journal of Medicine, 334*(13), 835-840. https://doi.org/10.1056/nejm199603283341306

Vihman, M. M., Nakai, S., DePaolis, R. A., & Hallé, P. (2004). The role of accentual pattern in early lexical representation. *Journal of Memory and Language, 50*(3), 336-353. https://doi.org/10.1016/j.jml.2003.11.004

Vinyard, Amy. (2018). Pupillometry as a test of infant word recognition. *Masters Theses.* 581. https://commons.lib.jmu.edu/master201019/581

World Health Organization (2020). *Constitution.* World health organization. https://www.who.int/about/governance/constitution

Williams, C. J. & Jacobs, A. M. (2009). The impact of otitis media on cognitive and educational outcomes. *Medical Journal of Australia, 191*(9), S69-S72. https://doi.org/10.5694/j.1326-5377.2009.tb02931.x

Yoshinaga-Itano, C., Sedey, A. L., Coulter, D. K., & Mehl, A. L. (1998). Language of early- and later-identified children with hearing loss. *Pediatrics, 102*(5), 1161-1171. https://doi.org/10.1542/peds.102.5.1161

Zumach, A., Gerrits, E., Chenault, M., & Anteunis, L. (2010). Long-term effects of early-life otitis media on language development. *Journal of Speech, Language, and Hearing Research, 53*(1), 34-43. https://doi.org/10.1044/1092-4388(2009/08-0250)