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A Systematic Literature Review of the ERP Patterns of Children with Specific Language Impairment During Sentence Processing Tasks

EMILY TECCO
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Reviewed and approved* by the following:

Carol Miller
Professor of Communication Sciences and Disorders
Honors Advisor and Thesis Supervisor

Chaleece Sandberg
Professor of Communication Sciences and Disorders
Faculty Reader

* Electronic approvals are on file.

ABSTRACT

Specific language impairment (SLI) is a communication disorder that impedes the development of language skills without the presence of intellectual disabilities, hearing loss, or any other medical conditions. Evaluating a child, who may have SLI, using sentence processing tasks, allows a clinician to evaluate their lexical-semantic development compared to their typically developing (TD) peers. Furthermore, using event related potential (ERP) data, specifically the N400 and P600 components, can give clinicians insight into the child's neural activity in relationship to their sentence processing, since these components relate to semantic and syntactic abilities. For this systematic review, forty-three articles were found through both PubMed and PsychINFO databases. Abstracts were examined to determine if the articles met the inclusion criteria: (1) a SLI or DLD child subgroup, (2) a semantic or syntactic task, (3) experimental testing seeking to show either a N400 effect or P600 effect. The full articles were then examined further and eleven articles were included in the review. The literature did not reveal any specific patterns between the ERP patterns of children with SLI and their TD peers. About half of the articles did not find a main effect of group while the remaining articles found a significant main effect of group. These differences may be due to the differences in samples and stimuli included in the studies. Further research should be conducted to investigate the N400 effect and P600 effect in children with SLI compared to their TD peers during semantic and syntactic tasks.

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Chapter 1

Introduction

Specific Language Impairment

Specific language impairment (SLI) is a communication disorder that impedes the development of language skills without the presence of intellectual disabilities, hearing loss, or any other medical condition. SLI can affect a range of language abilities like: speaking, listening, reading and writing, and is present in about seven percent of children in kindergarten (National Institute of Deafness and Other Communication Disorders [NIDCD], 2019). Some common presenting features of SLI include: a delay in starting to produce speech, the first words may not appear until 2 years of age or older, immature or deviant production of speech sounds, use of simplified grammatical structures, restricted expressive and receptive vocabulary, weak verbal short-term memory, and difficulties in understanding complex language (Bishop, 2006).

Specific Language Impairment vs. Developmental Language Disorder

It is important to note the ongoing changing terminology of specific language impairment to developmental language disorder (DLD). The reason for the switch from SLI to DLD was because the specific range of non-verbal IQ scores of above 85 does not seem to distinguish the various subtypes of children with language impairment and the strict definition of SLI may exclude children who need services (Volkers, 2018). According to the American Speech and Hearing Association (ASHA), DLD can also sometimes co-occur with impairments in the areas of attention, motor coordination, literacy, speech, behavior or emotional problems, executive

function, or auditory processing. In addition, a DLD diagnosis does not require a mismatch between verbal and nonverbal ability. (Volkers, 2018).

I chose to reference the disorder as SLI throughout my paper because during my search, more relevant sources that applied to my criteria were found when using the search term SLI compared to DLD. It is important to note that when conducting SLI/DLD research, it is necessary to continue to collect IQ information and use specific inclusion and exclusion criteria relevant to the questions being explored (Volkers, 2018).

Children with SLI and their sentence processing abilities

Sentence processing is a useful screening tool for the assessment of children with SLI. Together with event related potential (ERP) data, clinicians gain insight into how children's brains process the complex characteristics of sentences. It is believed that sentences tap into children with SLI's morphosyntactic ability, which is built on the foundation of lexical semantic development. There is a close relationship between morphosyntactic knowledge and sentence repetition that can help determine SLI in children. For example, Meir (2017) indicated that sentence repetition exhibited the largest performance difference between children with SLI and their typically developing (TD) peers, due to the high linguistic loads (Chun, 2020).

Children with SLI have the most evident deficiency in vocabulary, morphology and syntax. Vocabulary skills, which reflect semantic processing, are an important indicator of language skills in children. There is a close relationship between vocabulary skills and sentence processing; thus, lower sentence repetition accuracy in children with SLI reflects their poor semantic processing ability and will separate them from their TD peers. (Chun, 2020).

Within the area of syntax, finiteness marking may be especially challenging and children with SLI often omit these. Finiteness marking includes adding -s to the third person singular

present tense verbs, and adding -ed to regular past tense verbs, morphological verb stem changes for irregular past tense verbs, and non-lexical free-standing copula verbs or auxiliary verbs (Hoover & Storkel, 2013). In addition, children with SLI often misuse pronouns, for example using “her” instead of “she” (Volkers, 2018). The presence of SLI in a child can also be noted during sentence repetition when a child shows more errors with function words and inflections rather than content words. In previous studies, when comparing children with SLI to their typically developing peers, the peers displayed equal performance across all types of words (Chun, 2020).

Therefore, these factors will affect how children would process sentences without errors and sentences with syntactic or semantic errors after hearing them and then being asked a question. This is why researchers believe testing the sentence processing abilities of children with SLI may lead to a more insightful option when diagnosing the disorder.

Event Related Potentials and Their Role

Basic Background

Event related potentials (ERPs) are small voltages developed in the brain elicited by sensory, cognitive or motor events (Sur & Sinha, 2009). They are used as a method for direct and noninvasive measurements of human brain activity. This method provides a temporal resolution that supports measurement of the brain activity from one millisecond to the next. The timing is crucial because numerous aspects of attention and perception appear to operate on a scale of tens of milliseconds. ERPs consist of ERP components, which are the individual waves that make up the complete ERP waveform (Woodman, 2010). They are believed to consist of the summed activity of postsynaptic potentials elicited when a large number of cortical pyramidal neurons fire while processing information. ERP components are defined by their either positive or

negative polarity, timing, scalp distribution, and sensitivity to task manipulations (Sur & Sinha, 2009). The ERP components we are most interested in this review are N400 and P600.

The N400 Effect

The N400 effect is often related to the detection of a semantic error (Weber-Fox et al., 2010) and inversely related to the expectancy of a given word in a sentence (Sur & Sinha, 2009). The N400 effect is associated with the increase in negative polarity that peaks at about 300-500 ms after a semantically inappropriate word is presented (Haebig et al., 2018). Several studies have shown that the N400 amplitude is inversely related to the subjective predictability of a word in the sentence. The N400 will often reflect the familiarity of the word integrated into the current context (Herten, Kolk, Chwilla, 2005).

In a study conducted by Landi and Perfetti (2007), the N400 component of their study was sensitive to differences between skilled and less-skilled comprehenders during a semantic task. The skilled comprehenders showed positive deflections with greater absolute amplitude than the less skilled comprehenders who had more negative waveforms. Researchers suggested this difference in amplitude reflects an underlying processing difference that affects the N400 effect (Henderson et al., 2011). These insights will lead to how children with SLI and their comprehension and reading abilities affect their waveform.

The P600 Effect

In sentences, the P600 effect reflects the detection of syntactic violations, a non-preferred syntactic structure, or a complex syntactic structure (Sur & Sinha, 2009). It is a response to syntactic violations that is assumed to reflect late and relatively controlled processes of reanalysis and repair in phrases or sentences (Sabish et al., 2006). The P600 effect is associated with positivity around 500 ms after the stimulus is presented (Regel, Meyer, Gunter, 2014).

Anterior negativity is an additional component that marks the initial detection of a morphosyntactic error between 100 and 500 ms after the violation (Haebig et al., 2018). A P600 waveform is expected after phrase structure violations from TD individuals compared to those with a lower language proficiency, who may demonstrate a later negativity waveform and a smaller P600 component (Haebig et al., 2018). TD individuals also usually show a left anterior negativity in the early time window after the stimulus is presented (Sabish et al., 2006).

The P600 effect still needs to be further investigated to determine whether or not it provides insightful information for brain activity. Studies that explore syntactic errors report a variety of findings. For example, in a study conducted by Weber-Fox et al. (2010), TD children showed a P600 component after listening to verb agreement violation while children with SLI did not. However, these results do not match other studies that tested syntactic errors like wh-dependencies and word category violations. Another study noted that high language proficiency individuals displayed anterior negativity and P600 waveforms after hearing phrase structure violations but in contrast, individuals with low language proficiency demonstrated a later negativity waveform and also a smaller P600 component. From the variety of findings, the research has suggested that there are numerous neurocognitive processes in relation to grammatical comprehension (Pakulak & Neville, 2010).

Importance of using this method for research

ERPs can be extremely informative for capturing group differences that may not be evident from behavioral measures alone. ERPs provide an additional level of analysis that may be more sensitive to differences in the processing abilities, and can also indicate underlying aspects of processing (e.g., post-lexical syntactic re-analysis, ease of lexical access) (Weber-Fox et al., 2010). For example, ERPs provide an ongoing temporal record of brain activity from the

beginning of stimulus onset (Henderson et al., 2011). Using ERP data is a valuable tool for diagnosing children with SLI, as it gives clinicians more information on the children and their neural activity, in combination with behavioral data, which can lead to a more accurate diagnosis.

Researchers can then use both sentence processing tasks, combined with ERP data, to test the differences between children with SLI and their TD peers. The TD group would be expected to show a N400 effect after semantic violations and a P600 effect after syntactic violations. In contrast, the children with SLI would not be expected to show either a N400 effect or P600 effect because they experience difficulty within these aspects of their language.

Research Question

Are there any differences between the ERP data of TD children and children with SLI during sentence processing tasks?

Chapter 2

Methods

Search Strategy

A literature search was conducted through PennState Libraries and included both PubMed and PsychINFO databases. Two different searches were used in the databases. The first search terms included: [(specific language impairment) AND (event related potentials) AND (sentence processing) AND children]. The second set of search terms included: [(developmental language disorder) AND (event related potentials) AND (sentence processing) AND children]. The decision to include both specific language impairment and developmental language disorder in the searches was to accommodate for the changing terminology of the disorder/impairment. These terms were based on their relevance to the abstract and title field of the sources.

Study Selection Criteria

The sources were examined for relevance to the research question and included if they met three key criteria. The criteria included: (1) a SLI or DLD child subgroup, (2) a semantic or syntactic task, (3) experimental testing seeking to show either a N400 effect or P600 effect. After identifying the main criteria through the abstract, the full article was read for further data extraction. A large majority of the articles were excluded for testing children with disorders like autism or Down syndrome, or other language disorders like dyslexia.

Data Extraction

The following subtopics were extracted from each article for examination: participant data (number of participants, ages, comparison groups, diagnosis of SLI, and the authors reliance on previous testing, i.e., did the authors diagnose the children with SLI themselves or gather their

sample of children who have been previously diagnosed, type of sentence processing (semantic or syntactic), type of stimuli used, ERP components, and ERP differences. Once this information was identified, it was arranged strategically for ease of comparison.

An age range of 4 to 15 was used to ensure there was enough data to complete the review. Specifically, for the diagnosis of SLI, the criteria were looked at closely to see if all of the sources had similar diagnosis. Seven out of the eleven sources used the criteria of having the children with SLI perform 1 to 1.5 standard deviations below the age appropriate mean on a variety of standardized language tests. Three out of eleven sources used the criteria of children either performing below average for their age range or one year behind their chronological age also on a variety of standardized language tests. The last article did not note specific criteria, as they based their diagnosis off enrollment in a special school for speech and language impairment, and characterized the children as having severe language difficulties in the context of a broadly normal range nonverbal intelligence.

Search Outcome

See Figure 1 for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (PRISMA, 2015). Forty-three initial records were identified through database searching after duplicates were removed. Thirty-two records were excluded after failing the selection criteria. Eleven of the full text articles were assessed for eligibility and all eleven were included in the qualitative synthesis. One of the eleven articles was found in the reference page of an article identified through the database search. Ten of eleven the articles were accessed through PennState Libraries and the remaining article was accessed through contact with the author.

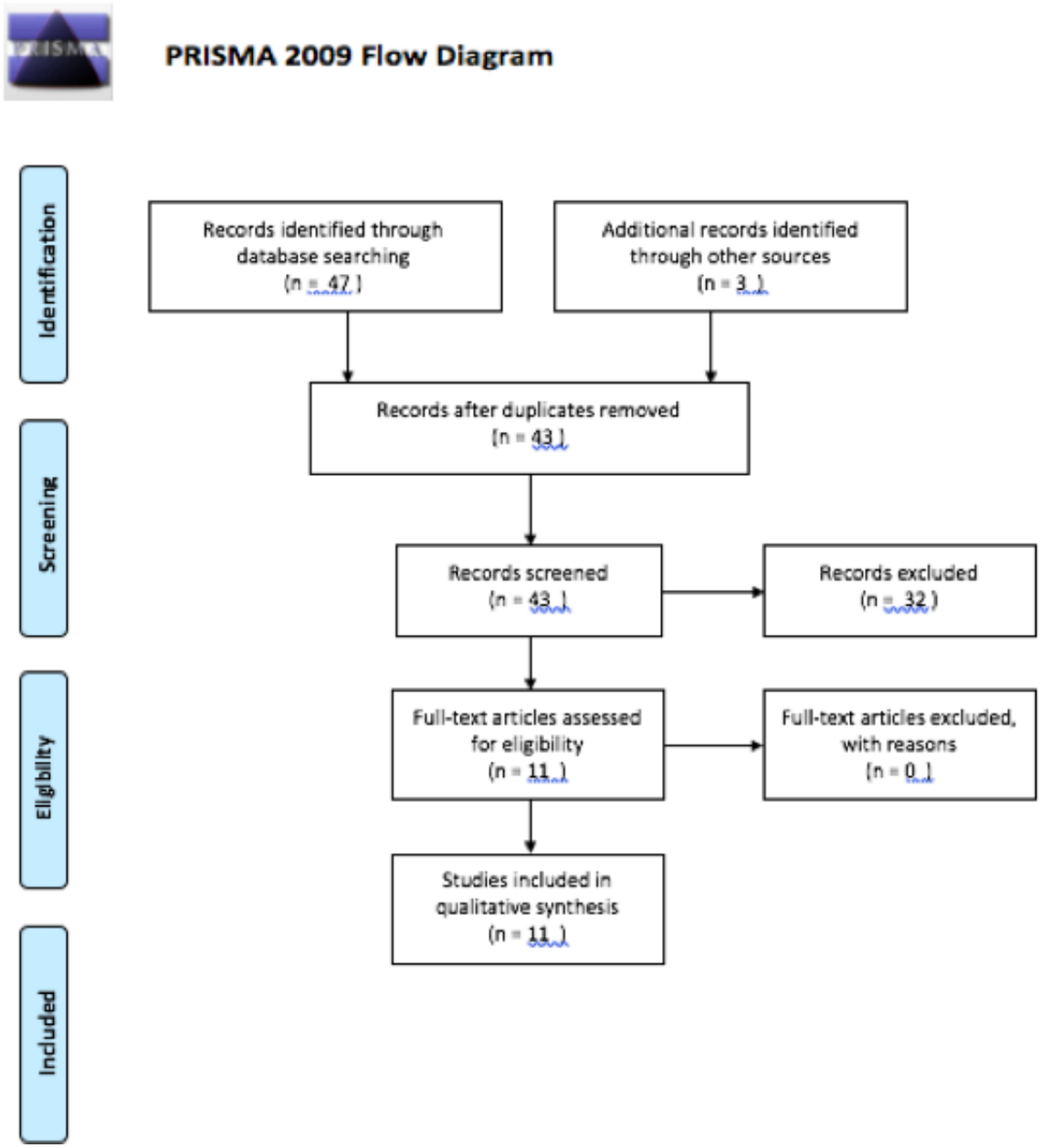

Figure 1: PRISMA Flow Diagram

Chapter 3

Results

The contrasting results from the studies shows the importance of investigating sentence processing of children with SLI and comparing the data to their TD peers even deeper. For this review, I focused on both the N400 and P600 effects, their presence in each group, and between-group differences. Six of the articles focused solely on testing the N400 effect, one of the articles focused solely on testing the P600 effect, and three of the articles incorporated both the N400 and P600 effect into their study.

N400 Results

When examining if both the children with SLI and their TD peers displayed the targeted N400 component in the studies, five of the articles found that both children with SLI and the TD group showed a similar N400 effects (Cummings et al., 2010, Haebig et al., 2017, Haebig et al., 2018, Neville et al., 1993, Weber-Fox et al., 2010). In contrast, three of the articles found only the TD group to show an N400 effect (Lorusso et al., 2015, Pijnacker et al., 2019, Sabisch et al., 2006), and lastly, one of the articles found that neither the children with SLI or the TD group to display the N400 effect (Betz, 2006).

Furthermore, of the nine articles that examined the N400 effect in children with SLI and their TD peers, four of the articles found a statistical significance between the two groups resulting in a main effect of the group (Lorusso et al., 2015, Neville et al., 1993, Pijnacker et al., 2019, Sabisch et al., 2006). Neville et al. (1993) discovered that the children with SLI displayed an abnormally large N400 effect compared to the TD peers, while in contrast, Pijnacker et al. (2019) and Sabisch et al. (2006) found that only the TD group showed an N400 effect while the

children with SLI did not. Similarly, Lourusso et al. (2015) found a reduced negativity for the SLI group compared to the TD group. Five of the articles did not find a statistically significant main effect of the group (Betz, 2006, Cummings et al., 2010, Haebig et al., 2017, Haebig et al., 2018, Weber-Fox et al., 2010).

The articles that did not exhibit a main effect of group found other noteworthy effects. Cummings et al. (2010) discovered a latency effect between the two groups, such that the N400 effect peaked 35 ms later in the children with SLI group compared to the TD group, in the word-elicited task. Haebig et al. (2018) found a main effect of condition indicating that mismatch trials elicited an increased amplitude for both groups compared to the match trials in the experiment. In addition, Weber-Fox et al. (2010) revealed a main effect of condition in the experimental condition of processing of verb-agreement violations. Similarly, Haebig et al. (2017) also found a main effect condition related to the semantic violation condition.

While Sabisch et al. (2006) did find a main effect of group, the researchers also found other important results related to sentence processing. The TD group showed the N400 effect while the SLI group did not, but both groups showed similar late positivity components. The SLI group late positivity was more broadly distributed compared to the TD group, and the researchers attribute that finding to children with SLI requiring more effort when performing judgement tasks.

P600 Results

The P600 effect was tested and analyzed in four articles. One of the four articles found both the children with SLI and the TD group displayed a P600 effect (Sabisch et al., 2009). Two of the articles found only the TD group to display a reliable P600 effect (Haebig et al., 2017,

Weber-Fox et al., 2010), while lastly, the remaining article found neither the children with SLI or TD group to display the P600 effect (Betz, 2006).

When examining which articles showed the main effect of group, two of the articles showed a statistically significant group difference (Haebig et al., 2017, Weber-Fox et al., 2010). Haebig et al. (2017) and Weber-Fox et al. (2010) both found that only the TD peers displayed a significant P600 effect while the children with SLI did not. The remaining two articles did not find a main effect of group (Betz, 2006, Sabish et al., 2009).

In Sabisch et al. (2009), other effects were still found. For all three time windows examined, Sabisch et al. (2009) found a main effect of condition. As for Betz (2006), there were no effects in either group, so no group differences occurred.

Left anterior negativity

Epstein et al. (2013), tested the left anterior negativity (LAN) between children with SLI and a TD group. Left anterior negativity is an additional way to mark the initial detection of morphosyntactic error around 500ms after, similar to the P600 effect. TD individuals are expected to show left anterior negativity after the stimulus is presented (Haebig et al., 2018). Epstein et al. (2013), predicted for both the children with SLI and TD group to show LAN, and that the amplitude of the children with SLI would be greater. Instead, the TD group showed anterior positivity, meaning there was an alternative type of processing with the questions. In addition, the SLI group showed a non-significant reduced anterior positivity. The results did not indicate a main effect of group for this experiment.

Table 1: Sources Information

Author	Sample size	Stimuli	Tested component	Results of group comparisons
(Betz, 2006)	SLI: 11 TD: 14	• Semantic controls vs. semantic anomalies. • Syntactic controls vs. overt finiteness errors. • Syntactic controls vs. omitted finiteness errors	N400 P600	(N400) • Neither TD group or SLI group showed N400 effect. • Did not find main effect of group. (P600) • Neither the TD group or SLI group showed P600 effect. • Did not find main effect of group.
(Cummings et al., 2010)	SLI: 16 TD: 16	Picture-sound matching design: pictures were presented with a word or environmental sound	N400	• Both TD group and SLI group showed N400 effect. • Did not find main effect of group.
(Epstein et al., 2013)	SLI: 13 TD: 17	Subject and object wh- questions	Left anterior negativity	• TD group showed anterior positivity. • Did not find main effect of group.

(Haebig et al., 2017)	SLI: 19 TD: 18	Sentence processing: each word that served as a control verb later served as a semantically anomalous verb in another sentence	N400 P600	(N400) • Both TD group and SLI group showed N400 effect. • Did not find main effect of group. (P600) • TD group showed P600 effect while SLI group did not. • Found main effect of group.
(Haebig et al., 2018)	SLI: 15 TD: 15	Mismatch paradigm with early emerging real words and their corresponding images	N400	• Both TD group and SLI group showed N400 effects. • Did not find main effect of group.
(Lorusso et al., 2015)	SLI: 12 TD: 15	Verb-object combinations in sentences: • congruent combinations of verb with concrete objects. • Congruent combinations of verbs with abstract object. • Incongruent combinations with implausible abstract object. • Incongruent combinations with implausible concrete object.	N400	• TD groups showed N400 effect while SLI group did not. • Found main effect of group

(Neville et al., 1993)	SLI: 16 TD: 16	Sentence processing: included either semantically appropriate word or semantically anomalous completion	N400	• SLI group showed significantly larger N400 effect compared to TD group. • Found main effect of group.
(Pijnacker et al., 2017)	SLI: 45 TD: 28	Sentence processing: semantically congruent sentences or semantically incongruent sentences from the final word	N400	• TD group showed an N400 effect while the SLI group did not. • Found main effect of group.
(Sabisch et al., 2006)	SLI: 16 TD:16	Sentence processing: either semantic violation or a correct condition	N400	• TD group showed an N400 effect while the SLI group did not. • Found main effect of group
(Sabisch et al., 2009)	SLI: 16 TD: 16	Sentence processing: sentences with syntactic or semantic constraints (altering prepositional phrases) and control sentences	P600	• Both TD group and SLI group showed P600 effects. • Did not find main effect of group.

(Weber-Fox et al., 2010)	SLI: 15 TD: 15	Sentence processing: a verb agreement violation sentence, a semantically unexpected verb, and control sentence	N400 P600	(N400) • Both TD group and SLI group showed N400 effect. • Did not find main effect of group. (P600) • TD group showed P600 effects while SLI group did not. • Found main effect of group.

Chapter 4

Discussion

There is not a clear pattern among the results of the reviewed articles when comparing the SLI and TD groups. For the N400 component, only four of the nine articles found a main effect of the group. For the P600 component, two of the four articles found a main effect of group. This leaves about half of the articles not discovering any statistically significant effects between the SLI group and their TD peers. These differences may be attributable to the variety of samples and stimuli used in the experiments.

P600

Only four of the articles included the P600 component and there are not clear patterns between the experiments. Weber-Fox et al. (2010) and Haebig et al. (2017) had similar outcomes. Both articles showed a main effect of group with only the TD group showing a significant P600 effect. The two articles used similar stimuli of sentences that included a semantically anomalous verb, and the participants were 15 years of age. In contrast, the results from Sabisch et al. (2009) showed both groups displaying a similar P600 effect. Sabisch et al. (2009) also had a similar set of stimuli compared to Weber-Fox et al. (2010) and Haebig et al. (2017), but the mean age of their sample was only 9;7 years old, which may be a factor that affected the results. As for Betz (2006), neither group displayed a P600 component. Betz (2006) originally expected the TD group to show a P600 effect. Betz (2006) was the only article that

used overt and omitted finiteness errors which may have caused different results compared to the other studies.

N400

Similar to the P600 component, the experiments did not yield a concrete pattern that elicited a N400 effect. Neville et al. (1993) was the only article that found a main effect of group by the SLI group showing an N400 component. The authors believed this occurred because the SLI group require more effort when integrating words into sentential contexts compared to their TD peers.

For the three articles that found a main effect of group through the TD group showing a N400 effect, Sabisch et al. (2006) and Pinjacker et al. (2017) had similar stimuli of a semantic violation in a sentence. Lorusso et al. (2015), who also found the same effect, had a much larger age range for their sample and a different task of verb-object combinations. Haebig et al. (2017) did not find a main effect of group and neither of the two groups displayed an N400 component. Researchers would have expected Haebig et al. (2017) to have a similar outcome to Sabisch et al. (2006) and Pinjacker et al. (2017) because Haebig et al. (2017) had similar semantically anomalous sentence processing tasks. Yet, Haebig et al. (2017) had a much larger age range in the sample, similar to Lorusso et al. (2015). This may have had an effect on the results. Cummings et al. (2010) and Haebig et al. (2018) had neither group show an N400 effect. Both of these articles used similar stimuli of matching pictures with words, which may have led to similar results.

Lastly, Betz (2006) and Weber-Fox et al. (2010) results showed neither group displayed an N400 component and these results were not expected. Weber-Fox et al. (2010) attributes this finding to the group differences that may have gone undetected due the background noise in the

waveforms. Betz (2006) noted both groups showed a P300 component rather than an N400 which could be viewed as a general response to the oddity of the task.

Call for research

There are multiple areas that researchers can examine more closely in the future. First, it may be helpful for future studies to insure uniformity in the ages of children being tested. For this review, the age of children broadly ranged from 4 to 15. As we age, our brain develops in different ways. During adolescence, which begins at about 10 years of age, children go through important emotional and cognitive changes. Specifically, there is a development of executive functions, cognitive processes control thoughts and behaviors, which then allow the individuals to flexibly adapt to new and complex situational tasks (Konrad, Firk, Uhlhaas, 2013). This shows why comparing a 4-year old's results to a 15-year old's results is not appropriate, due to the older children's different cognitive abilities.

In addition, all of the studies in this review were under 75 participants. Implementing a larger sample size may be needed to gain an overall better understanding of a true representative population including race, socioeconomic status, educational opportunities, and more. Lastly, a consistent set of stimuli among studies may yield an easier comparison of results between studies. For example, it may be inaccurate to compare Cummings et al. (2010) and Haebig et al. (2018) studies who both used picture matching stimuli compared to Haebig et al. (2017) who used semantically anomalous sentence tasks, even though they all found the same result.

Two possible research methods could be used to eliminate these factors among studies. One way is to have different researchers use a similar set of tasks, for example, sentences with semantically anomalous word versus a control sentence. The researchers could then test groups of different aged children with SLI to see how the ERP results change in one age group versus

another. A second possible research method is to have a narrowly defined age group of children with SLI and to test them on a variety of tasks, such as, both semantically anomalous sentences and a picture-matching design, to see how each task may show different ERP results.

To conclude, there is not a clear difference in the ERP patterns of children with SLI and their TD peers during sentence processing tasks. These results may be due to the differences among the samples and stimuli included in the studies. While this information does give some insight on brain processes during sentence tasks of some children with SLI, it is not the same for all children. This means using ERP patterns when initially diagnosing children with the disorder may not be an as accurate option to use. It is necessary to note that further research should be conducted to find (1) the relationship among ERP patterns and different age groups of children with SLI, (2) how they compare to their TD peers during semantic and syntactic tasks and (3) if these results are an indicator of SLI.

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ACADEMIC VITA

EMILY TECCO

EDUCATION

The Pennsylvania State University **University Park, PA**
Schreyer's Honor College
College of Health and Human Development *Class of May 2021*
Bachelor of Science Communication Sciences and Disorders

RESEARCH

NSSHLA Virtual Research Event **University Park, PA**
Presenter *November 18th, 2020*

- Developed and presented a research poster presentation based on thesis work
- Answered and elaborated on questions from staff and peers

Schreyer's Honors College **University Park, PA**
Thesis Work *January 2020-Present*

- Conducted a systematic literature review on children with specific language impairment and sentence processing
- Interpreted and analyzed EEG data from previous experiments and compared them

Child Language Development Laboratory **University Park, PA**
Lab Assistant *January 2019- Present*

- Collaborate with other lab assistants on results and analyze data during weekly meetings
- Assist at experiments and record data during live sessions

EXTRA-CURRICULARS

Teaching Assistant **University Park, PA**
Communication Sciences and Disorders *September 2019- May 2020*

- Collaborated individually with students taking Introduction to Audiology and Aural Rehabilitation
- Supervised and recorded key notes during classes

Phi Chi Theta Professional Business Fraternity **University Park, PA**
Active Member
September 2018-Present

- Practice professionalism, review resumes, mentor underclassmen, practice interviews

Penn State IFC/PanHellenic Dance Marathon (THON) **University Park, PA**
Special Interest Group (FOTO) *September 2017-Present*

- Passionately support children currently battling pediatric cancer through fundraising
- Help find a cure through raising money so one day no child will have to battle cancer

National Student Speech Language Hearing Association **University Park, PA**
Active Member *September 2017- Present*

- Participate in five hours of various service opportunities per semester
- Attend seminars/discussions regarding speech pathology, audiology, and bilingual education