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EXAMINING SIGNER-SPECIFICITY EFFECTS IN THE PERCEPTION OF WORDS
IN AMERICAN SIGN LANGUAGE

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Bachelor of Arts in Psychology
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at the

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ABSTRACT

Variability in talker identity, which is commonly referred to as one type of indexical variation, has demonstrable effects on the speed and accuracy of spoken word recognition. In the current study, I conducted two experiments designed to examine whether talker variability has an effect on the perception of words in American Sign Language. Native and non-native signers participated in two long-term repetition-priming experiments in which they performed two separate blocks of lexical decision trials. In Experiment 1, all participants were native signers. In Experiment 2, all participants were late signers. In both experiments, all participants performed both an easy and a hard lexical decision task. In the easy lexical decision task, the non-signs did not resemble real signs, making the task relatively easy. In the hard lexical task, the non-signs resembled real signs, making the task relatively difficult. In both experiments, some of the signs (and non-signs) in the second block also appeared in the first block (primed conditions) and some were new stimuli that had not appeared in the first block (control condition). Half the primed stimuli were produced by the same signer in the two blocks (matched condition) and half were produced by a different signer (mismatched condition). Based on previous research in spoken word recognition, I made the following predictions: 1) primed stimuli would be responded to more quickly than unprimed stimuli, 2) signs in the

match condition would be responded to more quickly than signs in the mismatch condition (i.e., a signer-specificity effect), and the signer-specificity effect was expected to be greater when processing was relatively slow, that is 3) in Experiment 2, with late signing participants, and 4) in the hard lexical decision task. The results inform theories and models of sign language perception, add to the knowledge of the circumstances in which variability is expected to have an effect on the recognition of words, and provide an opportunity to evaluate whether time-course effects in spoken word recognition extend to the visual perception of words in sign language.

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CHAPTER I

INTRODUCTION

One of the major ongoing debates in psychology is the degree to which mental representations are general or specific. The different models of representation are important to many areas of cognitive psychology, including categorization, memory, and language. In language, the debate is between two major approaches, namely the abstractionist and episodic views. Spoken word recognition is one particular area of investigation that sheds light on important representational question regarding abstract versus episodic representations.

According to the abstractionist view, only information necessary for distinguishing between words (e.g., phonological information) is represented. Abstractionist theories predict that details in the speech waveform that specify accent, tone of voice, or speaking rate are not stored as part of the lexical (word) representation (Goldstein, 2008). Speech that is abstractly processed goes through normalization, where

only the useful information is pulled out and makes it to the final stages of processing. The same word should be easily recognized through changes in volume, speaking rate and talker identity, as long as the basic information (i.e., the words or phonemes) remains unchanged.

An alternative theoretical position about the perception and storage of words is the episodic approach, which posits that details associated with indexical variation (e.g., tone of voice, talker, etc.) are stored as part of the lexical representation. Therefore, if there is a change in tone of voice from the original presentation of a word, then there will be a cost in accuracy or speed to word recognition. An extreme version of the episodic view on speech states that each unique presentation of the word has its own mental representation (Goldstein, 2008).

Talker effects in spoken word recognition support the episodic model of mental representations. According to episodic models, talker-specific details of spoken words are part of the stored representations. Consequently, when a word is repeated by a different talker – relative to hearing the repeated word spoken by the same talker – there should be a cost (referred to as a *talker effect*) in word recognition, in terms of slower or less accurate processing. It should be noted that although talker effects can present a cost to the speed of recognition, it does not change the meaning of the word. However, talker effects have been found inconsistently, appearing only under certain conditions. There are likely to be several factors important to the emergence of these effects, including processing time. There is evidence that talker effects appear relatively late in processing (Luce & Lyons, 1998). Manipulating the difficulty of the task creates a longer processing

time. When a task increases in difficulty, then processing takes longer and allows sufficient time for specificity effects to emerge.

Previous work (e.g., González & McLennan, 2007) used a long-term repetition-priming paradigm to examine spoken word recognition. The long-term priming paradigm procedure consists of one block of stimuli being presented to the participant for study, then participants work a distracter task for approximately five minutes, followed by a second block of stimuli. Within this second block of stimuli, the words are referred to as target words. Participants' responses to target words are analyzed as a function of prime type. Primed words are words that were also previously presented in the first block of stimuli. Within the second block, in addition to primed words, there are also new (unprimed) words, preceded in the prime block by unrelated control words that simply serve as filler words. The long-term repetition-priming paradigm takes advantage of basic priming effects. Priming occurs when the response to an item increases in speed or accuracy because it had been encountered recently.

Previous research (Luce & Lyons, 1998) contributed to the new directions I pursued in this experiment. These authors examined memory representations for spoken words. The goal of their experiment was to examine talker effects (i.e., reduced priming as a result of a talker change) in spoken word recognition. They used a long-term priming paradigm and a lexical decision task. Although they failed to find talker effects in their initial experiment, talker effects emerged in a second follow up experiment in which the difficulty of the task was increased. These latter findings are in line with the episodic model of how words are stored in memory. Each variation of the word is held in memory and affects the speed and accuracy of word recognition. The increase in task

difficulty lengthened the time required for processing, creating longer reaction times (RTs) that presumably contributed to the obtained talker effects. That is, these results provided the basis for the notion that indexical specificity effects – including talker effects – follow a particular time course, appearing relatively late in processing. The authors concluded that a better way to test for specificity effects is to ensure that there is enough time for specificity effects to emerge. According to this time-course hypothesis, specificity effects will be attenuated when the decision is easy and processing is fast, and robust specificity effects will emerge when the task is difficult and processing is slow.

Work by McLennan and Luce (2005) extended the work of Luce and Lyons (1998) by directly testing the time-course hypothesis. These authors examined the time course of indexical specificity effects in spoken word recognition on two different dimensions, talker identity and speaking rate. They used a long-term priming paradigm and a lexical decision task, much like the previously discussed work. In Experiment 1, they examined changes in speaking rate, and in Experiment 2 they examined changes in talker identity. These experiments were further divided into two levels of difficulty. In Experiments 1A and 2A, an easy discrimination task was used, while in Experiments 1B and 2B, a difficult discrimination task was used. To manipulate the levels of difficulty, two different types of nonwords were used. In the easy discrimination task, the nonwords were un-word like; and for the difficult task, the nonwords were word-like, making them harder to distinguish and increasing processing time. Following the time-course hypothesis, the authors did not expect to obtain specificity effects in Experiment 1A and 2A, because of the fast processing time and easy lexical decision task, but did expect to obtain specificity effects to appear in Experiments 1B and 2B, due to the use of a difficult

lexical decision task, creating the longer processing times. The results supported the time-course hypothesis. The RTs in the difficult discrimination tasks were significantly longer, providing evidence that the manipulation of ease of discrimination was effective in lengthening processing times. More importantly, and part of the focus of my study, is that specificity effects only emerged in the difficult conditions (1B, 2B) and not in the easy conditions (1A, 2A), providing strong support for the time-course of indexical specificity effects.

Beyond the work done by M^cLennan and Luce (2005) to examine speaking rate and talker changes, more recent additional support for the time-course hypothesis was found by Krestar and M^cLennan (2012) with intra-talker variation in emotional tone of voice. The authors used two different emotional tones, sad and frightened, to try and elicit specificity effects. These two tones were chosen because they were distinctive from one another (Sobin & Alpert, 1999). This experiment followed a similar design to M^cLennan and Luce (2005). There were two experiments, distinguished by the ease of the discrimination task, using a lexical decision task, and long-term repetition priming paradigm to examine the time course of specificity effects associated with emotional tone of voice. The first experiment was the easy task and the results supported the time-course hypothesis, with both matched tone of voice and mismatched tones producing equivalent RTs. These results are consistent with the time-course hypothesis that proposes that when processing is fast, indexical specificity effects will not emerge. In the hard discrimination task, specificity effects were found, also consistent with the time-course hypothesis.

Two additional studies support the time-course hypothesis. Matty and Liss (2008) examined the effects of stimulus variability on spoken word recognition using naturally

occurring degraded speech to mimic the less than optimal listening conditions of everyday listening. The authors used three types of speech to create different levels of difficulty; controlled speech spoken by an unimpaired speaker, and mild and severe dysarthric (i.e., disordered) speech. Consistent with the time-course hypothesis, when speech was normal, responses were fast and there were no talker effects, and when speech was degraded, responses were slower, and talker effects emerged. In addition, Vitevitch and Donoso (2011) demonstrated how change detection could be used to determine the processing of indexical and linguistic information in spoken word recognition. Consistent with the time-course hypothesis, these authors found that more listeners were “deaf” to a change in talkers (i.e., they failed to notice the talkers changed half way through the experiment) when performing an easy lexical decision experiment in which they were processing relatively quickly, and more listeners noticed the change in talkers when performing a hard lexical decision experiment in which they were processing relatively slowly.

CHAPTER II

AMERICAN SIGN LANGUAGE

The main purpose of the current study was to extend previous work in spoken word recognition to American Sign Language (ASL). ASL is a hand-based gestural language used primarily by deaf and hard-of-hearing Americans. It is a complete and complex language that employs signs made with the hands and other movements, including facial expressions and postures of the body (NIDCD, 2000). ASL is transmitted manually and received visually. Signs are composed of phonemes, which are created through a combination of four main features; hand shape, movement of the hands, orientation of palm with respect to the body, location, and other non-manual physical actions such as smiling, shrugging and nodding. Finger spelling is also sometimes used for names, proper nouns, and other special occasions. There are approximately 150 different hand shapes, with about 41 phonemically distinct hand shapes (Tenneant & Brown, 1998).

There are several factors that can affect the learning process of ASL. One factor is the age of initial exposure. When signers are exposed from birth, with deaf and signing parents, or at a very early age, they are considered *native signers*. For this experiment I defined native signing participants as people who self identified ASL as their first language and began learning ASL before age 6. However, less than 10% of signers are native signers, most commonly children of deaf parents (Singleton, 2004). Often deaf children are raised in an oral only environment, using lip reading, speech, and other tools to function in a hearing environment. They are exposed to sign language at varying ages, sometimes not until adulthood. These signers will be referred to as *late signers* (Singleton, 2004). For this study, I defined late signing participants as people who self identified ASL as being their second language or began learning ASL after age 6. As with spoken languages, late exposure to ASL comes at a cost to fluency and grammatical competence. Newport and colleagues found a consistent negative correlation between the age of exposure to ASL and grammatical competence, with a gradual decline with an increase of age of exposure (Newport, 1988; 1990; Newport & Supalla, 1989)¹.

Status as a native or late signer not only has consequences for fluency and grammatical knowledge, but also directly related to the current study, sign perception. In an experiment conducted by Emory (1991), in which deaf participants had to make a lexical decision with signs and non-signs, native signers were significantly faster at

¹The article referenced did not state a specific numerical age or age range for when the predicted decrease in competency began. I suspect the relationship between age of exposure and ASL competence is not entirely linear. Variability in learning atmospheres and individual difference will likely need to be taken into account.

rejecting non-signs compared to late signers. In the proposed study, a questionnaire will be given to participants to gather information about hearing status, age, and language background, to better understand how these factors contribute to the results of interest. See Appendix A for the complete questionnaire.

CHAPTER III

CURRENT STUDY

This current study extended work in spoken word recognition to ASL using the same experimental design as previous work by McLennan and Luce (2005) (and others). In addition, I used their results and the time-course hypothesis as the framework for the hypotheses of the current work. By using a long-term repetition-priming paradigm, I also expanded identity priming to research in ASL. Priming is a well-researched and supported topic in many areas of psychology. Priming effects have been found with written words (Baques, Saiz & Bowers, 2004), as well as words presented orally (Schacter & Church, 1992). Priming has also been found in previous work using ASL. Emmory and colleagues found morphological and semantic priming effects in previous experiments (Emmorey, 1999; Corina & Emmorey, 1993). However, at this time, I know of no other study using identity (i.e., same word) priming in ASL using the long-term repetition-priming paradigm.

I have already discussed specificity effects in spoken word recognition with a number of different types of indexical variability (speaking rate, emotional tone of voice, talker identity). The current research moves previous findings to an entirely new context. To my knowledge, there have been no studies examining analogous specificity effects in ASL. My findings from this study could support the conclusion that although ASL is presented visually, it is represented and processed similarly to spoken words, at least with respect to the time-course hypothesis of indexical specificity effects. On the other hand, different results could lead to new hypotheses and research directions about how ASL is represented and processed differently. This area of work is important to a large range of fields within psychology and related domains. Finally, my findings could lead to new theoretical and practical implications about ASL. New practical implications could be how ASL is taught in school to different age groups, as well as theoretical implications about how ASL is processed differently in the visual modality than spoken word recognition.

CHAPTER IV

EXPERIMENT 1: NATIVE SIGNING PARTICIPANTS

Method

Participants

There were a total of five native signing participants with a mean age of 39.4 years old. All participants were right handed with no reported visual or attention disorders. The average age that participants began learning ASL was 3.5 years old. Two participants were deaf and three were hearing. All native signing participants had at least one deaf parent, and three (of the five) also had deaf siblings. All participants considered themselves fluent in ASL. When asked what percentage of total language use in the past three months has been ASL, the average response was 73% ASL. Participants were recruited from the greater Cleveland Deaf² community, interpreters in the Greater

²Deaf with a capital “D” is used to refer to people who use sign language as their primary language and identify as member of the Deaf community, while deaf with a lowercase “d” only refers to a persons’ hearing status.

Cleveland area, as well as students enrolled in the ASL classes at Cleveland State University. All participants were paid \$10.00 for their time.

Materials

I used video clips of the signed words and signed non-words. The instructions for the experiment were also in ASL. The video clips unfold over time dynamically, similarly to how speech unfolds over time.³ Two different signers produced the stimuli and instructions; each of the signers was recorded individually. One signer was a hearing male late signer (C.I.) and the second signer was a deaf female late signer (N.J.). Although both are late signers, they are both experienced interpreters and highly proficient in ASL. C.I. is the owner of a local sign language company, and N.J. is an employee.

There were 16 real signs used, 12 of which were experimental signs and four of which were used only as filler stimuli in the prime block (for the experimental stimuli that are in an unprimed condition). There were also 32 non-signs, 16 of which were used in the easy lexical decision task and 16 of which were used in the hard lexical decision task (see Appendix B). The non-signs followed the design of the real signs. Changing the parameters of real signs created non-signs. There were two types of non-signs created to help distinguish the level of difficulty in the lexical decision tasks. The un-sign-like non-signs (UNS) were created by changing *two* of the four phonological parameters of a real sign (i.e., hand shape, location, orientation, and movement). I predicted that these would

³For native signers, English is their second language. Fluency in writing and reading English is often not on the same level as their fluency in ASL. Using written English could produce drastically different results.

be more clearly viewed as non-signs; therefore the UNS stimuli were used in the easy lexical decision task. The second group of non-signs was sign-like non-signs (SNS). Changing only *one* phonological parameter created these non-signs. I hypothesized that these non-signs would be more difficult to distinguish as non-signs. For example, the real sign for *book* was changed into an SNS stimulus clip, by changing only the hand shape; the movement, location and palm orientation were the same as the real sign for *book*.

All of the stimuli were recorded and edited at Cleveland State University's Digital Production Unit of the Integrated Media Systems and Services Office. The camera was approximately five feet away from the signers. The camera was focused about chest height on the signers, the view of the signer was approximately mid-thigh up to approximately six inches above the top of the signer's head. Both signers were standing in front of a solid black background. The original film was edited using Final Cut Pro. Signs and non-signs were edited to begin 10 frames (approximately one second) before the hands began to move from their resting position at the signer's side and end 10 frames after the sign was completed and the hands returned to a resting position.

The mean duration of the experimental stimuli for both signers was 2.46 seconds. The mean duration of the experimental stimuli for the female deaf signer (N.J.) was 2.25 seconds and the mean duration for the male hearing signer was 2.65 seconds. There was a significant difference in the mean durations between signers C.I. and N.J., $t(15) = 4.06$, $p = .001$. Although there was a significant difference between the mean duration for the two signers, it did not alter the results of the experiment. There was no significant difference between the reaction times to the male and female signer.

Design

Two blocks of 24 trials were presented for each lexical decision task. The test stimuli consisted of 12 sign prime-target pairs and 12 non-sign prime-target pairs. Primes either matched or mismatched to the targets, in terms of which signer presented during the prime and target block. For the control condition, the signs were presented by the male signer half of the time and the female signer for the remainder. Of the 24 prime-target pairs, eight real sign pairs matched, eight mismatched, and eight were controls. Each list of prime and target stimuli was randomized throughout six different version of the experiment. Stimuli were counterbalanced across participants through six versions of each of the experiments.

The native signing participants completed both the easy and hard lexical decision tasks. All participants completed the hard lexical decision task first so that if practice effects occurred, they simply made the easy task easier.

Procedure

Participants were tested individually in a quiet room. The experiments took place in small cubicles. All experimental stimulus clips and ASL materials were viewed on a Macintosh desktop computer. In all stimulus clips, both signers were wearing blue shirts, against a black background. The clips were shown as 8” squares, in the center of the computer screen, and embedded within another black background for the appearance of continuity. Participants filled out initial experimental paperwork (see Appendix C), and then watched a short video clip, approximately three and half minutes long, of a popular children’s story in ASL, *The Boy Who Cried Wolf* (Olsen, 2012). By watching a video of ASL, it should prime bilingual participants to view the upcoming materials in the

experiments in ASL (Grosjean & Miller, 1994) A different signer (not one of the two signers used for the main experiment) signed the Boy Who Cried Wolf video. Only of the experimental words (JOKE) was also included in the fairytale video. After watching the fairytale video, participants were instructed in ASL to decide as quickly and accurately as possible if each item was a real word in ASL or a nonword by pressing one of the two appropriately labeled buttons on the response box in front of them (see Appendix D). The red button was the correct response to respond to non-signs, and the green button was the correct response to a real signs. The RTs were recorded for each participant, measured from the onset of the presentation of the stimulus (the video clip showing a sign or non-sign being produced) to the onset of the participant’s button press response.

Results

All statistical analyses of RT data were performed on correct responses to experimental stimuli during the target (i.e., second) block. One value was missing in the easy task, because of two incorrect responses in a particular condition, and was replaced with the condition mean. A 2 X 2 X 3 completely within-participants ANOVA was performed with Lexical Decision (easy, hard), Signer (male, female), and Prime (match, mismatch, control) as the three factors.

Table 1: *Mean RTs for Native Signing Participants in Experiment 1*

	Collapsed across signer during target block			MEANS
	Match	Mismatch	Control	
Easy	2014	1817	1949	1927
Hard	1912	1974	2188	2025
MEANS	1963	1896	2069	1976

Predictions

Although I predicted that I would not find a main effect of Signer, Signer was included in the analyses in order to determine if there was a significant main effect or any interactions involving this factor. I predicted that the primed stimuli would be responded to faster than the unprimed stimuli. I further predicted that RTs would be faster in the match condition than the mismatch condition to show signer-specificity effects. Finally, I predicted greater signer-specificity effects in the hard lexical decision compared to the easy lexical decision.

Statistical Support

I found the following main effects and interactions. As predicted, there was no main effect of Signer, $F(1, 4) = 2.27$, $p = .21$, $\eta^2_p = .36$. Furthermore, Signer did not interact with Decision or Prime, all p s $> .05$. Therefore, I reported all the remaining analyses with RTs collapsed over Signer in a 2 X 3 ANOVA. There was no main effect of Lexical Decision, $F(1, 4) = .48$, $p = .53$, $\eta^2_p = .11$, such that RTs in the easy condition were equivalent to RTs in the hard condition. There was also no main effect of Prime, $F(2, 8) = .25$, $p = .79$, $\eta^2_p = .06$. The interaction of Lexical Decision X Prime was significant $F(2, 8) = 6.07$, $p = .02$, $\eta^2_p = .60$. However, there was no significant main effect of Prime in either the easy, $F(2, 8) = .87$, $p = .92$, $\eta^2_p = .02$, or the hard, $F(2, 8) = 1.21$, $p = .34$, $\eta^2_p = .23$ lexical decision tasks.

For planned comparisons, for effects of priming we compared the match minus the control reaction times, and for the specificity effects we compared the match condition minus the mismatch condition. Looking at planned comparisons for the main effect of Prime in easy lexical decision task, there was not a significant difference

between the match and control conditions, $p = 1.0$, and there was also not a significant difference between match and mismatch conditions, $p = 1.0$. Looking at planned comparisons for the main effect of Prime in hard lexical decision task, there was not a significant difference between the match and control conditions, $p = .83$, and there was also not a significant difference between match and mismatch conditions, $p = 1.0$.

Patterns

Although none of my predictions were statistically supported, it is important to further examine patterns in the data, particularly given the small sample size. Lexical decision was not significant, but as you can see referring to Table 1, the mean RT for the hard condition was slower than the mean RT for the easy condition, showing a pattern in the direction of my prediction. The main effect of Prime was not significant, but looking at Table 1, mean RTs in the primed condition are numerically faster than mean RTs in the control condition, trending towards priming. In the easy task, there were trends of priming, and the hard task showed trends of priming and specificity effects, with the mean match RT numerically faster than both the mean mismatch and mean control RTs.

Discussion

The main purpose of this experiment was to examine long-term repetition identity priming effects and signer-specificity effects in ASL. The statistical results of Experiment 1 are mostly inconsistent with my predictions. I did not find a predicted main effect of Lexical Decision, although the RTs are in the direction of my predictions with longer RTs in the hard lexical task. I also failed to find a significant main effect of Prime and there were no significant differences in RTs between the match and mismatch conditions, or between the match and control conditions, although again the results are mainly in the

direction of my predictions.

I was partially successful on one factor of analysis. I did not anticipate a main effect of Signer, and these results showed no significant difference in RTs to the male and female signers. Because these results are not entirely consistent with my predictions, they did not provide strong statistical evidence that the perception of signed words in ASL follows the same time course as spoken word recognition. However, I think one of the most important factors affecting the results of Experiment 1 is the small sample size of only five native signing participants. I naively approached this experiment underestimating how easy it would be to recruit the original plan of 12 native signing participants. According to the statistics mentioned earlier, that native signers are less than 10% of all signers, perhaps my difficulty at finding a sufficiently large sample in a limited period of time should not have come at such a surprise. Indeed, in my current investigation, native signers represented 20% of all participants. Nevertheless, despite my best efforts, 20% still only resulted in a total of five participants.

CHAPTER V

EXPERIMENT 2: LATE SIGING PARTICIPANTS

Methods

Participants

There were a total of 20 late signing participants. One participant was eliminated due to no response in the target block, resulting in 19 participants with applicable data. The mean age of participants in this experiment was 48.37 years old. Eighteen of the participants were right handed. The average age that that participants began learning ASL was 21.42 years old. Six participants were deaf, one was hard of hearing, and 12 were hearing. There were no late signing participants with deaf parents, three had a deaf sibling, and four had immediate family members (including spouses) that were native signers. Ten participants reported first being exposed to sign language in a school setting, and another six gave a range of answers, including sign language theater, church, and co-workers. Sixteen of the 19 participants considered themselves fluent. When asked what percentage of total language use in the past three months has been ASL, the average

response was 52.5%. Participants were recruited from the greater Cleveland Deaf community, interpreters in the Greater Cleveland area, as well as students enrolled in the ASL classes at Cleveland State University. All participants were paid \$10.00 for their time.

Material

The materials were identical to those used in Experiment 1.

Design and Procedure

The design and procedure were identical to those used in Experiment 1.

Results

Once again, all statistical analyses of RT data were performed on correct responses to the experimental stimuli in the target block. Two missing values, because of two incorrect values in a particular condition, were replaced with the condition mean. The same 2 X 2 X 3 completely within-participants ANOVA that was performed in Experiment 1 was performed in Experiment 2, with Lexical Decision (easy, hard), Signer (male, female), and Prime (match, mismatch, control) as the factors.

Predictions

Once again I predicted that I would not find a main effect of Signer, but Signer was included in the analyses in order to determine if there was a significant main effect or any interactions involving this factor. I predicted that the primed stimuli would be responded to faster than the unprimed stimuli. I further predicted that RTs would be faster in the match condition than the RTs in the mismatch condition to show signer-specificity effects, and that these effects would be greater in the hard lexical decision. I

also predicted greater signer-specificity effects in Experiment 2 with late signing participants, relative to Experiment 1 with native signing participants.

Statistical Support

As predicted, there was no main effect of Signer, $F(1, 18) = .178, p = .678, \eta^2_p = .010$. There were also no interactions involving Signer, all p s $> .05$. Therefore, as in Experiment 1, I will report the remaining analysis from a 2 X 3 ANOVA with RTs collapsed over Signer. I found a significant main effect of Lexical Decision, $F(1, 18) = 11.09, p = .004, \eta^2_p = .381$. Although there was no significant interaction for Lexical Decision X Prime, $F(2, 36) = .867, p = .429, \eta^2_p = .046$, given my a priori predictions, I examined Prime separately in the easy and hard conditions.

The main effect of Prime in the easy task alone was very nearly significant, $F(2, 36) = 3.14, p = .05, \eta^2_p = .149$. Looking at planned comparisons for the main effect of Prime in easy lexical decision task, there was not a significant difference between the match and control conditions, $p = .18$, and there was not a significant difference between match and mismatch conditions, $p = 1.0$. The main effect of Prime in the hard task alone was significant, $F(2, 36) = 6.36, p = .004, \eta^2_p = .261$. Looking at planned comparisons for the main effect of Prime in hard lexical decision task, there was a significant difference between the match and control conditions, $p = .03$, but there was not a significant difference between match and mismatch conditions, $p = .47$.

Table 2: *Mean RTs for Late Signing Participants in Experiment 2*

	Collapsed across signer during target block			MEANS
	Match	Mismatch	Control	
Easy	2102	2125	2294	2174
Hard	2337	2417	2690	2481
MEANS	2219	2271	2492	2328

Patterns

I found some significant results in this second experiment, but it is still important to further examine possible patterns in the data. There was a significant main effect of lexical decision reflected in the faster mean RT differences for the easy compared to the hard task, as shown in Table 2. For the easy task alone, the difference between match and mismatch was not significant, but in the direction of my prediction. The hard task alone also mirrored this trend, with mean match RTs faster than mean mismatch RTs, but there was a significant difference between the match and control condition, providing evidence for priming. These are important patterns that are promising for future research. The prime was significant and in line with my original predictions, showing significant priming effects and the trend of signer-specificity, with slower mismatch condition times, particularly in the hard condition.

Table 3: *Overall RT Means and Percentage Correct on Nonsigns*

	Native Signers		Late Signers	
	Easy	Hard	Easy	Hard
RTs	1926	2025	2174	2482
PC	88	95	78	67

Table 4: *Percentage Correct for Real Words*

	Native Signers		Late Signers	
	Easy	Hard	Easy	Hard
Match Condition	95	95	90	88
Mismatch Condition	85	95	89	90
Control	95	95	88	81

While the non-signs were not the focus of this study, the data I collected can still provide important information. Table 3 shows the overall means for all experiments and the percentage correct on non-signs. These data show that native signing participants overall were more accurate at identifying the non-signs as such, with an overall accuracy rate of 91%, compared to accuracy rate of 72% for late signing participants. All statistical analyses were performed on RTs, but percentages correct (PCs) on real and non-signs were also recorded and are reported in Table 4. Overall accuracy of all participants was 90%, with native signers at 93% accuracy on real signs, while late signers were 87% accurate on real signs.

Table 5: *Signer-specificity effects across Experiments 1 and 2*

	Lexical Decision		
	Easy	Hard	MEANS
	Mean match RT minus mean mismatch RT	Mean match RT minus mean mismatch RT	
Exp. 1: Native signers	56.1	-61.9	-2.9
Exp. 2: Late Signers	-22.98	-79.73	-51.35
MEANS	16.56	-70.81	

Given the large difference in sample sizes for Experiments 1 and 2, I could not perform a direct statistical comparison of specificity effects for native and late signers.

However, referring to Table 5 for visual inspection, and considering the main points of the study, namely to examine differences in specificity effects as a function of task difficulty (easy, hard) and signing status (native, late), there is some support for my predictions. First, the pattern of greater specificity effects in the hard lexical decision task is what I predicted at the outset of this study. Second, the pattern of greater specificity effects in Experiment 2 with late signers, compared to Experiment 1 with native signers, is also what I predicted at the outset of this study.

Discussion

According to the time-course hypothesis, signer-specificity effects should appear when the processing is slow and effortful, particularly in Experiment 2. As predicted, there was a significant main effect of Prime. I also found a significant main effect of Lexical Decision, creating a significant change in difficulty between the easy and hard tasks that resulted in faster RTs in the easy condition compared to the hard condition. Although the main effect of Prime was significant, there were no significant signer-specificity effects. The results of Experiment 2 are somewhat in line with my predictions. Once again it is important to pay attention to the data patterns, which are in line with my original predictions.

Table 6: *Magnitude of Specificity Effects*

	% of ASL Use	
	5-40%	80-100%
Match minus Mismatch	-94.56	-33.97

Originally all analysis was performed on raw RTs, which were positively skewed. I performed a speed transformation to normalize all data. I then ran parallel analyses on the transformed data. In Experiment 1, all patterns were consistent, except the Lexical Decision X Prime interaction was not significant, as it was with the raw data. For Experiment 2, all patterns were consistent with raw RT results. We also thought it was important to analyze data with any possible outliers removed to examine any possible shift in the results. Outliers two standard deviation below or above the mean RT were removed. For Experiment 1, no data were removed. For Experiment 2, six outliers were removed in the easy task, and six outliers were also removed in the hard task. Parallel analyses were run again with outliers removed. All patterns were consistent with raw data analysis, except for a significant difference of priming was created in the easy and hard task. Most importantly for the goal of this experiment, I examined the magnitude of specificity effects in relation to the percentage of ASL use reported by each participant. The eight participants with the lowest reported percentage of use was 5-40 % and the eight participants with the highest percentage of use were 80-100%. Referring to Table 6, the specificity effects were much lower for participants with a higher use of ASL, compared to participants with less use.

CHAPTER VI

GENERAL DISCUSSION

The main issue I examined was whether the perception of signed words followed the same patterns of results found in spoken word recognition. The goals were to examine long-term repetition identity priming effects, signer-specificity effects, and potential differences in signer-specificity effects as a function of whether the participants were native or late signers and as a function of whether the task was easy or hard.

The findings from this study are partially consistent with the data from spoken word recognition. For the first prediction, that primed stimuli would be responded to more quickly than unprimed stimuli, this was supported with significantly faster RTs in the match condition compared to control in Experiment 2, and a pattern in this direction in Experiment 1. I predicted great specificity effects for both experiments in the hard lexical decision, as well as greater specificity effects with late signing participants in Experiment 2. Planned comparisons showed there were no signer-specificity effects,

shown by faster RTs in the match condition than in the mismatch condition, in either experiment. Yet the patterns of the results showed longer RTs in the mismatch condition compared to the match condition. The results also provide some support that my difficulty manipulation between the easy and hard tasks was successful, as this effect was significant in Experiment 2 and trending in the right direction in Experiment 1.

The results of this study are informative in the fields of psychology, psycholinguistics and many other domains associated with ASL. These results are important by extending previous work with spoken word recognition and the time-course hypothesis to ASL, even though significant specificity effects did not appear. Because my results were not entirely in line with my predictions, there remains the possibility that ASL follows a different pattern for specificity effects than spoken words. A more complete understanding of the relationship between sign language and spoken language will require additional research.

Nevertheless, the current study is a great starting point for examining similarities and differences regarding theoretical and empirical issues in sign language and spoken language. There is a possibility to extend this work using other forms of variability unique to ASL, such as having signs viewed from different angles. During the preparation of the materials of the current study, the stimuli were recorded simultaneously from two different angles. The first angle was a head on view of the signer, referred to as Angle 1 (A1). The second angle was approximately 45° to the signer's left to produce a side view, referred to as Angle 2 (A2). All stimuli used in these current two experiments were from A1, although future work could compare A1 and A2.

Combining multiple signers and alternating angles could increase the difficulty between the easy and hard tasks.

There are also many other ways this experiment could be improved. In running participants and getting feedback from signers, there is a wide range of acceptable variability in ASL, due to regional signing differences, racial demographics, and learning styles. More importance could be placed on the geographical residence of signer, and where participants learned ASL to see if that accounts for any variability in participant responses. Next, a benefit to further research would be more time to seek out and use a larger number of native signing participants. Third, the questionnaire used in this experiment could be refined to get a better picture of signers and the factors that affect their language use. Additional questions could determine whether people with higher percentages of sign language use sign language more in a work setting (e.g., as an interpreter) or for personal use. There were many ways to extend this current work and gain more information. My current results are an important start to provide new information about theories and models of ASL.

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APPENDICES

APPENDIX A

PARTICIPANT INFORMATION FORM
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CLEVELAND STATE UNIVERSITY: DEPARTMENT OF PSYCHOLOGY
(216) 687-3834
E-MAIL: language@mac.com
WEBSITE: <http://web.mac.com/language@mac.com>

FOR LRL USE:
Room # _____
Participant # _____
_____ (credits) OR \$ _____
Experiment _____
Date _____
Experimenter _____

Please note that your responses to the following questions will *not* be directly linked to your name. As with any part of your experience as a research participant in our study, please feel free to ask the experimenter if you have any questions. Thank you.

Have you ever had a visual or reading disorder (other than glasses/contacts)?
(circle one) YES NO
If yes, please explain: _____

Have you ever been diagnosed with Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder (ADHD)?
(circle one) YES NO
If yes, please explain: _____

Select one for hearing status:
_____ Deaf _____ Hearing _____ Hard of Hearing

At what age did you begin learn ASL? _____

What is your primary language? (Note: a primary language is the language you learned **first**. If you learned more than one language simultaneously, please state both.)

Where were you first exposed to signing?

Mark as many as are relevant

Deaf Parent(s)/ Parent(s)
Deaf Sibling(s)/ Sibling(s)
School
Don't Know
Other

If other, please state: _____

Do you consider yourself fluent in ASL?

Do you speak or use a language other than ASL or English at home?

If so, explain:

Are any of your immediate family members native signers of ASL?

Have you been exposed to any other types of sign language, such as British Sign Language (BSL)?

If others, please give details:

If 100% is representative of all your language use, in the past 3 months, what percentage of your language use has been ASL? _____

Gender (circle one) Male Female

Your ethnic background is:

Hispanic or Latino/a _____

Not Hispanic or Latino/a _____

Your racial background is:

American Indian/ Alaskan Native _____

Native Hawaiian or Other Pacific Islander _____

White _____

Unknown _____

Asian _____

Black or African American _____

More than One Race _____

APPENDIX B

List of Signed Word, Nonword, and Unrelated Filler Stimuli for Experiments 1 and 2

Real Word Signs	
trouble*	nut
joke	goat
shoes	key
bicycle	deer
orange	tired**
sorry	college
heart	play
book	egg
SNS Stimuli	
trouble (PLM)***	nut (LOC)
joke (HS)	goat (LOC)
shoes (M)	key (HS)
bicycle (HS)	deer (HS)
orange (LOC)	tired (LOC)
sorry (M)	college (PLM)
heart (HS)	play (HS)
book (HS)	egg (HS)
UNS Stimuli	
red (HS, LOC)	rain (PLM, HS)
stop (HS, PLM)	airplane (HS,PLM)
morning (HS,PLM)	color (HS, M)
cousin (HS, M)	glass (HS, LOC)
star (HS, M)	computer (HS, M)
apple (HS, M)	odd (HS, M)
warn (PLM, HS)	improve (HS, LOC)
daily (HS, LOC)	help (HS, M)

*The first 12 stimuli in each group are the experimental stimuli, counterbalanced across participants to appear in all three prime conditions (i.e., match, mismatch, and control).

**The last four stimuli in each group are the unrelated filler stimuli (i.e., only appearing in the prime block in the control condition).

***For nonwords, the parameters that were changed are in parentheses. 1. HS = hand shape, 2. PLM = palm orientation, 3. M = movement, 4. LOC = location

APPENDIX C

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WEBSITE: <http://web.mac.com/language@mac.com>

This research project is being conducted for Hadiya Adams Master's Thesis under the supervision of Dr. M^CLennan.

There are two copies of this letter. After signing them, please keep one copy for your records and return the other one. Thank you in advance for your cooperation and support.

"I agree to participate in a perceptual experiment in which I will view signed words on a computer screen. I agree to respond to these signs by pressing a response button. I also understand that I may be asked to complete a few questionnaires. I further understand that confidentiality of my identity will be maintained at all times (i.e., a participant ID code will be assigned to all of my data).

I understand that the procedures to be followed in this experiment have been fully explained to me and that I may ask questions regarding the experiment at the end of the experimental session. I understand the approximate time commitment involved (approximately 30 minutes).

I understand that participation in this experiment involves minimal risk beyond those associated with daily living.

I understand that the purpose of this research is to add knowledge to the field of language perception. I understand that although there may be several indirect benefits of this study, its direct benefit is adding to the current body of knowledge on human perception.

I, the undersigned, am 18 years or older and have read and understood this consent form and hereby agree to give my consent to voluntarily participate in this experiment

I understand that if I have any questions about my rights as a research participant I can contact the Cleveland State University Institutional Review Board at (216) 687-3630.

Signature of Participant

Date

Name of Participant (PLEASE PRINT)

Date

APPENDIX C

PARTICIPANT INFORMATION FORM
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(216) 687-3834
E-MAIL: language@mac.com
WEBSITE: <http://web.mac.com/language@mac.com>

FOR LRL USE:
Room # _____
Participant # _____
_____ (credits) OR \$ _____
Experiment _____
Date _____
Experimenter _____

Please fill in the following information:

Name: _____

* Address: _____

E-mail address (es): _____

_____ Telephone Number: _____ Cell Phone Number: _____

Date of Birth: _____ Place of birth (City): _____

Major: _____

Place of Longest Residence (City): _____

Are you (circle one): right-handed left-handed ambidextrous

Would you like to be added to (or remain on) our "Paid Participants Database" so that we can notify you in the future of paid experiments for which you are eligible to participate? _____

** Note: If you would prefer not to provide your full address and phone number(s), you may simply provide your zip code. Thank you.*

APPENDIX D

Welcome to the Language Research Laboratory. We appreciate your helping us today.

In the experiment that you will be participating in today, you will see ASL signs on the computer monitor. Some of the signs will be real words in ASL; some will be nonsense words. We want you to decide as quickly but as accurately as possible if each item is a real word in ASL OR a nonword by pressing one of the two appropriately labeled buttons on the response box in front of you.

A typical trial will proceed as follows: A very short video will be played on the computer monitor. As quickly as you can, press the button labeled WORD if you think the item is a real word in ASL or NONWORD if you think the item is not a real word in ASL. Try to be as fast but as accurate as possible. As soon as you have responded, a new trial will begin.

Please rest your hands near the response box with your thumbs above the two buttons labeled WORD and NONWORD.

We will begin with a brief practice phase to familiarize you with the experiment. If you have any questions, please ask the experimenter now.

Let the experimenter know when you are ready to begin the experiment. Thank you.

- - - - -

The practice is over. If you have any questions, please ask the experimenter now.

Let the experimenter know when you are ready to begin the experiment. Thank you.

- - - - -

This portion of the experiment is now over.

APPENDIX E

Language Research Laboratory Mathematical Evaluation Test (MET)

Welcome to our research laboratory. We are attempting to determine the level of difficulty of certain math problems for another experiment in our laboratory. You can help us by completing the following problems as quickly but as accurately as possible. This is not a test of your intelligence or your math abilities. In fact, we will never associate your name with your answers. We are simply interested in determining which of the following problems are easy and which are difficult.

When the experimenter tells you to begin, turn the page and begin working on the problems. The experimenter will tell you when to stop working.

Thank you for helping us.

MET PART 1

1. $5387 \div 52 =$ _____

2. $585,975 \div 32 =$ _____

3. $7845.55 \times 77.99 =$ _____

4. $\left(\frac{77}{32}\right) \div \left(\frac{895}{84}\right) =$ _____ (express answer as fraction)

5. $945,759 \div 53 =$ _____

6. $\left(\frac{2997}{10,500}\right) \left(\frac{6799}{57}\right) =$ _____ (express answer as fraction)

7. $772,947 \times 48 =$ _____

MET PART 2

1. $4276 \div 41 =$ _____

2. $485,875 \div 22 =$ _____

3. $6835 \times 66 =$ _____

4. $\left(\frac{32}{77}\right) \div \left(\frac{84}{895}\right) =$ _____ (express answer as fraction)

5. $5369 \div 973 =$ _____

6. $\left(\frac{3897}{530}\right) \left(\frac{864,599}{29}\right) =$ _____ (express answer as fraction)

7. $397,947 \times 483 =$ _____

APPENDIX F



**Attention American Sign
Language Signers**

Be a **paid** participant in simple
language **research** experiments

Call, stop by, or e-mail the

Language Research Laboratory

Chester Building 249

(216) 687-3834

E-mail: **language@mac.com**

You are eligible IF:

- American Sign Language is your native language and **OR** you are proficient in ASL as a second language
- You are right handed and have no history of speech or hearing

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