TO BE OR NOT TO BE: PROCESSING OF NEGATION ACCORDING TO LANGUAGE BACKGROUND

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1. Introduction

Negation plays a crucial role in day to day communication, for example, the conversation in (1) between two people illustrates that negation is essential for explanation and comprehension of the conversation.

(1) *Speaker 1:* Are the curtains closed?
Speaker 2: The curtains are **not** closed, do you want me to close them?

Although negation is often necessary for communication purposes, negated sentences are said to be more effortful to process than their affirmative counterparts (Kaup & Zwaan, 2003; Kaup, Lüdtke, & Zwaan, 2006; Kaup, Yaxley, Madden, Zwaan, & Lüdtke, 2007). Consider the negated sentence "*The curtains are not closed"*, which means that the curtains are in fact open. Sentences of this type have been the topic of investigation regarding negation processing. Previous studies show that there are two proposed views in which negation is processed. On one hand, negation creates a processing cost (Kaup et al. 2006; Kaup et al., 2007), alternatively, negation does not create a processing cost, as long as the context surrounding the negated element is pragmatically sound.

Although sentential negation processing has been of interest in previous studies, little is known about how this processing occurs in bilingual speakers. More specifically, how a speaker's language background and the type of bilingual speaker, in particular simultaneous bilingual speakers and second language (L2) speakers, influences negation processing. The goal of the current study is to examine how simultaneous English-French bilinguals and L1 French-L2 English speakers process negation in real-time.

2. Background

2.1 Accounts for negation processing

Two major accounts for negation processing have been proposed; the two-step simulation hypothesis (Kaup et al., 2006), and the pragmatic account of negation processing (Nieuwland & Kauperberg, 2008). The two-step simulation hypothesis states that when negation is present within a sentence, it is initially bypassed and integrated at a later stage in comprehension, in other words, negation is not initially processed (Kaup et al., 2006, Kaup et al., 2007, Lüdtke, Friedrich, De Filippis, & Kaup, 2008). The two-step simulation hypothesis first arose from a study conducted by Kaup and colleagues (2006) with similar

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sentences to the example presented in (2). This study focused on how negative German sentences containing contradictory predicates are processed at different times in the comprehension process through the use of a sentence-picture verification task and delay response time conditions. The first step in this simulation is the processing of the sentence in the affirmative form, for example, the sentence in (2) is initially processed as the affirmative meaning of the sentence, where the curtains are closed (2a), as opposed to the correct negated form, the curtains being open (2b).

(2) The curtains are not closed
a. The curtains are closed – *Initial processing of the affirmative form: the negated state of affairs*
b. The curtains are open – *Correct meaning of the sentence: the actual state of affairs*

When the affirmative form of a negated sentence is processed, and the interpretation is incorrect, it is referred to as the negated state of affairs. Once the negated state of affairs is identified, the second step in processing occurs, where negation is integrated into the meaning of the negated state of affairs and provides the correct interpretation (b). This then creates the actual state of affairs.

This particular process has been proposed by Lüdtke and colleagues (2008), who conducted a sentence-picture verification task with native German speakers to investigate negation using behavioural and ERP (Event-Related Potential) measures. The results for the behavioural portion of the study reveal a processing cost associated with negation, as it is not initially integrated but is processed at a later stage in comprehension, supporting the two-step model. However, the ERP results illustrate that sentence context is crucial for negation to be processed as it is initially encountered.

In the pragmatic account of negation, both sentence context and real-world knowledge are taken into consideration when a negated element is encountered (Nieuwland & Kuperberg, 2008; Lüdtke et al., 2008). Specifically, negation can be incorporated at the initial stages of sentence comprehension if the semantic meaning of the sentence maps to a speaker's real-world knowledge. When a sentence is pragmatically sound, negation is integrated and processed when initially encountered, whereas, negation is interpreted as a violation and not integrated when a sentence is pragmatically flawed. Therefore, negation does not necessarily create a processing cost and is not claimed to be more difficult if it is present in a pragmatically true environment. For instance, the sentence in (3a) is pragmatically sound and claimed to be less effortful to process than the sentence in (3b), due to its alignment with what speakers know to be true. Whereas, the sentence in (3b) clashes with what we assume to be true in accordance to our real-world knowledge, as frogs do hop, therefore this sentence is not considered to be pragmatically sound and would be more difficult to process.

(3) a. Cows do not jump, and they are typically white and black.
b. Frogs do not hop, and they are typically green.

Nieuwland and Kuperberg (2008) tested the pragmatic account utilizing sentences that crossed over in truth-value and negation such that they were either pragmatically licensed, referring to the plausibility of the sentence (i.e., *With proper equipment, scuba-diving isn't very dangerous/safe and often good fun*) or unlicensed (i.e., *Bulletproof vests aren't very dangerous/safe and used worldwide for security*) in monolingual English speakers. Larger N400s were observed for pragmatically licensed false-negated and false-affirmative sentences, as well as pragmatically unlicensed false-affirmative, false-negated, and true-negated sentences. The absence of an N400 to negation in pragmatically licensed true sentences was interpreted as negation not causing any additional semantic processing cost.

Further support for the pragmatic account has previously been found in studies which indicate that negation is processed when the context is semantically related to the negated element and pragmatically licensed (Fischler, Bloom, Childers, Roucos, & Perry, 1983; Hagoort, Hald, Bastiaansen, & Petersson, 2004). Specifically, these studies indicate that negation is easier to process when present in a true context, as opposed to a false context. Fischler and colleagues (1983) utilized sentences where two nouns were either semantically related or unrelated, as well as true or false. False affirmative sentences (with semantically unrelated nouns) and true negated sentences (with semantically unrelated nouns) produced a larger negativity to their respective counterparts between 250-450ms post-stimulus onset. Overall, these results were taken to indicate that the increased negativity was in part due to the truth value of the sentences, as well as the semantic relationship between the nouns. Overall, negation, according to the pragmatic account, does not cause difficulties in processing, as long as the negated context is pragmatically sound. This account explains how and why negation appears to be used effortlessly in everyday conversation.

2.2 Monolingual negation processing

The processing of affirmative and negated sentences was previously investigated in a group of monolingual native speakers of English (Farshchi, 2018). The analyses of the time windows associated with the N400 (300-500ms) and P600 (500-700ms) over the posterior region revealed larger negative amplitudes for negated sentences (i.e., the jury found him *innocent* because the fire was recognized as *not* intentional in court) compared to affirmative sentences (i.e., the jury found him *guilty* because the fire was recognized as *intentiona*l in court) in both matching/true (i.e., the jury found him *innocent* because the fire was recognized as *not intentional* in court; the jury found him guilty because the fire was recognized as intentional) and mismatching/false (i.e., the jury found him *innocent* because the fire was recognized as *intentional* in court; the jury found him *guilty* because the fire was recognized as *not intentional* in court) conditions. This suggests that the processing of negated sentences was more demanding than that of affirmative sentences. Additionally, the ERP patterns for the congruency effects in affirmative and negated sentences revealed an N400 effect in response to the incongruities in affirmative sentences and a P600 effect in response to the incongruities in negated sentences. These patterns may suggest different processing mechanisms involved in the processing of incongruities in negated sentences compared to those in affirmative sentences. More specifically, the N400 effect in affirmative sentences reflects difficulties with the integration of the incongruent information (Kutas & Federmeier, 2011; Kutas & Hillyard, 1980), while the P600 in negated sentences suggests that the incongruities led to processes associated with re-evaluation of the larger context as found in previous studies reporting a P600 effect in response to semantic incongruities (Bornkessel-Schlesewsky & Schlesewsky, 2008; Brouwer et al., 2012; Burkhardt, 2007; Chow & Phillips, 2013; Kolk, Chwilla, van Herten, & Oor, 2003 van Herten, Kolk, & Chwilla, 2005; van Herten, Chwilla, & Kolk, 2006)

2.3 Bilingual processing

Bilingual speakers have yet to be specifically investigated in terms of how they process negation[1]. Although this is the case, several studies on simultaneous and L2 speakers have yielded results on other aspects of processing that can be extended into negation processing. L2 speakers have often been compared to monolingual speakers of the respective L2 language to determine how 'native-like' their processing is, as well as how processing between these groups differs. Typically, the earlier a speaker learns an L2, the higher the overall L2 ability (Birdsong, 1992) and more likely they attain native-like processing (Hernandéz, Li, & MacWhinney, 2005; Osterhout, Kim, & Kuperberg, 2012). Therefore, several factors are to be taken into consideration when investigating L2 sentence-level processing (Moreno & Kutas, 2005; Kotz, Holcomb, & Osterhout, 2008; Kaan, 2014; Jaeger & Snider, 2013), such as L2 age of acquisition (AoA), and proficiency.

Through the use of the ERP technique, Kotz and colleagues (2008) found that early L2 (before the age of 5) English speakers, show similar effects to syntactic anomalies and ambiguities as native speakers, indicating that an early AoA can result in native-like processing. Additionally, through the use of eye-tracking, Dussias , Valdés Kroff, Guzzardo Tamargo, & Gerfen (2013) found L2 speakers to use relevant gender information from a feminine determiner n French to predict an upcoming feminine noun, aligning with the results found in native speakers. Therefore, processing effects found for grammatical gender processing in L2 speakers patterned similarly to what was found with native speakers. L2 speakers of Japanese were also found to use anticipatory cues with the information provided from an adverb preceding an upcoming predicate at the end of a sentence similar to native speakers (Mitsugi, 2017).

Although early L2 speakers have been shown to reach native-like processing in certain domains of processing, it does not appear to be the case in all situations. For instance, L2 speakers have been shown to be unable to use predictive information cues in syntactic processing (Kaan, Dallas, & Wijnen, 2010). Kaan (2014) states that the inability to use predictive cues to process upcoming information can be caused by competing information from individual word meanings which can cause difficulty in accessing and processing information for L2 speakers. Although L2 speakers have the ability to access information in the respective language, it may take an increased amount of time to access,

[1] Although it is potentially the case that bilingual speakers have been studied, it is yet to be the included as a significant factor in regard to processing.

for example, the meaning a string of words in a sentence due to an increased cognitive load that can impede their processing speed.

3. ERPs and components of interest

In order to investigate how language is processed in real-time, the ERP technique, an online measure that reflects implicit processing, can be used to see how the brain reacts to certain stimuli and conditions. To measure ERPs, the continuous electroencephalograph (EEG) is recorded to language stimuli. This continuous stream of data allows us to look at processing as a stimulus is encountered, as opposed to solely the end result. While the EEG provides all brain activity that is occurring at a certain point in time, ERPs are associated with a response to a particular event. Certain components are sensitive to certain linguistic variables (Luck, 2014). For example, one component that has been found to be associated with language processing, specifically the grammaticality of a sentence is the P600, which is an increase in positivity to ungrammatical sentences that is maximal at 600ms after the onset of the critical event. ERP waves appear in positive and negative components. These components are associated with the time at which the waves shift post-stimulus onset in reaction to a particular stimulus. For example, an N400 can appear in several situations, such as when encountering low-frequency words, semantic violations, or when an unexpected word is encountered. An N400 to a low-frequency would result in a larger N400 than a high frequency word. The ERP components of interest for the present study are the N400 and P600.

3.1 N400

The N400 is a negative deflection in the brain waves, which is slightly right-lateralized, and typically largest over central and parietal electrodes (Luck, 2014; Figure 1). This ERP component occurs around 400ms after the onset of the stimulus and usually indicates a semantic violation where a participant encounters an unexpected word or a word that is less frequent in the vocabulary in comparison to expected and highly frequents words. The N400 can be found in isolated word contexts, as well as sentence contexts, such as the effects found in Nieuwland and Kuperberg (2008). For example, in a sentence such as "*I take my coffee with cream and socks",* the word *socks* would elicit a larger N400 than the word *sugar* in the same context (Kutas & Hillyard, 1980). Retrieval of the word *sugar* less effortful than *socks*, as the preceding context provides the relevant cues.

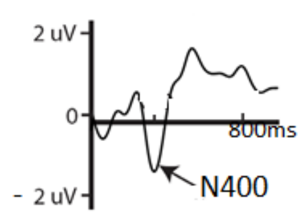

Figure 1. Example of an N400 (Adapted from Nieuwland, 2006)

3.2 P600

The P600 component is a late positive deflection in the brain waves, which is typically largest in central and parietal electrode regions (Luck, 2014; Figure 2). This effect occurs between 500-1000ms and indicates that a sentence is not syntactically well-formed or is composed of a structure that is difficult to parse (i.e., garden path sentences). Therefore, P600 effects tend to only be found within sentence contexts, for these types of anomalies in comparison to structures that are simpler to parse. This component is thought to occur later, as participants are attempting to reanalyze the syntactic anomaly and fix it in a later stage of syntactic processing (Steinhauer & Connolly, 2008). For example, a sentence such as "*The horse raced past the barn fell*" (Bever, 1970) will cause a larger P600 than *"The horse raced past the barn"*, as it requires more effort to parse.

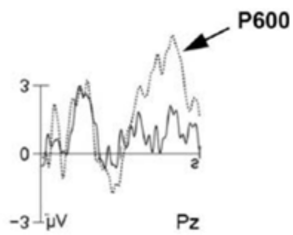

Figure 2. Example of a P600 (Adapted from Steinhauer & Connolly, 2008)

4. The present study

The present study aims to examine whether the electrophysiological responses to English negation in English-French simultaneous bilingual speakers and L1-French early L2 English speakers are comparable with either the two-step account or the pragmatic account. Additionally, simultaneous speakers serve as a control group in order to compare L2 speakers, who possess two languages, to a group of native speakers who also know two languages, specifically the same two languages. This will further allow for an accurate comparison between bilingual speakers. L2 speakers are expected to show a process that is similar to the two-step account, in that they will not initially process negation within a sentence, due to the competing information from individual word meanings (Kaan, 2014). This overload of information may lead to negation being processed at a later stage in the comprehension process, therefore any electrophysiological effects seen in L2 speakers should appear later than those shown in simultaneous speakers. Both groups of bilingual speakers are matched in terms of their proficiency in French, therefore any observed differences will not be due to either groups being less proficient. Should L2 speakers adopt a two-step account of negation processing, larger N400 responses are expected to all sentence types including negation, whereas, affirmative sentence types should contain small effects. On the other hand, simultaneous speakers are expected to process negated sentences similar to what has been proposed for the pragmatic account, aligning with previous findings on native speakers (i.e., Nieuwland & Kuperberg, 2008). Should simultaneous speakers align with a pragmatic account, larger N400 are expected for all false affirmative and negative sentence types. If present, smaller effects indicative of an N400 are expected for true affirmative and negated sentences in simultaneous speakers, indicating that the falsity of the sentence is what has an impact on processing, as opposed to the negation.

4.1 Participants

Twenty-three participants (10 simultaneous bilinguals, 13 L2 speakers) recruited through the University of Ottawa's Integrated Psychology participant pool completed this study for partial class credit. All participants were right-handed, between the ages of 17-21 (mean=19.09 years) and resided in the Ottawa-Gatineau region at the time of testing.

Participants were assigned to their respective language group based on their responses on a language background questionnaire (LBQ; Sabourin, Leclerc, Lapierre, Burkholder, & Brien, 2016). Table 1 presents the age range of first exposure to English (Ao1E), as well as the age of immersion (AoI) of participants in an English environment. Participants who acquired both French and English from birth were classified as simultaneous bilingual speakers. These L2 English speakers were classified as those with French as their L1, having acquired French from birth, and whose Ao1E to English was after the age of 4 (mean = 5.5 years). L2 speakers were also immersed in an English environment after the age of 4 (mean = 6.3 years).

Table 1. Participant information

Language group	N	Age of exposure to English (Ao1E)	Average Ao1E	Average Age of Immersion in English environment (AoI)	Average AoI	Mean English proficiency score (/50)
L2 English	13	4-10 years	5.5	4-10 years	6.3	43
Simultaneous bilingual	10	From birth		From birth		43.5

All participants completed an English proficiency test (Brown, 1980) to determine their eligibility. Eligible participants scored 31/50 or higher, categorizing them as highly proficient. No significant differences in proficiency scores between groups were found (p=.243).

3.2 Materials

Stimuli for this study was originally used in Farshchi's study on sentential and prefixal negation processing in monolingual English speakers (Farshchi, 2018) and consists of 68 English sentences. Twenty target adjectives of varying frequency and length were extracted from the Corpus of Contemporary American English (COCA; Davies, 2008). These adjectives were grouped into pairs with their negated counterpart, using the word *not* (i.e., "intentional-not intentional", "authorized-not authorized"). The affirmative and negated forms appeared at the end of the sentence, and either agreed or contradicted with the adjective or verb that was present at the beginning of the sentence rendering the sentence true or false (Table 2, the bolded words indicate the matching and mismatching adjective/verb distinction). The adjectives or verbs that appeared at the beginning of the sentence remained the same, regardless of whether the affirmative form or the negative form of the target adjectives were used at the end of the sentence (i.e., "neglected" and "recognized", "neglected" and "not recognized"). Additionally, each pair of affirmative and negated sentences were identical, with the sole difference being that *not* was inserted before the second predicate adjective to form the negated sentences.

Table 2. Example of stimuli and sentence types

Sentence Type	True or False	Matching/ Mismatching	Sentences
Affirmative	True	Matching	His money was **recovered** after bankruptcy because his investment was **<u>insured</u>** by the bank.
	False	Mismatching	His efforts were **neglected** by the music industry and his talent was **<u>recognized</u>** after many years.
Negated	True	Matching	His efforts were **neglected** by the music industry and his talent was **not <u>recognized</u>** after many years.
	False	Mismatching	His money was **recovered** after bankruptcy because his investment was **not <u>insured</u>** by the bank.

Of the 68 sentences used in this study, 34 were affirmative and 34 were negated. Within these were 17 true-affirmative, 17 true-negative, 17 false-affirmative, and 17 false-negative sentences. All sentences followed the same format as seen in Table 2, and the adjective of interest never appeared as the final word in the sentence. An explicit effort was made to ensure that all sentences were similar in terms of length.

3.3 Procedure

Prior to performing the experiment, participants completed the LBQ. During the experiment, participants were seated in a sound-attenuated room, where they read 68 sentences (34 affirmative, 34 negated) via the Rapid Serial Visual Presentation (RSVP) paradigm. Participants saw sentences containing the target adjectives twice, once in the affirmative form and once in the negated form. The experiment was executed using the Neurobehavioral Systems program, Presentation, on a computer screen. Instructions for the task were presented on the computer screen in English, as well as orally explained by the experimenter to ensure that the participant understood the task. Each trial began with a fixation point, participants then saw each sentence presented one word at a time in the middle of the screen. Words were presented for 300ms with an ISI of 200ms. At the end of each sentence, three question marks (???) appeared, prompting participants to respond to an acceptability question with a button press to determine whether the sentence made sense. At the beginning of the experiment, participants completed 2 practice sentences where the experimenter remained in the room with the participant to address any questions or concerns. While reading the sentences, the continuous online EEG signal was recorded. Following the completion of the experiment, participants filled out the English proficiency test.

3.4 Analysis

ERP data from both groups of speakers were analyzed using Brain Electrical Source Analysis (BESA ERP analysis). For the current set of analyses, a subset of 9 electrode sites (circled in Figure 3) were chosen; F3, Fz, F4 (frontal electrodes), C3, Cz, C4 (central electrodes), P3, Pz, and P4 (parietal electrodes). All electrodes were re-referenced offline to the mastoids (M1 and M2). Epochs were segmented starting at -100ms baseline pre-stimulus onset and ending at 1000ms, the same time window was used for artifact rejection. Data was filtered through a low cut-off filter at a frequency of .10Hz, with a slope of 6dB/octave.

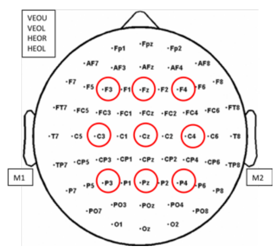

Figure 3. Overall distribution of electrodes. All electrodes included in analysis are circled.

On average, at least 70% of trials for each condition were included for analysis. The 30% or less of trials not included was due to noise in the data for a particular stimuli item (i.e., noise caused my muscle movement) Data from each participant was averaged across trials for each condition using BESAs averaging function. The averages of each participant were then combined in a grand-average according to language group (simultaneous bilinguals and L2 speakers). ERPs were time-locked to the critical word (underlined in Table 2), which were used to analyze the N400 and P600. The N400 was investigated between 300-400ms and 400-500ms post-stimulus onset, while the P600 was investigated between 500-700ms and 700-900ms.

5. Results

The results presented include comparisons between the true affirmative and true negated sentences contexts, as well as the false affirmative and false negated contexts. These specific contexts are of interest, as they allow for us to investigate whether differences arise between the affirmative and negated sentences regardless of the truth condition.

5.1 True affirmative vs. true negated

5.1.1 Simultaneous bilinguals

Visual inspection of the data shows that true affirmative sentences have an increased positivity around 700ms, as seen in Figure 4). However, no significant 3-way interaction in any time window; 300-400ms: $F(4,36)=1.136$, $p=.355$, 400-500ms: $F(4,36)=1.060$, $p=.391$, 500-700ms: $F(4,36)=.214$, $p=.929$, 700-900ms: $F(4,36)=.722$, $p=.583$ was found for true affirmative and true negated sentences, indicating that the observed positivity is not indicative of a significant P600 effect. The analysis of each time window indicates that there were no significant interactions containing condition. Further investigation and an increased number of participants is needed to accurately determine what in particular this positivity is signifying.

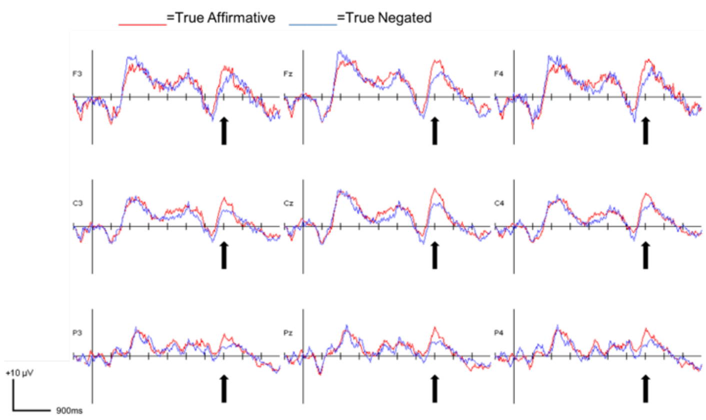

Figure 4. True affirmative vs. true negated waves for simultaneous bilingual speakers. Arrows indicate regions of effect.

5.1.2 L2 speakers

True negated sentences show an increased negativity beginning around 650ms, primarily across frontal and central electrode sites. Separate ANOVAs indicate that there are no significant 3-way interactions in any time window analysis for true affirmative and true negated sentences; 300-400: $F(4,48)= 1.206$, $p=.36$, 400-500ms: $F(4,24)=.1.948$, $p=.118$, 500-700ms: $F(4,24)= .1.366$, $p=.26$, 700-900ms: $F(4,24)=1.366$, $p=.26$. A significant main effect of condition was found between 500-700ms and 700-900ms ($F(1,12)=8.885$, $p=.011$*). These effects signify a delayed N400 effect to true negated sentence, which occurs at a later stage in processing with L2 speakers.

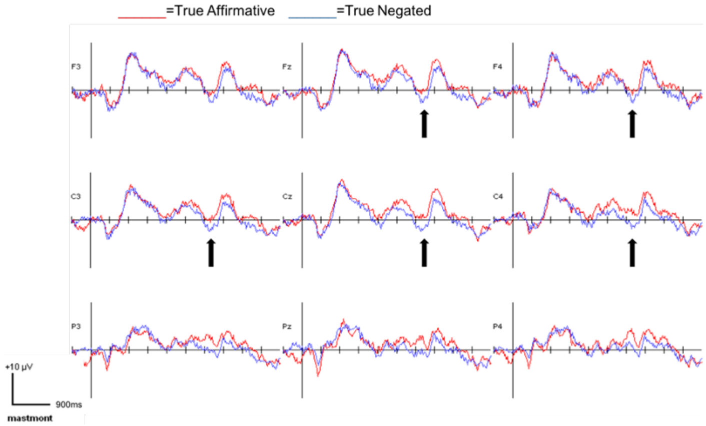

Figure 5. True affirmative vs. true negated waves for L2 speakers. Arrows indicate regions of effect.

5.2 False affirmative vs. false negated

5.2.1 Simultaneous bilinguals

False negated sentences show an increased negativity, predominately across parietal electrodes sites. This negativity appears to shift into a positivity at around 500ms across frontal and central electrode sites. An analysis of each time window illustrates that there is no significant 3-way interaction; 300-400ms: $F(4,36)=2.105$, $p=.1$, 400-500ms: $F(4,36)=1.168$, $p=.341$, 500-700ms: $F(4,36)=.986$, $p=.437$, 700-900ms: $F(4,36)=.306$, $p=.874$. Within the 300-400ms time window, an interaction between condition and anteriority ($F(2,18)=4.780$, $p=.022$*) was found to be significant, as well as a near significant interaction between condition and laterality ($F(18,2)=3.184$, $p=.065$). Significance for condition and anteriority extended to the 400-500ms time window ($F(2,18)=5.864$, $p=.011$*). These effects are seen as an N400 in (Figure 3) with a negativity between 300-500ms to false negated sentences across parietal electrodes, as well as in C3 and Cz. The 500-700ms time window produced a significant main effect of condition, ($F(1,9)=16.475$, $p=.003$*). The apparent negativity between 300-500ms may indicate that there is an interaction between negation and truth condition. This is also shown with the shift in effect for false negated sentences, which appears as an increased positivity across frontal and central electrode sites around 500ms.

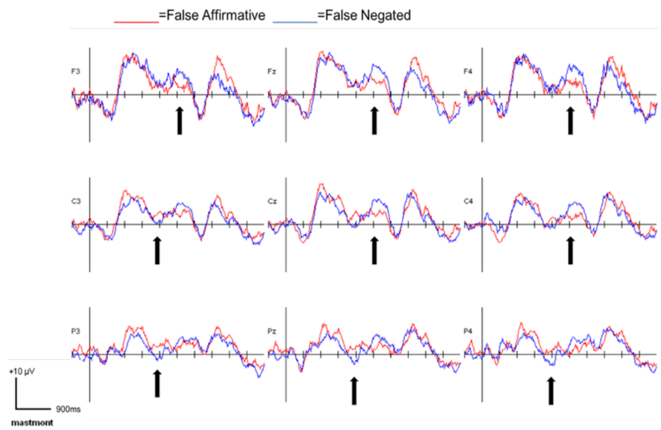

Figure 6. False affirmative vs. false negated waves for simultaneous bilingual speakers. Arrows indicate regions of significant effect.

5.2.2 L2 speakers

False affirmative sentences, in comparison to false negated sentences show an increased positivity around 750ms. These effects are primarily seen across frontal and central electrode sites. All ANOVAs conducted for false affirmative and false negated sentences produced non-significant values for a 3-way interaction; 300-400: $F(4,48)=.568$, $p=.687$, 400-500: $F(4,48)=681$, $p=.609$, 500-700: $F(4,24)=.681$, $p=.608$, 700-900: $F(4,24)=947$, $p=.397$. A near significant main effect of condition was found in the 700-900ms time window ($F(1,12)=3.502$ $p=.086$), as well as a significant effect of condition and laterality ($F(2,24)=4.164$, $p=.028$*). The delayed positivity effect is indicative of a P600 effect, which occurs at a slightly later point in time than in native speakers.

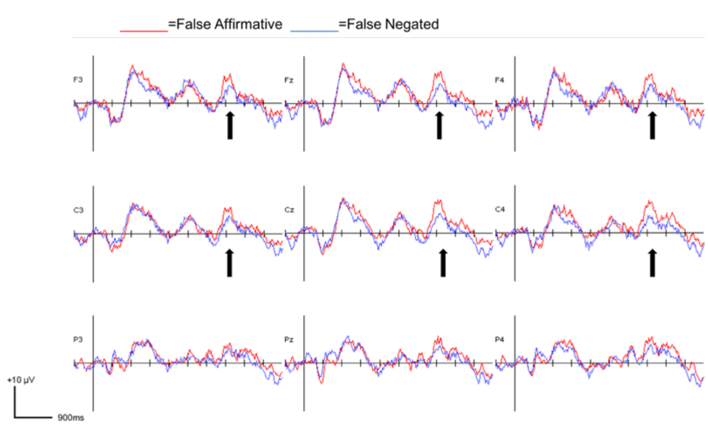

Figure 7. False affirmative vs. false negated waves for L2 speakers. Arrows indicate regions of significant effect.

5. Discussion

The present study investigated the effects of negation in pragmatically true and false sentences with matching and mismatching predicates in simultaneous bilingual and L2 speakers. Simultaneous bilingual speakers showed an N400 effect to false negated sentences, but not true negated sentences. This effect indicates that negation is not necessarily more difficult to process unless it is in a false and pragmatically unsound context, aligning with the pragmatic view of negation processing. L2 speakers demonstrate slightly different results, where true negated sentences produce an N400, and false affirmative sentences show a P600. Sentences in the false negated context appear to be processed without difficulty. Interestingly, the N400 effects observed across all participants is associated with difficulty in integrating the negated element into the negated sentence contexts, whereas the P600 appears within affirmative contexts, opposite of the findings on native speaker processing in Farshchi (2018).

The negativity to false negated sentences produced by simultaneous speakers indicates that negation may not necessarily be more effortful to process than affirmative sentences. If negation were difficult to process, similar effects would be present for true negated sentences. Therefore, as seen in previous studies (Fischler, et al., 1983; Hagoort, et al., 2004), negation appears to be more difficult to process in pragmatically unsound contexts. Nieuwland and Kuperberg (2008) found an N400 to pragmatically licensed true negated and false affirmative sentences, indicating that negation is not more difficult to process, due to the lack of effects found to true negated sentences. This is similar to what is found in simultaneous speakers, with the exception of the lack of an N400 to false affirmative sentences. The differences between the current study and previous findings may in part be due to the nature of the stimuli. Nieuwland and Kuperberg (2008) constructed sentences where negation is integrated at an earlier stage syntactically, whereas the current stimuli consist of sentences where negation is presented at a later point. The negativity present in the false negated sentences may also be due to an interaction between the negation and truth condition of the sentence which can then cause added difficulty in the semantic integration of negation.

The negative neural responses present to true negated sentences, in comparison to the affirmative counterpart, in L2 speakers, is potentially indicative of processing difficulty for negation as it is initially encountered. Furthermore, the negativity is slightly more delayed, as it occurs outside of the typical N400 time window of 300-500ms, potentially caused by competing information from individual word meanings, leading to longer processing times. Overall, L2 speakers appear to utilize a processing system that is similar to the two-step system proposed by Kaup and colleagues (2006, 2007) when negated sentences are pragmatically true, which found that negation is processed at a later stage in the comprehension process. The two-step model was previously found in native speakers, yet results supporting this process were not found in the simultaneous bilingual native speakers of English in the current study. Although further research involving larger language populations is required to enhance our understanding of negation processing in bilingual speakers, the results of the current study suggest that simultaneous and L2 speakers are utilizing different processing mechanisms while processing negation.

6. Conclusion

The current study investigated negation processing in simultaneous and L2 speakers through the use of the ERP technique. The main findings suggest that simultaneous bilingual speakers and L2 speakers do not process negation similarly. This supports previous findings in that a two-step process, as well as a pragmatic account can be observed, but in this case, across different language groups. L2 speakers appear to possess difficulty in processing negated sentences in comparison to their affirmative counterparts. This difficulty is also seen at a later time post-stimulus onset, demonstrating that there is a delay in processing. Although the L2 speakers included in the current study are earlier learners of the respective L2, they do not process negation in the same manner as native speakers. Therefore, highlighting differences between the organization of the language systems present in these language groups and emphasizing that the processing of negation is dependent on a speaker's language background.

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