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Differences In Eyewitness Accuracy Amongst The Deaf And Hearing Populations

By

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Differences In Eyewitness Accuracy Amongst The Deaf And Hearing Populations

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Abstract

Eyewitnesses are often utilized by law enforcement as invaluable sources of information regarding crime events. Although deaf individuals have the same potential as their hearing counterparts to witness a crime on a daily basis, their perception of a crime may differ in important ways. To date, only one study has compared hearing and deaf populations in eyewitness memory performance and it focused exclusively on children. Porter, Yuille, and Bend (1993) found that overall, deaf children were just as accurate as hearing children in recalling crime event information but were less accurate than their hearing counterparts when direct versus open-ended questions were used.

The purpose of the current study was to clarify the advantages and disadvantages, if any, that deaf individuals have within their perceptual experience of a crime. To investigate this research question, volunteer participants were exposed to a brief video clip of a crime event and had their memory for the event tested through open and closed ended questions in an electronic survey format. Participants were classified into 3 groups: (1) those who identify as culturally Deaf, (2) hearing participants who watched the crime event with sound, and (3) hearing participants who watched the crime event without sound. It was hypothesized that Deaf individuals would have superior memory recall (i.e., higher accuracy), for "peripheral" details compared to "central" details when compared to the hearing individuals without sound, and that accuracy may vary as a function of the type of question asked (open versus closed-ended).

A 3 (participant type: hearing with sound vs. hearing without sound vs. Deaf) x 2 (question type: open vs. closed) x 2 (detail type: central vs. peripheral) mixed Analysis of Variance (ANOVA) was used to examine the interacting effects of experimental group

and two within subject variables, question type and detail type, on the primary dependent variable: accuracy rate (e.g., the proportion of correct details out of all details provided). The analysis revealed a main effect of detail type on participant accuracy, F(2, 166) =123.10, p < .001, partial $\eta^2 = .43$. Participants were more accurate when answering questions about details classified as central (M = .69, SD = .14) compared to peripheral (M = .45, SD = .23). Another main effect was revealed of question type on participant accuracy, F(1, 166) = 174.33, p < .001, partial $\eta^2 = .51$. Overall, participants were more accurate when answering open ended questions (M = .79, SD = .14) compared to closed ended questions (M = .46, SD = .18). This effect was qualified by a significant detail type by question type interaction, F(2, 166) = 54.49, p < .001, partial $\eta^2 = .25$. The effect of question type on participant's accuracy rates was more pronounced for central details compared to peripheral details, all p's < .001. Lastly, a marginal effect of participant type on accuracy was revealed, F(2, 166) = 2.96, p = .055, partial $\eta^2 = .03$. Hearing participants who viewed the video with sound tended to be more accurate overall compared to hearing participants who viewed the video without sound (hearing control group) and Deaf participants. However, this marginal effect should be interpreted within a significant question by participant type interaction, F(2, 166) = 3.88, p = .023, partial η^2 = .05. Hearing participants' accuracy was less impacted by the question type compared to the other groups.

The current study's primary hypothesis that Deaf individuals would have better accuracy of details for an experienced crime due to perceptual advantages was not supported. Interestingly, hearing participants were less influenced by the type of question asked (closed-ended vs. open-ended) and tended to be more accurate overall regardless of

detail type (peripherally vs. centrally presented details). The second hypothesis that Deaf individuals have better recall for peripherally presented details vs. centrally presented details was not fully supported; however, Deaf participants performed significantly more accurate than hearing controls on peripheral details. This finding provides some support for previous literature that has linked Deaf individuals to having better recall (i.e., higher accuracy) for peripherally presented details vs. centrally presented details (Cattani, Clibbens, & Perfect, 2007).

Differences In Eyewitness Accuracy Amongst The Deaf and Hearing Populations

Most of society is detached from the existence of the deaf community. Deaf individuals comprise a minority group that are usually forgotten unless they intermingle with hearing individuals. Although this is likely attributed to an unintentional out of sight, out of mind approach, it fails to bring attention to or bridge the gap between hearing and deaf individuals. As a result, deaf individuals are often overlooked in general and specifically in scientific research. An unfortunate reality that society is faced with is that crime doesn't discriminate. This means that crime can happen anywhere, at any time, and involve anyone. In other words, anyone located within the proximity of that crime can become an eyewitness. Eyewitnesses are often utilized by law enforcement as invaluable sources of information. They are utilized to collect information about the crime including the description of the criminal(s), clarification as to what happened, clarification of when the crime took place, and provide details as to where the criminal(s) went after the crime occurred. Deaf individuals have the same potential as their hearing counterparts to witness a crime on a daily basis. Their perception of a crime, however, may differ in important ways from the perception offered by hearing individuals. To date, very limited research has directly compared hearing and deaf populations in eyewitness memory performance. Therefore, the purpose of this study was to investigate this important and understudied topic.

Deaf Culture

Deaf individuals represent a significant but underrepresented population within the world. An estimated 15-26% of the world's population reported a degree of hearing loss (Fellinger, Holzinger, & Pollard, 2012). Additionally, this population is considered a

minority group within the United States. It is difficult to quantify the number of Deaf individuals in the United States as the U.S Census has not counted the Deaf since 1930 (Harrington, 2018). In 2016, the National Institute on Deafness and Other Communication Disorders (NIDCD) published their latest findings on Deaf and Hard of Hearing Americans. According to the NIDCD, over 30 million Americans or 13% of the total American population aged 12 years or older, have reported hearing loss in both ears (NIDCD, 2016). The Deaf community is a diverse population and are estimated to be comprised of 9.4% Caucasians, 4.2% African Americans, and 4.2% Hispanics (Andrews et al., 2004). Moreover, men are almost twice as likely as their female counterparts to have reported hearing loss in people aged 20 to 69 years old (NIDCD, 2016).

Furthermore, approximately 2 to 3 out of every 1,000 children born in the U.S have a screen able level of hearing loss in either one ear or both (CDC, 1999-2007).

Researchers investigating potential differences between hearing and deaf individuals must take into consideration how the deafness manifested and deaf culture. There are two main classifications of deaf individuals in regard to when the "deafness" appears. The first classification is called congenital deafness. Congenital is a term that denotes a disorder or condition that an individual is born with. Congenital deafness can also be identified as an acquired or inherited condition or disorder that appears prior to birth (Shiel Jr., 2016). Examples of inherited deafness include inherited genetic mutations, inherited atypical development of certain structures within the ear (can be non-inherited as well), and infections suffered by the mother during pregnancy and passed to the child (including prenatal rubella or meningitis), just to name a few (Glickman, 2013). The second classification is called acquired deafness. Acquired

denotes that the individual's disorder may or may not be due to a source. The individual may have been born with a disorder that manifests at a later time or somehow obtained the deafness after birth (Shiel Jr., 2016). Examples of acquired deafness include severe damage to the ear or perhaps there is a delay in the expression of a genetic mutation associated with deafness.

In addition to the above, there are individuals that choose to identify as culturally Deaf. This is a separate distinction that not every deaf individual chooses to identify as. Deaf individuals usually denote their connection to the Deaf community and the associated culture, by referring to themselves as Deaf with a capital D (Padden & Humphries, 1988). The culture associated with the Deaf community is intricate and includes the use of sign language as their primary mode of communication (ASL in the U.S.), a shared, positive perspective about themselves and the larger role they play in society, and their own set of social norms. When individuals utilize deaf with a lowercase d it is only specifying the individual's condition of not being able to hear. These individuals who refer to themselves as deaf with a lower-case d often do not connect to the Deaf community or have access to the population's resources. Researchers must take into consideration the extent to which potential participants identify as culturally Deaf as well as the extent to which they connect to the language, knowledge, practices, and social norms of that community. For the purpose of the present study, deaf will be operationalized as individuals who identify as being culturally Deaf.

Perceptual Differences Between Hearing and Deaf Individuals

Does auditory deprivation afford deaf individuals certain sensory deficiencies, enhancements, or a combination of both? It is usually assumed that deaf individuals are

in possession of only sensory deficiencies, but countless scientific studies have been conducted that offer support contrary to these beliefs. The findings for these studies offer promising, albeit muddled, support for deaf individuals possessing unique sensory enhancements. If the sensory enhancements do exist, what are they and how may they serve to make a deaf individual's eyewitness experience different or unique in comparison to their hearing counterparts?

Peripheral Vision and Attention. Deaf individuals have shown to be efficient at utilizing attentional resources within a visual context (Colmenero, Catena, Fuentes & Ramos, 2004; Parasnis & Samar, 1985; Stivalet, Moreno, Richard, Barraud & Raphel, 1998). For example, the findings of one study demonstrated that deaf individuals were faster and more accurate at discerning the direction of visual stimuli (Neville & Lawson, 1987).

In previous experiments, a pattern of visual enhancement has also emerged with respect to how deaf individuals perform when given tasks which utilize their peripheral vision (Chen, Zhang, & Zhou, 2006; Loke & Song, 1991; Nava, Bottari, Zampini, & Pavani, 2008). Deaf individuals have demonstrated faster overall reaction times for the detection of visual targets (Bottari, Caclin, Giard & Pavani, 2011), primarily in the peripheral area of the deaf individual's visual field (Bottari, Nava, Ley & Pavani, 2010; Loke & Song, 1991; Reynolds, 1993). With converging evidence that deaf individuals are superior to their hearing counterparts with perceiving information in peripheral vision, research has explored whether there is a central-peripheral trade-off in deaf individuals' visual perception.

Dye, Hauser, and Bavelier (2009) conducted an experiment to ascertain whether individuals with auditory deprivation would display enhanced performance for tasks that utilized peripheral visual attention. In order to determine whether auditory deprivation afforded deaf individuals an enhancement in visual peripheral attention, the researchers utilized the Useful Field of View task (UFOV). This task measured individuals' ability to identify a centrally presented target while at the same time localizing a simultaneously presented peripheral target within a field of distractors. Thus, the UFOV task measures whether an enhancement in peripheral target identification comes at a cost of reduced performance in central visual attention.

The Central Stimulus identification task required participants to identify a centrally presented stimulus (face) by indicating whether the face had long or short hair. The peripheral attention task involved presenting a peripheral target at one of eight possible locations. The individuals were instructed to touch the screen at the place where they thought they saw the peripheral target. In the training task there were no distractors and in the experimental task, the target was presented within a field of 27 distractors. The experimenters determined a trial to be correct if the individual properly identified the central face's identity and the position of the peripheral target. The time each individual spent to accurately complete the last ten trials of the tasks was averaged in order to calculate a threshold measure.

Using the UFOV task, Dye et al. (2009) conducted two separate but related experiments in order to focus on different age groups and the use of sign language. The first experiment utilized four groups of adult participants including: deaf native signers, deaf non-signers (enrolled in ASL class with no previous exposure), hearing signers, and

hearing non-signers. These individuals were recruited in order to aid the experimenters in assessing if there are possible effects, individual and resulting from interaction, that occur from audio deprivation and sign language use. Analyses revealed that deaf individuals took less time to discriminate a centrally presented target while localizing a particular peripheral target within a field of distractors compared to hearing individuals. This finding supported previous hypotheses that auditory deprivation affords deaf individuals with an advantage in peripheral vision, without reducing performance on a central task. There was no statistically significant effect of sign language within the deaf sample. Both the deaf signers and deaf non-signers demonstrated better performances in the UFOV task than their hearing signers and hearing non-signer counterparts. An interesting finding worth noting, however, is that when the researchers analyzed results from the training tasks, the findings were slightly different.

The central stimulus identification training task required participants to identify a centrally presented stimulus (face) by indicating whether the face had long or short hair. The divided attention training task utilized the same task as the previously described central stimulus identification task with an additional peripheral target. The additional peripheral target component presented a peripheral target to the individual in one of eight possible locations. Individuals were then instructed to touch the screen at the place where they thought they saw the peripheral target. Within an analysis of the training task results, a singular finding emerged for the deaf non-signer participants. Although they had superior UFOV task performance when compared with their hearing counterparts, they displayed worse performance in the central stimulus identification and divided attention tasks during the training session. Despite the similarity between the UFOV, central

stimulus identification, and divided attention tasks, there are some key differences between them, which provide a possible explanation for the discrepant findings. The UFOV and divided attention tasks both utilize central and peripheral processing in the same way but the divided attention task uses less attentional load than the UFOV task. Both the central stimulus identification and divided attention tasks also included shorter time periods for stimulus presentation than the UFOV task, 17-33 milliseconds compared to 40-80 milliseconds respectively. This suggests that the perceptual advantage of deaf individuals compared to hearing individuals may depend on the duration of stimuli presentation and the attentional load involved.

The second experiment utilized three different age group categories among deaf and hearing children including: Elementary school children (7-10 years old), Middle school children (11-13), and High school adolescents (14-17). These particular individuals were recruited in order to aid the experimenters in assessing if there are possible effects, individual and resulting from interaction, that occur from audio deprivation and age. Analyses revealed a significant interaction between auditory deprivation (deaf vs. hearing) and age group (elementary vs. middle-school vs. high school). There were no differences in UFOV task performance thresholds as a function of age group in hearing subjects. However, performance for deaf participants did vary as a function of age. Specifically, deaf elementary school children (7-10) performed similarly in the UFOV task to their hearing elementary school counterparts; however, deaf middle school (11-13) and high school (14-17) children performed significantly better in their UFOV task thresholds than their similarly aged hearing counterparts. The training task

results revealed that the elementary school children (7-10) performed the worst of all of their hearing and deaf peers.

The results of the study provided support for the hypothesis that deaf individuals are afforded an advantage in enhanced performance for tasks that require the use of visual selective attention and this advantage does not reduce accuracy at a task requiring central vision. Audio deprivation and age of the individual are two major factors that affected visual selective attention performance for stimuli presented peripherally. This advantage did not emerge till after the 7-10 years of age timeframe (Dye, et al., 2009). These findings were pertinent to the analysis of potential differences between hearing and deaf eyewitnesses because the UFOV tasks are comparable to real-life scenarios. An example would be eyewitness situations in which a deaf individual may have focused on something within their central field of vision (e.g., a perpetrator or weapon) but also can identify peripherally presented details of the crime amidst other visually distracting stimuli (e.g., the presence of co-witnesses or perpetrators or other relevant details from the scene). This contributed support to the possibility that deaf individuals may experience and remember a crime differently than their hearing counterparts.

Eye Structure. In an effort to explain why deaf individuals have superior peripheral visual capabilities in comparison to hearing individuals, research has investigated potential differences in the structure of the eye. According to the cross-modal plasticity theory, visual cortical changes affect the visual behavior of deaf individuals including enhancement of peripheral vision (Colomenero, Catena, Fuentes, & Ramos, 2004; Loke & Song, 1991; Neville & Lawson, 1987). One experiment in particular investigated neural plasticity at the retina and optic nerve levels in both deaf

and hearing individuals to explore whether changes in the retina are responsible for differences in the sensitivity of peripheral vision (Codina, Pascalis, Mody, Toomey, Rose, & Gummer, 2011). In order to conduct this investigation, the researchers utilized Optical Coherence Tomography (OCT) and Goldmann perimetry. This allowed them to take images, compute the microstructure of the retina and determine if changes in the retina are connected to sensitivity of peripheral vision. They also wanted to determine if retinal structure is different in deaf and hearing individuals. The OCT method was used to enumerate the micro-structure of the retina in both deaf and hearing individuals, measure the thickness of retinal nerve fibre layer (RNFL), and evaluate the optic disc and cup areas as well as the neuroretinal rim area. Goldmann perimetry was utilized to evaluate the size of the mid-peripheral and far-peripheral visual fields. The experimenters obtained their OCT measurements by first dilating both of each participant's eyes with a solution of 1% Tropicamide. Afterwards, measurements of both the participant's eyes were taken at 2.9mm and 6.8mm diameters. This procedure was performed 6 times for each eye and then later averaged to obtain a mean value for each eye of the participant. Only 18 participants completed the Goldmann perimetry portion of the experiment.

Consistent with previous research, the experiment revealed differences in neural rim area measurements between deaf and hearing participants; Deaf individuals had thicker neural rim area measurements than hearing individuals. There were no statistically different results found for optic cup or disk measurements between deaf and hearing individuals. These findings, along with previous histological examinations, display a correlation between the size difference of both neural retinal rim area and retinal areas to the amount of Retinal ganglion cells (RGCs) an individual has within their

optic nerve (Chen, Cense, Miller, Rubin, Deschler, et al., 2006; Varma, Quigley, & Pease, 1998; Wirtschafter, Becker, Howe, & Younge, 1982).

The use of Goldmann perimetry allowed the experimenters to have demonstrated that Deaf adult participants had larger visual field areas for their mid and far peripheral fields in comparison with their hearing counterparts. Deaf individuals had bigger neural rim areas and visual field areas in comparison to their hearing counterparts. The findings provide evidence that peripheral vision enhancement within deaf individuals is connected to differences in retinal structure of both hearing and deaf participants. The researchers also reported that Retinal nerve fiber layer (RNFL) measurements were significantly thicker in the nasal peripapillary area of deaf participants compared to their hearing counterparts. The nasal peripapillary area aids the monocular temporal visual field and a majority of the peripheral visual field areas. Although deaf participants had thicker RNFL associated with enhancements in peripheral vision, they also had less thickness in RNFL associated with central vision including the papillomacular bundle. Hearing participants were superior in tasks requiring the use of central vision compared to their deaf counterparts. These findings demonstrate that there is a RNFL tradeoff within both hearing and deaf individuals.

Deaf individuals performed better in tasks that required the use of peripheral vision while hearing participants performed better in tasks that required use of central vision. There is reason to believe that structural differences in RNFL thickness in Deaf individuals are a specific retinal adaptation. In sum, the results suggest that greater RNFL thickness in the monocular temporal visual field is given preferential treatment in response to having less RNFL thickness in the binocular nasal field. This creates a

specific peripheral vision advantage for deaf individuals, which supports results from previously conducted experiments.

Memory. Research has also suggested that deaf individuals may show superior performance on memory tasks involving spatial perception and visual memory (i.e., memory for designs and faces; Arnold & Murray, 1998; Blair, 1957). Specifically, research has demonstrated that deaf, signing children and adults show enhanced facial discrimination compared to their hearing (non-signing) counterparts (e.g., Bettger, 1992; Bellugi & Emmorey, 1993). Other research has suggested that the use of visual language (American Sign Language) may be a key factor in enhancing this type of memory as deaf and hearing signers, compared to hearing non-signers, showed superior performance in a memory task for facial and shoe stimuli (Arnold & Mills, 2001; Cattini, Clibbins, & Perfect, 2007).

Despite demonstrating enhanced performance in visual and spatial memory tasks, doubts have been expressed as to whether deaf individuals display similar performance in autobiographical memory tasks in comparison to their hearing counterparts. There have been several experiments suggesting that there is a time component in language development, which may contribute to an individual's ability to encode memories as cited in Bauer et al., (1998) and Peterson & Rideout (1998). For example, Wiegle and Bauer (2000) found that delayed language development in deaf participants may result in less detailed memories compared to their hearing counterparts. In another study, Burch, Jaafar, West, and Bauer (2008) examined, in a more general manner, the effects that delayed language development can have on deaf individuals' reported memories of an event or several events. In this experiment, participants were interviewed and asked to

report their earliest memories about two specific events of their choosing. They were specifically asked to report memories of four events, two events that happened before the age of 10 years and two events that happened after the age of 10 years. After the details of each event were obtained through interviews, each participant was asked to complete a survey that further prompted them to report details about the timing, importance, and reporting frequency of the events. Each interview was then coded for two specific aspects: how coherent the narrative was and whether they included internal states. The number of words within the transcriptions of a participants' report led to a determination of the report's length.

Researchers defined coherence as the clarity and quality of each participant's report. In particular, researchers coded for three dimensions within coherence. This includes the amount of contextual details provided (context dimension), if the narrative was told across a timeline (temporal dimension), and the existence of a theme (theme dimension). Each of these three dimensions was assigned a score along a scale of 0-4. Greater amounts of coherence were assigned higher scores (3-4) as opposed to less coherence, which was assigned a score between (0-2).

Researchers' coded for several types of internal states found within a participant's report including mental, perceptual, physiological, and emotional states. Mental states were defined as moments in which the participant referred directly to the use of their five senses (e.g., taste, touch, smell, sound, and touch). Physiological states referred to any instances in which the narrator mentioned biologically connected states including hunger, sleepiness, or the presence of an illness. Emotional states referred to instances in which the participant mentioned either others' or their own feelings. The researchers coded each

of the emotional states as either containing positive, neutral, or negative context.

Researchers also chose to note whether any of the internal states were in reference to themselves (self-referenced) or others (other-reference).

The results of the study were different than the researchers predicted they would be. It was expected that deaf participants who experienced delays in language from their hearing parentage, would have reports with less quality and details than those of their hearing counterparts. Instead, this was only slightly supported by the research. Hearing participants did tend to produce reports of greater length than those of their deaf counterparts (Burch et al., 2008). However, there were no statistically significant differences in the level of coherence of either group's reports. Additionally, the researchers also found that earlier memories were more fragmented when compared to the memories reported within a later portion of the participant's lives. These earlier memories suggest they are fragmented because they were specifically less coherent across both temporal and thematic dimensions in comparison to memories formed later within the participant's life.

There were some differences found in reported internal states made by deaf participants as opposed to their hearing counterparts. Deaf individuals' reports included more reported emotions than their hearing counterparts. This leads researchers to believe that deaf individuals can still perceive and understand expressions of emotion despite the expectation that delays in language development would occur in deaf individuals born to hearing parents. The differences in the amount of reported internal states were also found across the timing of the individual's memory. The earlier memories reported by participants contained more references to internal states compared to later memories.

Interestingly, these differences specifically manifested as a greater amount of positive emotionality, perceptual states and references to their own internal states. Researchers hypothesized that this increased reference to internal states among the deaf versus hearing groups may allow deaf individuals to understand what had happened in their past based on their assessments of a prior experience (Burch et al., 2008). In sum, Deaf and hearing individuals' autobiographical reports were similar in their level of coherence, but deaf participants' reports tended to be shorter and contained more references to internal states than the deaf participants. This could contribute to an advantage for deaf individuals in the utilization of emotional states to evaluate and understand events within their past. It remains unclear, however, whether providing fewer details with more personal references will be helpful or detrimental when deaf individuals are asked to recall a crime event in an eyewitness context.

Visual Memory

Pre-existing research has suggested and supported the possibility that deaf individuals that utilize sign language have better visual memory than their hearing counterparts. It has not been established by previous experimentation whether this is due to the individuals being Deaf or whether it is due to their use of visually oriented language such as sign language (Smith, Lentz, & Mikos, 1988). Previous research also suggests that deaf individuals show an enhancement in visual memory for specific items such as faces but not for every day, easy to describe items (Arnold & Mills, 2001). In a study conducted by Cattani, Clibbens, and Perfect (2007), the researchers attempted to specifically test the validity of the existence of a visual enhancement in deaf signers. They also wanted to determine the limits, if any, of the applicability of their visual

enhancement. This was accomplished using a test that utilized both ordinary objects and abstract shapes. Additionally, the researchers attempted to discern whether the visual enhancement in deaf individuals was related to their auditory deprivation or use of a visually oriented language such as sign language (see Cattani et al., 2007 for a review).

In order to test the presence of a visual enhancement and any of its limits, the researchers devised a testing procedure that specifically focused on these elements. The experiment was split into two separate rounds that randomly and consecutively started with the presentation of either ordinary objects or abstract shapes. Each trial started with the presentation of two objects or shapes for 150 milliseconds followed by a 1-second pause. The shapes or objects were presented on the far-left hand or far-right hand sides of the screen. This was done purposely so that the shapes and objects would be viewed using the participant's peripheral vision. The participants were asked to remember which two shapes they had seen before the 1-second pause. Afterwards, another set of two ordinary objects or abstract shapes were presented. The participants' memory was tested when they had to determine whether the second set of objects or shapes matched the first set or ad changed. When the participants had completed the first set of either ordinary objects or abstract shapes, the same procedure was repeated for the remaining set (either ordinary objects or abstract shapes dependent on which set had been tested first).

The results of the experiment did confirm several of the hypothesized outcomes made by the researchers and supported by pre-existing research. There was a statistically significant finding that individuals who utilized sign language had greater accuracy for correct item identification than individuals that didn't sign. This finding was limited only to abstract shapes as supported by previously conducted research. There were no

differences in accuracy for correct familiar object identification found between individuals who utilized sign language as opposed to those who didn't. This finding is in opposition to previous research, which indicated that non-signing individuals displayed better accuracy in the identification of familiar objects.

Additionally, the researchers failed to find any statistically significant findings in support of audio deprivation demonstrating visual enhancement in the deaf individual's peripheral field of vision. These lack of findings specifically occurred despite the experimenter's consistent presentation of abstract shapes within the participants' peripheral field of vision. The researchers hypothesized that the experience of being deaf has the potential to specifically contribute to improving the skills utilized for spatial locations in peripheral vision. The experimenters also believed that any visual enhancements obtained from the use of sign language can be utilized with other abilities. The other abilities had to utilize similar processes that occur within sign language but not be directly linked to sign language. The data collected by the researchers has the potential to demonstrate that an individual's memory for abstract shapes necessitates an activation of specific processes commonly utilized in sign language. This includes the individual's ability to create abstract representations of visually viewed objects. This finding demonstrated that sign language plays an important role for both hearing and deaf individuals because it contributes specifically to a performance improvement for the memory of abstract objects.

Theoretical Explanations

To understand and explain the observed perceptual differences between deaf and hearing individuals, it is important to consider two theories: Cross-modal plasticity and

the Multiple Resource Theory. Cross-modal plasticity occurs when individuals who have been deprived the use of one sensory system (i.e, hearing) re-allocate the processing of another sensory system (i.e, vision) to the unutilized cortical area of the brain (Hauthal, Sandmann, Debener, & Thorne, 2013). In the case of deaf individuals, auditory information is not utilized; instead, visual information is processed in both the visual and auditory cortical areas of the brain as opposed to merely being processed in the visual cortical area of the brain. This can afford deaf individuals certain advantages and disadvantages over their hearing counterparts.

In addition, deaf individuals may experience less cross-modal interference when processing sensory information. Cross-modal interference refers to the process in which multiple sensory inputs compete for resources when an individual attempts to remember both visually and aurally presented information (e.g., about a crime). The manner in which the information is presented to a witness (auditory or visual), can affect the information recalled (Pickel & Staller, 2011). In other words, visually presented information can interfere with eyewitness recall for aurally presented information (Pickel & Staller, 2011). Cross-modal interference can occur when two or more tasks compete against each other for the use of limited or strained resources (Pickel & Staller, 2011; Wickens, 2008).

Experimental findings lend support to cross-modal plasticity in deaf individuals, who display activation of multiple sections of the brain when processing visual information. For example, previous studies have demonstrated that deaf individuals' auditory association cortex was activated when viewing sign language and the primary auditory cortex of deaf individuals was activated when viewing visual stimuli (Fine,

Finney, Boynton, & Dobkinsl, 2005; Finney, Fine, & Dobkins, 2001; Lambertz, Gizewski, De Greiff, & Forsting, 2005). Another previously conducted experiment demonstrated cross-modal plasticity in hearing and deaf cats; Peripheral vision was significantly more sensitive in deaf cats than in hearing cats and certain areas within the auditory cortex are correlated with better visual performance of deaf versus hearing cats (Lomber, Meredity, & Kral, 2010). These enhanced visual abilities are thought to correlate between the deaf auditory cortexes, not visual cortexes. Thus, cross-modal plasticity provides a possible explanation as to why deaf individuals may show an advantage in their perception of visual stimuli, in this case, the visual perception of a crime (Hauthal et al., 2013).

Multiple resource theory (MRT) or the Multiple Resource Model is an intricate theory that attempts to explain how simultaneously occurring tasks can result in a degradation in our ability to perform these tasks. This is due to the idea that the performance of simultaneously occurring tasks exceeds our limited amount of resources (Wickens, 2008). Presently, MRT contends that there are four dimensions of information processing which occupy our mental resources (Wickens, 2008). Understanding these dimensions helps to explain how attention is allocated and divided depending on the stage of processing of the task (e.g., perceiving, processing, or responding), the type of working memory being used (spatial versus verbal), the type of sensory processing being used (visual versus auditory), and the specific type of visual processing being used (focal versus ambient). Each layer of each dimension is proposed to use a different aspect of our limited resources and corresponds with different task abilities. For example, focal visual processing is responsible for object and symbol recognition and high acuity visual tasks

like reading whereas ambient visual processing is responsible for perception of movement and peripheral vision, across the visual field (Horrey, Wicken, & Consalus, 2006). When completing two tasks simultaneously, the Multiple Resource Model suggests that the quality of the completed dual tasks depends upon which dimensions of mental resources are being utilized concurrently. If an individual is completing two tasks that utilize resources from a similar mental resource dimension, but at different levels (e.g., perceptual tasks involving both verbal and spatial information), usually both tasks are completed well and successfully. If there are two tasks competing for the same resources and require a large amount of effort that can result in one task being completed more effectively than the other.

Multiple Resource theory provides a plausible explanation for why deaf and hearing individuals may encode a crime event differently. For example, deaf individuals may experience less cross-modal interference when processing sensory information. In contrast, hearing individuals may find that their attention is divided between complex visual and auditory aspects of the crime whereas, deaf individuals may focus exclusively on the visual details. This theory provides a possible explanation as to how cross-modal interference can affect eyewitness recall (Pickel & Staller, 2011).

Eyewitness Memory Research

Although there are many studies examining factors that influence eyewitness memory recall, there has been a miniscule amount of research examining if there are any differences between the eyewitness accounts of hearing and deaf individuals. Eyewitness recall refers to an individual's ability to accurately report details pertaining to a witnessed crime. This includes the criminal's appearance and voice, the weapon's existence, the

weapon's appearance, the direction the fleeing criminal, etcetera (Pickel & Staller, 2012). Any previously conducted research on differences between hearing and deaf populations in eyewitness contexts is limited and has focused almost exclusively on children. The first study investigating potential differences between deaf and hearing individuals was prompted by an apparent pattern of bias within the justice system that was calling into question the accuracy or trustworthiness of deaf witnesses' or victims' testimony as evidenced in several court cases (Jericho Hill, 1993; Sulivan, Vernon & Scanlon, 1987; Leippe & Romanczyk, 1989). Given this skepticism regarding deaf individuals' eyewitness testimony in general, and concerns regarding children's susceptibility to suggestive interviewing practices in particular, Porter, Yuille, and Bend (1993) conducted a study to examine potential differences in eyewitness memory between deaf and hearing children.

The researchers had a threefold purpose to determine if there are differences in the eyewitness testimony between deaf and hearing children based upon differences in the amount of details recalled, the accuracy of those details recalled and if the type of interview questioning style (open ended or specific questions) affected the amount and accuracy of the recounted information. In order to test their hypotheses, the researchers designed a study that utilized 15 deaf children, all assumed to be deaf due to congenital reason, and 11 hearing children. The deaf children's ages averaged at nine years, one month, and the hearing children's ages averaged at eight years, ten months. The experimenters used a twenty-four slide show to depict the narrative of a woman's wallet being stolen in order to test the children's memory for recounting the "witnessed" details of the crime. The slides were shown individually to each child for a couple of seconds per

Slide. Children were then interviewed using a method based on Yuille, Hunter, Joffe, and Zaparniuk's Step Wise Interview protocol (1993). The interview included a free recall portion followed by specific questions meant to expand upon the responses collected from the previous free recall portion. For the deaf children, relay interpretation was used in which the interviewer asked the question in English to a hearing interpreter who then signed the question to a deaf interpreter, who signed the question to the child and then signed the child's response back to the hearing interpreter to translate to the interviewer.

Responses were classified as: correct, incorrect, or unclassified. In addition, one point was awarded to answers if they were specific in nature, and a half a point was awarded if the detail reported was true but not specific. Zero points were awarded to any detail that couldn't be verified by the experimenters. Accuracy was calculated as the number of correct details over correct and incorrect details recalled.

Analyses revealed no statistically significant difference in the amount of details recalled by deaf and hearing individuals (average of 23.7 for deaf children and 27.8 for hearing children). There were also no effects of questioning type on the number of details recalled. With respect to accuracy, there was a significant question type by participant type interaction on the accuracy of details recalled. Question type affected the accuracy of deaf children's responses but did not affect the accuracy of hearing children's responses. Overall, children were more accurate in response to free recall questions (94.7%) compared to specific question (82.6%). However, for deaf participants, accuracy declined significantly in response to specific questions (76.7%) compared to free recall (94.5%). Not much difference in hearing children's recall was noticed due to questioning type (94.5% for free recall compared to 90.7% for specific, open questioning).

Overall, the experimenters found no differences between deaf and hearing children's memories in terms of the amount and accuracy of details recalled. Hearing and deaf children both demonstrated their abilities to recount accurate and detailed responses regarding the crime witnessed. Interestingly, the accuracy of deaf children's responses significantly decreased once specific questioning was utilized and this was not the case for the hearing children, whose accuracy was not significantly affected by question type. The experimenters hypothesized that this effect may be due to the slightly suggestive manner of American Sign Language (ASL). For instance, in purported sexual abuse interviews ASL interpreters will point to the body parts of the child when asking whether an individual touched those areas. This manner of questioning through ASL creates an opportunity for a highly suggestive scenario to occur specifically for deaf children. ASL visually emphasizes certain body parts through pointing which can feed incorrect information to that child. In conjunction with their young age (young age of the individual has been shown to demonstrate more suggestibility than their older counterparts) and greater dependence upon adults for attention and protection, the way in which questions are asked needs to be taken into consideration when conducting interviews with deaf children. Other possible reasons include the possibility that deaf children are more imaginative than their hearing counterparts, might hope to please the interviewer more than their hearing counterparts, or may have become attentive as the interview progressed. It was suggested by the experimenters that deaf children may be more suggestible than their hearing counterparts. This study suggests that deaf individuals should be interviewed in a free recall format, using specific questions only if necessary because it can impair the accuracy of information provided to the interviewer.

The Rationale for the Present Study

Lack of research into Deaf individuals' unique perceptions of a crime created a deficit in the existing body of research for eyewitness recall. Presently, some research suggests that a visual perceptual advantage may exist amongst deaf individuals whereby they have demonstrated enhanced peripheral vision. This may lead to meaningful differences in deaf individuals' ability to recall critical details concerning a witnessed crime when compared with their hearing counterparts. Deaf individuals have demonstrated that their eyewitness accounts were less accurate than their hearing counterparts' when direct questions were used, as opposed to open ended questions (Porter et al., 1993). Some research has demonstrated that Deaf individuals show enhanced performance for the memory of abstract shapes due to similar processes utilized for sign language (Cattani, Clibbens, & Perfect, 2007). Additionally, research has suggested that Deaf individuals tend to have autobiographical reports that are shorter in length than their hearing participants; however, there were no statistically significant differences in the level of coherence of either group's reports (Burch et al., 2008).

The present study aimed to clarify the advantages and disadvantages, if any exist, that deaf individuals have in their perceptual experience, and later memory accuracy, of a crime. The study also aimed to serve and expand on the small body of knowledge that exists on this underserved minority group. It is hypothesized that the advantages of the perceptual experience of a crime will afford deaf individuals a greater accuracy of details recalled about the crime. In order to more closely examine whether deaf individuals benefit from reduced cross-modal interference at the time of encoding (e.g., fewer distractions by aurally presented stimuli), the present study included a hearing control

group, who were exposed to the visual stimuli without sound. Consistent with previous literature showing a perceptual advantage for peripherally presented stimuli, it is hypothesized that deaf individuals have superior memory recall (i.e., higher accuracy), for "peripheral" details compared to "central" details when compared to both hearing groups. Central details were operationalized to include any details that fall primarily within the center of the participant's view of the screen and "central" to the crime. Peripheral details were operationalized to include any details that fall primarily to the left or right sides of the participant's view of the screen (i.e. within their periphery) and is secondary to the crime.

Method

This study examined differences in eyewitness memory across three groups of individuals: hearing vs. deaf vs. hearing control (i.e., hearing participants who viewed the video without any sound). The study was posted electronically on PsychData, and all participants remained anonymous. Participants who were interested in the study were directed to a cover page, which explained the study they participated in involved a study on perception. Participants were first asked to complete a demographic questionnaire. Afterwards, all participants viewed a video clip, completed an eyewitness memory questionnaire, and a final questionnaire that debriefed all participants. Participation took an average of 20 minutes to complete.

Hearing Participants

A total of 196 hearing participants accessed the survey. Forty-five hearing participants were excluded for failing to pass the manipulation check questions: correctly identifying the background noise (if applicable) and having exposure to the actor or video

clip prior to this study. Eight additional participants were excluded due to incomplete or inappropriate responses. Examples of responses from these eight participants included: "I saw nothing, sorry.", "Heart-touching", "Video did not load.", or "Are you serious, bruh." Four additional hearing participants were excluded from analysis due to hearing problems they reported in their demographic questionnaire. Therefore, the final sample of hearing participants was 140 individuals.

Deaf Participants

A total of 53 Deaf participants accessed the survey. Two Deaf participants were excluded as they failed to complete the demographic questions. One participant was excluded as they reported they recognized the actor. One additional Deaf participant was excluded from analysis due to a reported Usher syndrome (a condition which affects an individual's vision) in their demographic questionnaire. Upon running an exploratory analysis using a stem and leaf plot of the data, one additional deaf participant was excluded as they were an extreme outlier for open-ended accuracy of responses. This participant reported "I don't know" for each of the open-ended responses. Therefore, the final sample of Deaf participants was 42 individuals.

Deaf participants reported several different languages as their main language growing up. A majority of the sample (62.8%) reported American Sign Language (n = 27) as their main language when growing up followed by 23.3% of participants who reported English, 7% of participants who reported American Sign Language and English, and 7% of participants who reported Spoken English as their main language growing up. When asked what type of school they attended, 74.4% of Deaf participants reported attending a Deaf school (n = 32) and 25.6% of Deaf participants reported not attending a

Deaf school (n = 11). An additional 62.8% of Deaf participants reported attending a mainstream program (n = 27) as opposed to 37.2% of Deaf participants who did not attend a mainstream program (n = 16). In this sample, 79.1% of Deaf participants reported identifying as culturally Deaf (n = 34) and the remaining 20.9% of Deaf participants did not identify as culturally Deaf (n = 9). Regarding other forms of communication, 65.1% of Deaf participants reported that they cannot lip read (n = 28) and the remaining 34.9% reported that they can lip read (n = 15). One hundred percent of Deaf participants reported American Sign Language (ASL) as their current form of communication despite only 72.1% of these participants having reported that it was their first language (n = 31). The remaining 27.9% of participants reported that ASL was not their first language (n = 12). When asked the age of onset of their deafness, 58.1% of deaf participants reported they were born deaf (n = 25) with the remaining 41.9% of them not having been born deaf (n = 18).

Final Sample: All Participants

The final sample of Deaf and hearing participants (N = 184), were comprised of 65.2% females (n = 120) and 32.1% males (n = 59). Participants ranged in age from 18 to 33 with a mean of 20.75 (SD = 2.9). When asked to identify a gender, 2.2% of participants selected other and then wrote in their gender identity: 1% of participants identified as gender fluid (n = 2), <1% of participants identified as non-binary (n = 1), and <1% of participants identified a frustration with gender identity (n = 1). The remaining <1% of participants failed to specify their gender (n = 1). For their highest level of education completed, 30.4% of participants reported having a high school degree (n = 56), 48.8% reported having completed some college (n = 90), 9.8% reported having

an Associate's degree (n = 18), 9.8% reported having a Bachelor's degree (n = 18), and <1% reported having a Master's degree (n = 1). Additionally, <1% of participants failed to specify the highest level of education completed (n = 1).

All participants for this study reported enrollment in a wide assortment of college majors totaling 52 different areas of study. The following majors are reported in order of largest enrollment to least enrollment: Psychology 15.5% (n = 29), Biology 8.7% (n = 29)16), Criminal Justice and Nursing tie with 7% each (n = 13), Pre-Nursing 4.3% (n = 8), Education 4.2% (n = 8), Undecided 3.8% (n = 7), Computer Science and Business/Business Management 3.1% (n = 6), Sports Management 2.7% (n = 5), and both History and Social Work have 2.1% (n = 4). There are several majors that reported 1.6% enrollment including English, Forensic Psychology, Information Technology, International Studies, Photography, Political Science, and Pre-Law (n = 3). An additional 11 majors reported 1% enrollment (n = 2) and 21 different majors reported <1% enrollment (n = 1). Each participant reported completing the study's survey on a cell phone (25.5% or n = 47), laptop or desktop computer (72.3% or n = 133), or tablet device (2.2% or n = 4) and 100% of participants reported never seeing the study's video before. Participants reported they either wore glasses or contacts (46.7% or n = 86) or did not wear either (52.7% or n = 97) with <1% of participants failing to report whether they used glasses, contacts, or neither (n = 1).

Materials

Demographic Questionnaire. All participants were asked to report their age, gender, level of education, their designated college major, and for the hearing population, whether English is their first language and to list any other fluent languages (Appendix

E). All participants were asked whether they wear corrective lenses for vision impairment and whether they are currently wearing them while participating in the study. All participants were asked if they have been diagnosed with Usher Syndrome (associated with deficits both in hearing and peripheral vision).

Deaf participants were asked to indicate their current method of communication (American Sign Language (ASL), speech lip reading, or other), whether ASL was their first language, and whether they were deaf before the age of 3 (indicating their status as pre-lingually or post-lingually deaf). Deaf participants were asked questions about their childhood communication, family, and education. Specifically, whether they grew up in a deaf family, what their primary mode of communication was while growing up, and the type of education they received (i.e., a mainstream program or a deaf school).

Crime Stimulus Video. All participants viewed a short video clip from the Television show Luther, which depicted a criminal event: a suspect walked up to parked cars on a busy street, climbed up and jumped on three cars, then beat one of the cars with a hammer, and spray painted it with a symbol while car alarms sound in the background and numerous bystanders pass by. The clip was selected such that it was not extremely popular and contained a sequence of events involving a primary target person, numerous onlookers or background individuals, background noise that would serve as a potential distractor for hearing participants, and sufficient background details that would be important to solving the crime (e.g., specific details about the suspect, the make and model of a car, witnesses, and weapons used to vandalize).

Eyewitness Memory Questionnaire. Participants were asked to remember details using both recall (short answer) and recognition items (Appendix.G). Details

selected for inclusion on the eyewitness memory questionnaire were sampled from those details deemed to be "central" to the crime and generally portrayed within the center of the observer's visual field (e.g., the perpetrator and his action) and details that are "peripheral" both in their relevance to the crime (e.g., scene details, setting, bystander details etc.) and in the position of those details within the observer's visual field.

Debriefing Questionnaire. Participants were asked on what device they completed the survey, whether they have ever seen the video clip (or TV show) used in the study, confirm whether the video had sound, and were asked if they recognized the actors in the clip (Appendix H).

Design and Procedure

The current study examined differences in eyewitness memory across three groups of individuals: hearing vs. Deaf vs. hearing control (i.e., hearing participants who will view the video without any sound). The study was posted electronically through PsychData, and participants remained anonymous. Participants interested in the study were directed to a cover page, which explained that they participated in a study on perception.

Participants were first asked to complete the demographic questionnaire. All participants then viewed the video clip, followed by the eyewitness memory questionnaire, and a final debriefing questionnaire. Participation took an approximate 20 minutes.

Coding System

Each open-ended response was first broken down into identifiable units (e.g., the smallest piece of information that can be independently verified for accuracy against the

video clip). Accuracy was calculated as the proportion of correct units recalled out of all units provided. Total accuracy was calculated and the following sub-categories of details: central vs. peripheral and details elicited by question type: open vs. close-ended question format. Reliability analyses were performed on a subset of 18% of the participants. See Table 1 for a detailed breakdown of interrater agreement calculations for each question. Average interrater agreement for all questions was an intraclass correlation coefficient (ICC) of values ranging from (.73 - 1.00).

Table 1. *Interrater Reliability of Participant's Coded Responses*

Question	Detail Type	Mean ICC
Describe what the suspect	Correct	.95
looked like	Incorrect	.91
	Not Scored	.82
What was the suspect wearing?	Correct	.86
	Incorrect	.79
	Not Scored	.95
What exactly did the suspect do	Correct	.92
with the parked cars?	Incorrect	1.00
-	Not Scored	.94
What did the suspect do with	Correct	.86
the 2 nd item that was pulled out	Incorrect	.82
of his bag	Not Scored	.90
What was the color of the van	Correct	.73
that passed by the man?	Incorrect	.83
	Not Scored	.94
What was the old man with the	Correct	.82
beard wearing?	Incorrect	.92
	Not Scored	.87
What was the make and model	Correct	.80
of the black car?	Incorrect	.92
	Not Scored	.96
What color was the bus parked	Correct	1.00
in the background?	Incorrect	1.00
	Not Scored	1.00

Results

To test the primary hypothesis that eyewitness accuracy will differ between hearing and deaf participants, a 3 (participant type: hearing with sound vs. hearing without sound vs. Deaf) x 2 (question type: open vs. closed) x 2 (detail type: central vs. peripheral) mixed Analysis of Variance (ANOVA) was used to examine the interacting effects of experimental group and two within subject variables, question type and detail type, on memory accuracy rate (e.g., the proportion of correct details out of all details provided); See Table 2.

Table 2. 3 x 2 x 2 Analysis of Variance Results

Variable	df	SS	MS	F	p	partial η ²
Detail Type	1	6.32	6.32	123.11	.000**	.43
Question Type	1	9.52	9.52	174.33	.000**	.51
Participant Type	2	0.51	0.26	2.96	.055	.03
Detail *Question	1	2.97	2.97	54.49	.000**	.25
Detail * Participant	2	0.22	0.14	0.11	.124	.03
Question * Participant	2	0.42	0.21	3.88	.023*	.05
Error	166					

Note: *p < .05 and **p < .001

The analysis revealed a main effect of detail type on participant accuracy, F(2, 166) = 123.10, p < .001, partial $\eta^2 = .43$. A follow up paired samples t-test revealed that overall, participants were more accurate when answering questions about details classified as central (M = .69, SD = .14) compared to peripheral (M = .45, SD = .23), t(168) = 13.08, p < .001, 95% CI [.20, .28].

The analysis also revealed a main effect of question type on participant accuracy,

F(1, 166 = 174.33, p < .001, partial $\eta^2 = .51$. A follow-up paired samples t-test revealed that overall, participants were more accurate when answering open ended questions (M = .79, SD = .14) compared to closed ended questions (M = .46, SD = .18), t(180) = 22.38, p < .001, 95% CI [.30, .36]. This was qualified by a detail type by question type interaction, F(2, 166) = 54.49, p < .001, partial $\eta^2 = .25$. Post-hoc pairwise comparisons with a Bonferroni adjustment revealed that for central details, the effect of question type on participants' accuracy rates was more pronounced compared to peripheral details, all p's < .001.

The analysis also revealed another significant interaction between question type and participant type, F(2, 166) = 3.88, p = .023, partial $\eta^2 = .05$. Post hoc comparisons using a Bonferroni adjustment revealed that for hearing participants who saw the video with sound, the effect of question type was less pronounced. Specifically, hearing participants with sound had significantly higher accuracy rates for closed ended questions compared to hearing participants without sound, p = 034, 95% CI [.01, .20], as their accuracy rates remained high regardless of question type.

Finally, a marginal effect of participant type on accuracy was revealed, F(2, 166) = 2.96, p = .055, partial $\eta^2 = .03$. Hearing participants who viewed the video with sound tended to be more accurate overall (M = .60) compared to hearing participants who viewed the video without sound (hearing control group; M = .53), but not more than Deaf participants (M = .57). See Table 3 for means and standard deviations for each group as a function of question type and detail type.

Table 3

Means and Standard Deviations of Accuracy Rate as a Function of Participant Group

	Hearing with Sound		Hearing Without Sound		Deaf	
	M	SD	M SD		M	SD
Open ended						
Central	.87	.11	.86	.12	.85	.14
Peripheral	.57	.36	.43	.36	.43	.32
Closed ended	_					
Central	.51	.22	.47	.27	.59	.22
Peripheral	.46	.23	.39	.21	.41	.23

Discussion

The purpose of the present study was to examine whether Deaf individuals experienced perceptual differences in their experience of a crime that would afford them greater accuracy for recall of crime details. It was hypothesized that Deaf individuals would have better accuracy of details for an experienced crime due to the advantages of their perceptual experience documented in basic research on human perception. This hypothesis was not supported. Although not statistically significant, the marginal effect of participant group revealed that hearing participants who were able to hear the background noise, recalled the event more accurately than hearing participants who viewed the video without sound. Interestingly, Deaf individuals' accuracy rates fell in the middle, thus supporting the notion that hearing individuals benefit from access to auditory stimuli to supplement visual stimuli. Although they did not demonstrate a perceptual advantage per se, the fact that Deaf participants performed similarly to, if not better than, the hearing participants without sound overall suggests that eyewitness performance is comparable across groups when the same sensory stimuli is encoded.

Consistent with previous literature, the present findings suggest that open-ended

questions yield higher accuracy rates compared to closed ended questions (Porter et al., 1993). Perhaps more importantly, the present study highlights the potential moderating effect of question type (closed-ended vs. open-ended) and detail type (peripherally vs. centrally presented details) on comparisons of Deaf and hearing individuals on eyewitness memory. Deaf individuals performed similarly to their hearing counterparts with and without sound when questioned in an open-ended format about central details and in a closed-ended format regarding peripheral details; however, the means suggest that Deaf individuals tend to have a better accuracy for "peripheral" details when compared to both the hearing and hearing control groups. This perceptual advantage on peripheral details is consistent with previous research (Codina, Pascalis, Mody, Toomey, Rose, & Gummer, 2011). The present study extends these findings and suggests that any advantage in perceptual encoding is dependent upon how the question is asked during the recall phase.

Findings as a function of theory and previous research

Previously conducted research on Deaf children suggested that question type (open-ended vs. closed-ended) had a statistically significant effect on their accuracy for recall of details (Porter et al., 1993). Porter et al.'s study specifically found that Deaf children demonstrated greater accuracy for details recalled when presented in an open-ended (i.e., free recall) question format versus a closed-ended question format. The results of the current study further support previous literature for greater accuracy of details recalled for Deaf individuals when questioned in an open-ended format versus closed-ended format. Deaf individuals were more accurate (64%) for details gathered in an open-ended response format was compared to details collected via a closed-ended

response format (50%). Further research is needed to expand upon this finding by using a larger number of Deaf participants and also, using Deaf participants' primary means of communication via American Sign Language.

While the first hypothesis was not supported, examination of the means in the current study reveal that participants' responses to open-ended, peripheral questions varied most as a function of participant group. While Deaf participants and hearing controls showed a similar accuracy rate of 43%, the hearing with sound group was noticeably higher at 57% accurate for open-ended, peripheral questions.

Limitations

There are several notable limitations to this study. One of the limitations includes missing ethnic and racial demographic information for the participant sample. This missing information limits the generalizability of the findings to the public. An estimate of the participant's reported race and ethnicity are provided below. These estimates were gathered from both recruitment universities utilized for data collection including Barry University and Gallaudet University. Barry University's total student enrollment for Fall 2017 was 7,358 individuals. These students reported their ethnicities as follows: 7% non-resident alien, 29% Hispanic, 1% American Indian, 3% Asian, 29% Black, 0% Hawaiian or Pacific Islander, 26% White, 1% reported two or more races, and 4% Ethnicity Unknown (Barry University Office of Institutional Research, 2017). Gallaudet University's total student enrollment for 2018 was 1,900 individuals. These students reported their ethnicities as follows: 52.8% white, 15.4% Black, 10% Hispanic, 9.5% Ethnicity Unknown, 7.3% Non-Resident Alien, 3.7% Asian, 0.6% American Indian, 0.5% Native Hawaiian or Pacific Islander (College Factual, 2018). Thus the Gallaudet

sample likely contained a higher percentage of White participants than the Barry University sample.

Another limitation of this study is the use of a college sample population. In an effort to more closely compare the performance of hearing and Deaf individuals of similar cognitive functioning and socioeconomic status, college-aged participants were targeted. This recruitment strategy however, limits the findings of this study and their generalizability to the public. particularly because rates of college education are higher among hearing than Deaf people. An estimated 50% or more of deaf and hard of hearing individuals have completed their high school education or less than a high school education compared to only 40% of hearing people (National Technical Institute for the Deaf, 2019). Additionally, only 24% of deaf and hard of hearing individuals are college graduates compared to 39% of the hearing population (National Technical Institute for the Deaf, 2019). These facts alone suggest that further research should include non-college educated individuals for both hearing and deaf populations to increase the generalizability of the findings.

A final limitation for this study was the use of online administration via

PsychData. To examine the size of the viewing screen, we asked participants to report the device on which they completed the survey. Approximately 29% of participants reported completing the survey on a cellular or tablet device compared to 71% that reported completing the survey on a computer. There were no differences as a function of participant group with respect to which device was used. As the survey was taken online wherever the participant was instead of in a controlled lab environment, the researcher was unable to ensure that both hearing participant groups had noise-cancelling

headphones to drown out background noise that could have served as a potential distractor. Online administration also makes it difficult to ensure that participants encoded the event or paid full attention to the crime event. Another limitation of online administration is the inability to ensure that a participant didn't take the survey more than once.

Additionally, the use of online administration was done to substitute the need for an interpreter; however, the use of a Sign Language interpreter would have allowed all instructions to be standardized, filmed, and given to deaf participants whose main language growing up was American Sign Language (62.8%). A limitation of this study was to use English written instructions at an 8th grade reading level. Participants for the study reported they might not have utilized English as much when growing up (i.e., 23.3% for those who used English only and 7% of participants that utilized both ASL and English).

Conclusions and Future Directions

In conclusion, the current study was the first study to compare the eyewitness accuracy of the Deaf and hearing populations using an adult sample. The findings suggest that Deaf participants have certain perceptual differences that allow them to experience a crime differently than their hearing counterparts. Although Deaf participants did not show greater accuracy for recalled details compared to their hearing counterparts as predicted, their performance relative to the comparison hearing groups varied as a function of the type of question asked and the detail type. Specifically, if questioned about central details in an open ended way, they had higher accuracy rates than both hearing groups. The second hypothesis that Deaf participants would have greater

accuracy rates for recall of "peripheral" details compared to "central" details when compared to hearing participants was not fully supported by the results of the current study. Instead, Deaf individuals tended to perform more accurately than the hearing controls but not hearing participants who viewed the crime with sound, regardless of detail type.

Researchers, the police, lawyers, and eyewitness interviewers can benefit from the current study's findings. The current study's research data demonstrates how both hearing and deaf participants are questioned by the police, lawyers, or eyewitness interviewers can affect the accuracy of details recalled. The current findings may be useful, along with further research, to inform guidelines to for police, lawyers, or eyewitness interviewers on how best to question eyewitnesses in general and Deaf eyewitnesses in particular, in order to assure easy to utilize best practices are developed to increase the accuracy of details recalled by these eyewitnesses. The findings from this study suggest that both hearing and deaf participants had better accuracy for recalling details about a crime in a free-recall (i.e., open-ended questions) response format compared to a closed responses format. Given the low accuracy rates overall with peripheral details and closed ended questions, further research is needed to investigate whether similar findings would be present when a best-practice interview is conducting using primarily open ended questions focusing on details central to solving the crime.

Researchers would find this study useful when further exploring the perceptual differences experienced by deaf and hearing individuals and differences in memory and details recalled. Additionally, eyewitness researchers might find the data from this current study promising as it is the first time that college aged Deaf students have ever

been studied for the accuracy of details recalled from a crime event. Previously, a study with data gathered from hearing and deaf children was one of the few to have investigated the accuracy rates of reported eyewitness crime details (Porter, Yuille, and Bend, 1993).

There are numerous future research goals that can be explored with the Deaf population in investigative interviewing contexts. The findings from this study, if expanded upon through the inclusion of an interpreter for ASL translation for Deaf participants, could be used to examine the effect and role of interpreters working with non-native speakers during eyewitness interviews. Finally, future research expanding upon the current findings to include the an ASL interpreter could explore deception detection, adding to the current body of research investigating the important effects of using interpreters in an interrogation context.

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Appendix A

Letter to request faculty sponsorship

To whom it may concern:

My name is Amanda Garcia and I'm a graduate student in Barry University's clinical psychology master's program. I am writing to request your assistance in sponsoring a research project for submission to Gallaudet University's Institutional Review Board. Specifically, I am interested in recruiting students from Gallaudet University for participation in my master's thesis research project, which is an online study exploring differences in eyewitness memory between hearing and deaf individuals. Participation is completely voluntary and will take 20 minutes. Students' responses will remain anonymous. If you would be willing to sponsor this research, please find attached the approved IRB proposal from Barry University and my complete master's thesis proposal for your review.

If you have any additional questions or concerns, please contact me, Amanda Garcia, at <u>Amanda.garcia2@mymail.barry.edu</u>, or (850-491-6821) my faculty Advisor, Dr. Jillian Rivard at <u>JRivard@barry.edu</u> or (305) 899-3273, or the Institutional Review Board Point of Contact: Estela Azevedo at <u>eazevedo@barry.edu</u> or (305)-899-3021.

Thank you for your time and assistance.

Best regards,

Amanda Garcia

Appendix B Barry University Recruitment Flyer



for a study on perception



It takes 20 minutes! Just watch a video & answer questions. You get a \$15.00 Amazon gift card!

Eligibility requirements:

- Be between 18-30 years old
- Enrolled in university classes
- Be able to read and write in English
- Identify as culturally Deaf

If you need to, contact:

- Amanda Garcia,
 - $Amanda.garcia 2@\,mymail.barry.edu$
- Dr. Jillian Rivard, <u>Jrivard@barry.edu</u>
- Jasmine Trana, <u>Jtrana@barry.edu</u>

If interested, please follow this link: https://www.psychdata.com/s.asp?SID=179501 or take one of the tabs below:

| https://www.psychdata.com/ |
|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| s.asp?SID=17950 | s.asp?SID=179501 |

Appendix C

Barry Email Solicitation

Dear Research Participant:

Your participation in a research project is requested! To participate, you must:

- Be between 18-30 years old
- Enrolled in university classes
- Be able to read and write in English
- Have access to internet with sound

This study will explore perceptual differences between Deaf and hearing students. You will be asked to:

- Take 20 minutes of your time
- Answer questions about yourself, your education, and background
- Watch a brief video
- Answer questions about the video and your experience

Your consent to participate in this research is strictly voluntary and any information you provide will be kept anonymous. No names, student ID numbers, or other identifiers will be collected.

If you are a student currently enrolled in a psychology course, you <u>may</u> be able to receive 1 extra credit point for your participation at the discretion of your instructor.

If you decide to participate, please click on the link below. This link will take you to PsychData.com. There you will find a cover letter, which provides further information about the research being conducted.

Link: PSYCHDATALINK

For questions or concerns contact me, Amanda Garcia,

Amanda.garcia2@mymail.barry.edu, or (850-491-6821), my faculty Advisor, Dr. Jillian Rivard at JRivard@barry.edu or (305) 899-3273, or the Institutional Review Board Point of Contact: Estela Azevedo at eazevedo@barry.edu or (305)-899-3021.

Thank you for your interest!

Sincerely,

Amanda Garcia

Appendix D

Gallaudet Email Solicitation

Dear Research Participant:

Your participation in a research project is requested! To participate, you must:

- Be between 18-30 years old
- Enrolled in university classes
- Be able to read and write in English
- Identify as culturally Deaf

This study will explore perceptual differences between Deaf and hearing students. It takes just 20 minutes to complete. Just watch a video and answer questions. Participation is voluntary and any information you give will be anonymous.

If you decide to participate, please click on the link below. You will get a 10.00 Amazon gift card as a token of our appreciation.

Link: http://www.psychdata.com/s.asp?SID=17950

If you need to contact me, Amanda Garcia <u>Amanda.garcia2@mymail.barry.edu</u>, my faculty Advisor, Dr. Jillian Rivard at <u>JRivard@barry.edu</u> or the IRB point of contact Jasmine Trana <u>Jtrana@barry.edu</u>

Thank you for your interest!

Sincerely, Amanda Garcia

Appendix E Cover Letter: Barry University

Barry University

Dear Research Participant:

Your participation in a research project is requested. The title of the study is "Perceptual Differences Amongst Deaf and Hearing Populations." The research is being conducted by Amanda Garcia, a student in the Psychology department at Barry University, and is seeking information that will be useful in the field of psychology. The aims of the research are to better understand how perceptual experiences differ between hearing and self-identified culturally Deaf individuals. In accordance with these aims, the following procedures will be used: answer questions about yourself, view a video, and answer questions about the video. We anticipate the number of participants to be 200.

If you decide to participate in this research, you will be asked to do the following: (1) provide basic demographic information, (2) answer questions about your education and language background, (3) view a brief video, (4) answer questions about the video. The entire survey is estimated to take approximately 20 minutes to complete.

Your consent to be a research participant is strictly voluntary and should you decline to participate or should you choose to skip questions or drop out at any time during the study, there will be no adverse effects against you in any way. If you are a student currently enrolled in a psychology course, you <u>may</u> be able to receive extra credit for your participation at the discretion of your instructor.

There are no known risks to you. Although there are no direct benefits to you, your participation in this study may help our understanding of the perceptual experiences of hearing and self-identified culturally Deaf individuals.

As a research participant, information you provide will be kept anonymous, that is, no names or other identifiers will be collected. Your opinions will be collected via an anonymous online survey tool, PsychData. The following description outlines PsychData's policies with respect to confidentiality and data security: "PsychData is specifically designed to meet and exceed industry standards for Internet security as well as IRB standards for the protection of research participants. Our servers, database, and web presence employ multiple forms of enterprise-level security features to accomplish these goals. PsychData utilizes Secure Socket Layer (SSL) 256-bit encryption technology to ensure protection of all data transactions on our website. Data is encrypted at the instant that a user submits it and can only be decoded by the target server. PsychData maintains an SSL certificate from VeriSign, the industry leader in SSL technology." In addition, PsychData allows for disabling IP address collection, thereby assuring that the results I will receive will be truly anonymous and there will be no record kept of your IP address nor linkages I could utilize to identify you. Upon completion of data collection, all electronic data will be downloaded and then deleted from the PsychData server. Upon completion of data collection, all electronic data will be downloaded and then deleted from the Psychdata server. The electronic data will then be kept on the primary researcher's password protected personal computer and on the faculty advisor's password protected office computer as a backup. All data will be kept for a minimum of five years upon completion of the study and then indefinitely.

By clicking the "continue" button below you have shown your agreement to participate in the study.

For questions or concerns contact me, Amanda Garcia, Amanda.garcia2@mymail.barry.edu, or (850-491-6821), my faculty Advisor, Dr. Jillian Rivard at JRivard@barry.edu or (305) 899-3273, or the Institutional Review Board Point of Contact: Estela Azevedo at eazevedo@barry.edu or (305)-899-3021.

Thank you for your participation.

Sincerely,

Amanda Garcia

Appendix F Cover Letter: Gallaudet University

Barry University

Dear Research Participant:

Your aid in a research project is requested. The title of the study is "Perceptual Differences Amongst Deaf and Hearing Populations." The research is being conducted by Amanda Garcia. She is a student of Psychology at Barry University. She is seeking information that will be useful to the field of Psychology. The purpose of the study is to learn the differences between the experiences of hearing and self-identified culturally Deaf people. Participants will need to answer questions about themselves. Participants will view a video and answer questions about it. We believe there will be 200 participants.

If you participate in this research, there are several tasks you will be asked to complete. First, complete basic information about yourself. Second, answer a variety of questions. Third, watch a brief video. Last, answer questions about the video. The survey should take about 20 minutes to complete.

You can choose to participate or not participate in this study. You can drop out at any time. There are no negative consequences if you drop out of the study. If you are taking a psychology course, you may be able to receive extra credit. This will depend on your professor.

There are no known risks to you. There are no direct benefits to you. If you participate it may help us better understand the differences between the experiences of hearing and self-identified culturally Deaf people.

If you participate, your responses will be kept anonymous. Your responses will be collected by PsychData, an anonymous online survey tool. PsychData uses encryption to protect all collected data on the website. PsychData was created to follow and exceed internet protection rules created by the IRB. There will be no record kept of your address nor links I could use to identify you. When data collection is finished, all of it will be downloaded and then deleted from the server. Data will then be kept on the main researcher's password protected personal computer. It will also be kept on the faculty advisor's password protected office computer as a backup. All data will be kept for a minimum of five years upon completion of the study and then indefinitely.

If you click the "continue" button below you have agreed to participate in the study. You will get a \$15.00 Amazon gift card for your participation.

For questions or concerns contact me, Amanda Garcia, <u>Amanda.garcia2@mymail.barry.edu</u>, or (850-491-6821), my faculty Advisor, Dr. Jillian Rivard at <u>JRivard@barry.edu</u> or (305) 899-3273, or the Institutional Review Board Point of Contact: Jasmine Trana at <u>Jtrana@barry.edu</u>.

Thank you for your participation.

Sincerely, Amanda Garcia

Appendix G

Demographic Questions for Deaf Participants

1.	What is your age?							
2.	What	t is your gender?						
	a.	a. Male						
	b.	Female						
	c.	Transgender						
	d.	Other						
3.	Were you born deaf?							
4.	If not, at what age were you deaf?							
5.	Growi	ng up, what was your main language?						
6.	Was S	ign Language your first language?						
7.	What i	That is your current form of communication (select all that apply)?						
	a.	American Sign Language (ASL)						
	b.	Speech lip reading						
	c.	Other (please specify):						
8.	. Do you consider yourself culturally Deaf?							
9.	9. Did you go to a mainstream program?							
10.	10. Did you go to a deaf school?							
11.	How n	nuch schooling have you had?						
	a.	High School Degree						
	b.	Some college						
	C	Associate's Degree						

- d. Bachelor's Degree
- e. Master's Degree
- f. Other
- 12. What is your major?
- 13. Do you have Usher syndrome? _____
- 14. Do you wear contacts or glasses? _____

Appendix H

Demographic Questions for Hearing Participants

1.	What is your age?						
2.	What is your gender?						
	a. Maleb. Femalec. Transgenderd. Other						
3.	How much schooling have you had?						
	 a. High School Degree b. Some college c. Associate's Degree d. Bachelor's Degree e. Master's Degree f. Other 						
4.	What is your major?						
5.	What language(s) do you speak (list all)?						
6.	Do you use American Sign Language?						
7.	Does anyone in your family use American Sign Language?						
8.	Do you have Usher syndrome?						
9.	Do you wear contacts or glasses?						
10.	Do you have hearing difficulties (please explain)?						
11.	. Do you use hearing aids or other hearing devices?						
12.	Is anyone in your family deaf?						

Appendix I Eyewitness Memory Questionnaire

1.	Describe what the suspect looked like.							
2.	What was the suspect wearing?							
3.	What exactly did the suspect do with the parked cars?							
4.	What of	did the suspect do with the 2 nd	item that was pulled out of the bag?	?				
5.	Where did the suspect come from at the beginning of the clip?							
	a.	Down the steps of a brick bui	lding					
	b. Down the steps of a house							
	c.	Down the steps of a gazebo						
	d.	Down the steps of a restauran	t					
6.	How n	How many cars did the suspect touch in the clip?						
	a.	1	c. 2					
	b.	4	d. 3					
7.	What was the color of the suspect's shoulder bag?							
	a.		c. beige					
	b.	brown	d. grey					
8.	What	was the 1st item the suspect pul						
	a.	hatchet	c. hammer					
	b.	gun	d. crowbar					
9.	What	was the color of the van that pa	assed by the man?					
		was the old man with the beard	<u>e</u>					
		is the make and model of the bl						
		color was the bus parked in the						
13.		was the company name on the						
		FedEx	c. Sprint					
	b.	Verizon	d. UPS					
14.	What color was the car the suspect marked with a symbol?							
		White	b. black					
	b.	Green	d. silver					
15.	How n	nany people turned to look at v	-					
	a.	1-3	c. 8-10					
	b.	4-7	d.11-13					
16.	What	type of vehicle was the old man	n standing next to?					
	a.	van	c. bus					
	b.	truck	d. motorcycle					

Appendix J

Debriefing Questionnaire

Please answer the following questions truthfully.

- 1. On what device did you complete the survey?
 - a. Cell phone
 - b. Laptop or desktop computer
 - c. Tablet device
 - d. Other (specify): _____
- 2. Have you ever seen the video before?
- 3. Have you ever seen the show "Luther"?
- 4. Do you recognize the actor who played the suspect in the video?

For hearing participants:

- 5. Was the sound on during the video?
 - a. Yes
 - b. No
- 6. What was the background noise in the video?
 - a. Music
 - b. Car alarm
 - c. Siren
 - d. None

If answered yes to wearing corrective lenses:

7. Were you wearing your contact lenses or glasses during the study?

Thank you note:

Thank you for your participation in this study. Your answers are important to understanding perceptual differences between hearing and deaf students. Please print a copy of this page if you require proof of your participation.

For questions or concerns, please contact me, Amanda Garcia, at <u>Amanda.garcia2@mymail.barry.edu</u> or at 850-491-6821.