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Morphosyntax Production of Preschool Children with Hearing Loss: An Evaluation of the Extended Optional Infinitive and Surface Accounts

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Abstract

Purpose: The first aim of this study was to explore differences in profiles of morphosyntax production of preschool children with hearing loss relative to age- and language-match comparison groups. The second aim was to explore the potential of extending two long-standing theoretical accounts of morphosyntax weakness in children with specific language impairment to preschool children with hearing loss.

Method: This study examined conversational language samples to describe the accuracy and type of inaccurate productions of Brown's grammatical morphemes in 18 preschool children with hearing loss as compared to an age-matched group (± 3 months, n = 18) and a language-matched group (± 1 raw score point on an expressive language subtest, n = 18). Age ranged from 45 to 62 months. Performance across groups was compared. Additionally, production accuracy of CHL on morphemes that varied by tense and duration were compared to assess the validity of extending theoretical accounts of children with specific language impairment to children with hearing loss.

Results: Children with hearing loss exhibited particular difficulty with morphosyntax relative to other aspects of language. Additionally, differences across groups on accuracy and type of inaccurate productions were observed. Finally, a unified approach to explaining morphosyntax weakness in children with hearing loss was more appropriate than a linguistic-only or perceptual-only approach.

Conclusions: Taken together, the findings of this study support a unified theoretical account of morphosyntax weakness in CHL in which both tense and duration of morphemes play a role in morphosyntax production accuracy, with a more robust role for tense than duration.

Children with hearing loss (CHL) are less proficient than their peers with normal hearing in many areas of expressive language (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007), similar to children with specific language impairment (SLI; Leonard, 2014). One area of language that leads to particular difficulty for both of these populations is expressive morphosyntax, or the production of grammatical morphemes. The present study explores expressive morphosyntax in preschool CHL who utilize amplification and spoken English relative to age- and language-matched peers with normal hearing and typical language acquisition.

Theoretical Explanations of Morphosyntax Errors of Preschool Children with SLI

The present study draws on two long-standing theoretical approaches to explaining English-language morphosyntax deficits in children with SLI and extends these approaches to evaluate their validity for CHL. These two theoretical approaches were selected for this study because of their focus on morphosyntax, which is known to be of particular difficulty for children with hearing loss who speak English. The search for a clinical marker of SLI led researchers to propose two theoretical explanations of the weaknesses in morphosyntax observed in children with SLI: the Extended Optional Infinitive Account (Rice, Wexler, & Cleave, 1995) and the Surface Account (Leonard, Eyer, Bedore, & Grela, 1997). These two theoretical approaches take divergent, but not mutually exclusive, perspectives. The Extended Optional Infinitive Account proposes a linguistic explanation of morphosyntax difficulty of children with SLI, and the Surface Account proposes a primarily perceptual explanation.

Extended Optional Infinitive Account. Rice et al. (1995) argued that SLI is a period of Extended Optional Infinitive, wherein children with SLI do not mark tense in obligatory contexts for a longer developmental period than is observed in children with typical language. That is, during the Extended Optional Infinitive stage, children with SLI continue to produce bare stem lexical verbs (e.g., I jump yesterday; She run) where inflected forms are required for the adult target (e.g., I jump*ed* yesterday; She run*s*). Most research in this area has focused on regular past tense and regular third person singular tense-marking. Empirical support for the Extended Optional Infinitive theoretical approach abounds. Many research groups have reported that tense marking represents a prolonged course of development for children with SLI, wherein children with SLI never fully attain the tense-marking accuracy of their peers with typical language (Bishop, 1994; Eyer & Leonard, 1994; Fletcher & Peters, 1984; Leonard, Caselli, Bortolini, McGregor, & Sabbadini, 1992; Marchman, Wulfeck, & Weismer, 1999; Rice et al., 1995; Rice, Wexler, & Hershberger, 1998).

By five years of age, children with typical language mark tense on lexical verbs with over 90% accuracy; in contrast, children with SLI average only about 30% accuracy (Rice & Wexler, 1996). Children with SLI also mark tense with less accuracy than younger children matched for language abilities, who average approximately 50 – 60% accuracy (Rice & Wexler, 1996), suggesting that the Extended Optional Infinitive stage for children with SLI does not represent merely a delay in language acquisition. Over time, the gap in tense marking accuracy between children with SLI and children with typical language narrows in spoken language (Marchman et al., 1999; Rice et al., 1998).. By age 8, children with SLI, though still less accurate than their peers with typical language, average approximately 89% accuracy (e.g., Rice et al., 1998). Werfel, Hendricks, and Schuele (2017) reported that when asked to mark tense in more complex language tasks, such as oral reading, however, the gap between SLI and typical language for older elementary students reemerges. Children with SLI were only 60% accurate at marking past tense in oral reading, compared to 92% accuracy for children with typical language; virtually all errors of children with SLI were bare stem productions. Likewise, older elementary and middle school students with SLI omit tense markers in written composition at a much higher rate than chronological-age peers (Windsor, Scott, & Street, 2000). Thus, it is clear that the Extended Optional Infinitive Account has widespread empirical support in the case of children with SLI.

Surface Account. Whereas the Extended Optional Infinitive Account proposes a linguistic (i.e., tense) basis of morphosyntax weakness in children with SLI, the Surface account proposes a largely perceptual one (Leonard et al., 1992; Leonard et al., 1997). That is, the difficulty in morphosyntax observed in young children with SLI can be attributed to a general perceptual processing limitation in SLI that is exacerbated by the general surface features, i.e., duration, of bound grammatical morphemes, rather than a linguistic-specific deficit in tense-marking bound morphemes. Bound morphemes are often single phonemes (e.g., /t/, /d/, /s/, /z/) or unstressed, unlengthened syllables (e.g., /əd/, /əz/). Most research in this area has focused on regular plural and possessive inflection, along with the previously described tense morphemes. Many research groups have reported that children with SLI exhibit more omissions of bound morphemes such as regular plural and possessive inflection than age- or language-matched peers (Bedore & Leonard, 1998; Conti-Ramsden, 2003; Leonard et al., 1992; Leonard et al., 1997; Oetting & Rice, 1993; Rice & Wexler, 1996).

In preschool, it is clear that the morphosyntax weakness of children with SLI is not limited to tense-marking morphemes. Children with SLI during this developmental period also exhibit lower accuracy than children with typical language on production of nontense bound morphemes. For example, preschool children with SLI are approximately 80 – 90% accurate at marking regular plural in spontaneous language, compared to 96 – 99% accuracy for their language- and age-matched peers with typical language, respectively (Leonard et al., 1997; Rice & Wexler, 1996). Likewise, children with SLI performed lower than age-matched peers on a noun composite score that included regular plural and possessive inflection (Bedore & Leonard, 1998).

Children with SLI in these three studies, however, also exhibited lower accuracy in marking bound tense morphemes than children with typical language. In fact, the accuracy rates on tense morphemes for children with SLI were much lower than for regular plural. Further, beyond the early preschool years, at least for regular plural, children with SLI do not differ in production accuracy from children with typical language; the accuracy on regular plural marking of children with SLI consistently exceeded 90% from age 5 (Rice et al., 1998).

When considered synchronously, then, both the Extended Optional Infinitive Account and the Surface Account appear to explain morphosyntax deficits in young, preschool children with SLI who speak English. These children with SLI exhibit lower accuracy rates than children with typical language in marking tense- and nontense-bound morphemes, supporting the Surface Account. However, marked differences emerge in the magnitude of group differences between tense- and nontense-bound morphemes, such that children with SLI mark tense morphemes at lower accuracy rates than nontense bound morphemes. Therefore, it appears that, at least early in English language acquisition, surface features such as duration of bound morphemes affect children's language production, and linguistic features such as tense engender additive difficulty in production of morphosyntax by children with SLI. Interestingly, cross-linguistic studies have revealed differing accuracies of the predictions of these two accounts across SLI in different types of languages (for a review, see Leonard, 2017).

Morphosyntax Weakness in Other Populations with Language Impairments

The current study focuses on morphosyntax weakness in CHL. Such a focus is motivated, in part, by the presence of morphosyntax weakness in other clinical populations other than SLI. This body of work has in particular sought to determine if the basis of development language disorders is the same across different clinical groups, and has important implications for clarifying the broader nature of language impairments (Rice, Warren, & Betz, 2005). The findings of these investigations across populations have indicated a broad morphosyntax deficit that is expressed in slightly different ways depending on the features of specific conditions. For example, children with Down syndrome experience more difficulty with morphosyntax than with vocabulary acquisition, but their specific patterns of morphosyntax deficits differed somewhat from those of children with SLI (Laws & Bishop, 2003). Laws and Bishop proposed that the strength in irregular past tense production of children with Down syndrome compared to children with SLI was linked to higher vocabulary abilities in Down syndrome relative to SLI. Additionally, children with autism who had co-morbid language impairment performed much more poorly on morphosyntax tasks than children with autism who did not have co-morbid language impairment (Roberts, Rice, & Tager-Flusberg, 2004).

Similar to children with Down syndrome, the specific types of morphosyntax deficits of children with autism differed from children with SLI; in the case of autism, these differences involved echolalic responses. This body of work motivates the current investigation of the specific nature of morphosyntax deficits in CHL. The investigation employs the framework of comparing one theoretical account linked to tense-marking that broadly explains morphosyntax deficits in language impairments and one account linked to speech perception, known to be a specific difficulty of CHL.

Morphosyntax Weakness in Children with Hearing Loss

Although limited research has been conducted in the area of expressive morphosyntax with CHL compared to children with SLI, there is some evidence of a similar gap in grammatical morpheme production between CHL and children with normal hearing. It is clear from these studies that morphosyntax production of CHL lags behind children with normal hearing (Svirsky, Stallings, Lento, Ying, & Leonard, 2002; Tomblin et al., 2015); however, few studies have measured morphosyntax in ways that allow for evaluation of the validity of the theoretical approaches of interest. Findings from a limited number of studies in this area alternately support the Extended Optional Infinitive and Surface Accounts for explaining the observed morphosyntax weaknesses in CHL.

First, Norbury, Bishop, and Briscoe (2001) evaluated tense marking in elementary school children with mild-to-moderate hearing loss. Their results indicated large group effects compared to age-matched peers on production of regular third person singular morphemes (Cohen's d = 0.88) and regular past tense morphemes (Cohen's d = 0.87). A comparison to language-matched children with normal hearing revealed a medium effect on production of regular third person singular morphemes (Cohen's d = 0.63) and no group effect on production of regular past tense morphemes (Cohen's d = 0.07). Findings from this study indicate that, like children with SLI, CHL appear to exhibit a period of Extended Optional Infinitive. Nontense morphemes were not addressed, so a concurrent evaluation of morphosyntax in light of the Surface Account is not possible.

Alternately, McGuckian and Henry (2007) extended the work of Norbury et al. (2001) to include comparisons of nontense morphemes in addition to tense morphemes of children with moderate hearing loss (aged 6 years, 7 months – 8 years, 5 months) relative to only a language-match control group (aged 2 years, 9 months – 3 years, 7 months; an age-matched group was not included). Two relevant findings emerged. First, relative to these very young preschool children, CHL exhibited lower accuracy on nontense morphemes but not tense morphemes. Second, CHL presented with a different order of accuracy in morpheme production than did the language-matched group. Specifically, possessive inflection represented the highest accuracy for children with typical language but the lowest accuracy for CHL. Findings from this study seem to lend more support to the Surface Account than the Extended Optional Infinitive Account for CHL.

Finally, work with children with profound hearing loss who utilize cochlear implants appears to support primarily the Surface Account for CHL. For example, Nicholas and Geers (2017) reported that breadth of bound grammatical morpheme use was associated with aided thresholds for preschool CHL who use cochlear implants. Further, it appears that the Surface Account may be valid for a longer developmental period in CHL than in children with SLI. That is, preschool children with normal hearing, including children with SLI, produce regular plurals with greater accuracy than copula verbs, but elementary school CHL have low accuracy across the two morphemes (Svirsky et al., 2002). This finding supports the idea that morphosyntax weakness of CHL is related to perceptual features of morphemes. It should additionally be noted that Svirsky et al. (2002) reported that past tense accuracy for CHL was much lower than regular plural accuracy, lending concurrent support to the Extended Optional Infinitive Account.

To summarize, findings of studies of morphosyntax production in CHL have been mixed when interpreted in light of the Extended Optional Infinitive and Surface Accounts of morphosyntax weakness. The two theoretical accounts lead to differing, but not mutually exclusive, predictions for morphosyntax production. First, the Extended Optional Infinitive Account would predict that tense morphemes would result in lower accuracy than nontense morphemes (Rice & Wexler, 1996; Rice et al., 1995). Second, the Surface Account would predict that short duration would result in lower accuracy for CHL than comparison groups (Leonard et al., 1992; Leonard et al., 1997). Limitations of these existing studies preclude conclusions about the validity of each theoretical perspective when applied to CHL. Study design weaknesses include addressing only one type of morpheme (Norbury et al., 2001), including only a language-matched comparison group (McGuckian & Henry, 2007), and including comparison groups not matched to the CHL (Svirsky et al., 2002). To more fully explore the validity of the Extended Optional Infinitive and Surface Accounts for preschool CHL, there is a need for research in the area of morphosyntax production for CHL that includes (a) tense and nontense morphemes and (b) age- and language-matched comparison groups.

The Present Study

The purpose of this study, therefore, was to examine the morphosyntax production of CHL in spontaneous language relative to age-matched and language-matching children with normal hearing. Several research questions were addressed. The first two questions were related to general morphosyntax production of CHL. The third research question was designed to directly address the validity of the Extended Optional Infinitive and Surface Accounts to explain morphosyntax weakness in CHL.

- Do CHL exhibit lower accuracy in productions of Brown's morphemes than CHN-AM and/or CNH-LM?
- Do CHL differ in types of errors of Brown's morpheme productions from CNH-AM and/or CNH-LM?
- Do CHL exhibit differential accuracy on tense bound morphemes and nontense bound morphemes?

Method

This study was approved by the University of South Carolina Institutional Review Board, and all participants' parents provided informed consent prior to study participation.

Participants

This study consisted of three groups: a group of preschool children with bilateral hearing loss (CHL), as well as two control groups of preschool children with normal hearing – an age-matched group (CNH-AM) and a language-matched group (CNH-LM).

Participants were recruited from preschools, speech-language pathology and audiology clinics, and social media groups across the United States.

CHL group. The CHL group consisted of 18 children with hearing loss who utilized amplification and were developing spoken language (mean age = 52.61 months; SD = 5.00; range 45 – 62). Nine CHL utilized bilateral hearing aids, five CHL utilized bilateral cochlear implants, two CHL were bimodal (one hearing aid, one cochlear implant), and two CHL utilized bone-anchored hearing aids. The CHL group contained three children with reported race of Black or African American and one child with reported race of Asian. Chi square analysis indicated that expressive language scores, measured by the *Test of Early Language Development – 3rd Edition* expressive subtest (Hresko, Reid, & Hammill, 1999) and by MLU in morphemes from spontaneous language samples, did not differ by amplification type (*p* >.05 for both). Level of hearing loss ranged from moderate to profound, and all participants had a confirmed diagnosis of permanent hearing loss by a certified audiologist. Children with mild hearing loss were not eligible to participate, because moderate hearing loss places the morphosyntax phonemes of interest (e.g., /s/ and /z/) outside the unaided audibility range for CHL. Average age at identification was 10.78 months (SD = 14.53; range = 0 – 36 months), and average age at amplification was 15.40 months (SD = 14.03; range = 1.5 – 42 months). All participants were enrolled in speech-language therapy at the time of study participation.

Age-matched control group. The first control group was an age-matched control group of children with normal hearing (CNH-AM). The 18 CHL described above each were matched with one CNH who was within 3 months chronological age. Mean age in months of the CNH-AM group was 50.61 (SD = 4.71; range = 45 – 61). The CHL and CNH-AM groups did not differ on age in months (p = .402). The CNH-AM group contained two children with reported race of Asian and one child with reported race of Native Hawaiian or other Pacific Islanders. All children in the CNH-AM group passed a bilateral hearing screening prior to study participation.

Language-matched control group. The second control group was a language-matched control group of children with normal hearing (CNH-LM). The 18 CHL described above each were matched with one CNH who scored within 1 raw score point on the *Test of Early Language Development – 3rd Edition* expressive subtest (Hresko, Reid, & Hammill, 1999). Additionally, average MLUm did not differ across the CHL and CNH-LM groups. Mean age in months of the CNH-LM group was 49.72 (SD = 4.10; range = 45 – 58). The CNH-LM group contained two children with reported race of Black or African American and one child with reported race of Asian. All children in the CNH-LM group passed a bilateral hearing screening prior to study participation.

All participants had nonverbal intelligence scores within or above the average range, as measured by the *Test of Nonverbal Intelligence – 4th Edition* (L. Brown, Sherbenou, & Johnsen, 2010), spoke English as their primary language, and had no diagnoses known to affect language or cognition (e.g., autism, Down syndrome) other than hearing loss for the CHL group. As shown in Table 1, the groups did not differ on maternal education or nonverbal intelligence, but differences were observed on omnibus language, as measured by the TELD-3 (Hresko et al., 1999). All children in the control groups scored within the average range on the Spoken Language Quotient of the TELD-3. Additionally, the groups did not differ by gender or racial distribution (p

= .926, .521, respectively). Children in all groups had English as the language spoken at home at least 75% of the time.

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Procedures

As part of a larger longitudinal study on early language and literacy acquisition in children with hearing loss (Werfel, 2017), participants completed measures of early language skills. Participants completed approximately two hours of individual testing in a private room at the author's lab or a local public library. The larger study measures were administered in a predetermined randomized order. Of interest here is one measure from the larger study: children's spontaneous language production.

Language sample elicitation procedures. The Hadley (1998) protocol was utilized to collect conversational language samples to measure children's spontaneous language production. The Hadley protocol was selected because interviews that contain expository and story retelling contexts for language samples elicit longer, more varied utterances and measure a greater range of linguistic capabilities than play-based language samples (Evans & Craig, 1992; Masterson & Kamhi, 1991). Picture support (e.g., photos of pets, movie characters) was used to scaffold children's ability to participate in the conversational language samples.

Each language sample lasted approximately 12 minutes (mean time = 12 minutes, 54 seconds, SD = 1 minute) and consisted of 3 blocks. For the first four minutes, the examiner elicited personal narratives about a birthday party or recent holiday and stories about his/her siblings or other family members. For the second four minutes, the examiner elicited expository explanations about how to care for a pet and how to play a favorite game. For the third four minutes, the examiner elicited narrative retells of favorite movies and/or favorite books. Length of language sample in time did not differ between groups (p = .643). Examiners audio and video recorded the language sample to allow for subsequent transcription of the dialogue.

Language sample transcription procedures. The language sample transcription procedures involved three steps. First, an undergraduate lab volunteer transcribed a first pass of the language sample. The purpose of the first pass transcription was to simply type out what was said during the interaction and to label each utterance with the appropriate speaker identifier. After the first pass, a second, more senior, lab member completed a second pass to check the accuracy of the first pass transcription, divide utterances appropriately, mark speaker overlap, and add gloss and comment lines to aid interpretation of the communicative interaction. Utterances were divided as described in Werfel and Douglas (2017). Finally, a third lab member – the author or a doctoral student in the lab, who both are certified speech-language pathologists, or a second-year speech-language pathology master's student who had completed coursework in language sample analysis completed the final transcription pass. During the final pass, the lab member ensured final transcription accuracy. If errors were discovered, the transcript was sent back to the second step for correction until consensus was established. Therefore, the final transcriptions represented 100% agreement.

All transcribers were trained prior to beginning transcription responsibilities. The training consisted of reading the lab's language sample transcription manual, transcribing an example language sample and comparing their transcription to the key, and following up with a senior lab member or the lab director to discuss consistent errors in their transcription. This process was repeated as needed to ensure transcription accuracy.

Language sample coding procedures. After the transcription process was finalized, each language sample was coded for Brown's 14 grammatical morphemes (Brown, 1973). Bound morphemes were slashed using predetermined codes. In addition to Brown's morphemes, contracted negation (e.g., not [can/n't]) and contracted verbs (e.g., have [we/'ve]) were slashed for purposes of calculating mean length of utterance. Free morphemes were coded in one of two ways. For free morphemes that have many exemplars (e.g., irregular past tense verbs), predetermined codes within square brackets were placed immediately following the exemplar. For free morphemes that occur as only those words (e.g., *in, the*), no special codes were used because they are easily searchable (see analysis below) as is. Omissions of bound morphemes, prepositions, and articles were marked with an asterisk. Other errors, including omission of free morphemes, were marked with an error code: [err]. Utterances were coded for obligatory context of Brown's morphemes in the adult target of an utterance in the case of child errors. For example, *I runned down the street* would be coded as *I runned [ptirr] [err] down the street*, because the adult target is *I ran down the street.* Figure 1 displays a summary of the coding scheme.

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A three-step process was utilized for grammatical morpheme coding. First, a trained lab member made a first pass of grammatical morpheme coding. Second, the author checked the coding. Third, any disagreements were resolved by consensus.

Thus, there was 100% agreement of the final coded transcripts. To ensure reliability of coding, 20% of the samples in each group were subjected to the same procedure performed by two additional lab members. In this process, the more senior member of the lab (a doctoral student) performed the first pass, and the more junior member (an undergraduate student) checked the coding. Again, disagreements were resolved by consensus, resulting in 100% agreement between the two lab members. The samples did not contain information about group membership. The final coded samples from each pair of coders was compared on an item-by-item basis for each grammatical morpheme code. There was 94% reliability overall between the two pairs of coders (range 89% - 98%). Reliability was 93% for the CHL group, 95% for the CNH-AM group, and 93% for the CNH-LM group.

Language sample analysis procedures. After the coding process was finalized, each transcript was analyzed using SALT 12 Research Software (Miller & Iglesias, 2012). The analysis set for each child consisted only of his/her complete and intelligible utterances; any utterance that was abandoned, interrupted, or contained at least one unintelligible word was excluded from analysis. The number of utterances in the analysis set did not differ across groups (p = .821).

First, the Standard Measures function was utilized to calculate mean length of utterance in morphemes (MLUm), number of different words (NDW), total number of words (TNW), length of sample - time, and length of sample – number of utterances. Next, the Explore function was utilized to search for each coded feature listed in Figure 1. Appendix A contains the Explore lists utilized to search for each code of interest.

Finally, the SALT Explore output was used to calculate four scores for each of Brown's morphemes: percent correct, number omitted, and number of errors.

Statistical analyses. Descriptive data were analyzed using a one-way analysis of variance (ANOVA) and follow-up Tukey tests. Because the data for research questions 1 and 2 did not meet assumptions of normality for one-way ANOVA, Kruskal-Wallis H tests were used to compare performance across the three groups. Mann Whitney U tests were used for follow-up comparisons. Data for research question 3 did not meet assumptions of normality for two-way repeated measures ANOVA; therefore, square root transformation was used.

Results

The purpose of this study was two-fold: first, to examine the morphosyntax production of CHL in spontaneous language relative to age-matched and language-matched children with normal hearing and second, to evaluate the validity of the Extended Optional Infinitive and Surface Accounts to explain morphosyntax weakness in CHL. Table 2 displays results of the Standard Measures calculated from the language samples. These follow-up tests indicated that CHL had lower MLUm than CNH-AM but did not differ from CNH-LM.

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To address the first research question, Kruskal Wallis H tests with each percent correct variable were conducted. Only morphemes for which at least 10 children in each group attempted productions were included in analysis; possessive inflection and uncontractible copula were excluded because fewer than 10 CHL attempted these structures. The follow-up Mann Whitney U tests indicated that CHL had lower percent correct than CNH-AM and CNH-LM on regular plural (*d* = 1.01, 0.95, respectively), regular past tense (*d* =1.43, 1.13, respectively), regular third person singular (*d* = 1.28, 0.69, respectively), and irregular third person singular (*d* = 1.08, 1.27). Table 3 displays results of this analysis. As a follow-up to the first research question, the relation of age of identification and age of amplification of CHL to percent correct on each morpheme was examined. Pearson correlations were not significant between these two demographic variables for any morpheme (p >.05).

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To address the second research question, Kruskal Wallis H tests were conducted on percent of omissions and errors for all morphemes on which the CHL had lower percent accuracy than the control groups. The purpose of this analysis was to characterize the types of productions that led to lower accuracy for CHL. The follow-up Mann Whitney U tests indicated that CHL omitted a higher percentage of the bound morphemes: regular plural (*d* = 0.94, 0.64), regular past tense (*d* = 1.53, 1.23), and regular third person singular (*d* = 1.38, 0.77) than CNH-AM and CNH-LM, respectively. Additionally, CHL had a higher percentage of errored productions of irregular third person singular (*d* = 1.31, 1.33) than both control groups. No other differences in types of inaccurate productions emerged. Table 4 displays results of this analysis.

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To address the third research question, a two-way repeated measures ANOVA with group (CHL, CNH-AM, CNH-LM) as the between-subjects factor and morpheme (regular third person singular, irregular third person singular, regular plural) as the within subjects factor was conducted. These morphemes were selected because (a) regular third person singular and regular plural are marked with identical perceptual features but represent differing linguistic features and (b) regular third person singular and irregular third person singular represent identical linguistic features but are marked with differing perceptual features. There were main effects of morpheme, F(2, 37) = 8.221, $p < .01$, $\eta_p^2 = .308$, and group, F(2,38) = 8.659, $p < .001$, $\eta_p^2 = .297$. Pairwise follow-up comparisons indicated that CHL were lower than both comparison groups (p = .001, .005 for CNH-AM and CNH-LM, respectively). Additionally, regular third person singular did not differ from irregular third person singular, but both were lower than regular plurals (see Figure 2). The interaction of morpheme and group was not significant (p = .105). These findings suggest that CHL exhibit lower accuracy on all three morphemes but do not differ in their patterns of morphosyntax production relative to children with normal hearing.

-----INSERT FIGURE 2 HERE-----

Discussion

This study evaluated morphosyntax production in CHL compared to age- and language-matched peers with normal hearing. It is noteworthy that the sample of CHL in this study did not differ from either control group on non-language demographic measures, including maternal education, nonverbal intelligence, gender, and racial minority composition. These similarities across groups represent an improvement over much previous research, most of which has not reported information on these variables (e.g., McGuckian & Henry, 2007; Svirsky et al., 2002; Tomblin et al., 2015). CHL presented with lower MLUm than age- but not language-matched peers. No other standard language sample analysis measure, such as number of different words, differed across groups. These findings indicate that CHL exhibit particular difficulty with morphosyntax relative to other aspects of language. Additionally, findings revealed differences across groups on accuracy and type of inaccurate productions. Finally, findings suggested that a unified theoretical approach to explaining morphosyntax weakness in CHL is more appropriate than a linguistic-only or perceptual-only approach; however, tense morphemes present greater difficulty relative to nontense morphemes, suggesting a stronger linguistic than perceptual component.

Accuracy

The first research question addressed the accuracy of expressive morphosyntax of CHL. Findings indicated that, generally, CHL differed from age-matched children with normal hearing on accurate production of bound morphemes but not free morphemes. Two exceptions to this pattern were observed. First, CHL differed from age-matched peers on all bound morphemes except for present progressive. This pattern of performance is similar to that which has been observed in children with SLI and children with typical language. Present progressive is the earliest developing morpheme in children with normal hearing (Brown, 1973), and the same appears to be true for CHL. Possessive inflection was excluded from analysis because too few CHL attempted at least one obligatory context for this morpheme; only 7 of the 18 CHL attempted possessive inflection (their mean accuracy was 43.29% compared to 82.48% for CNH-AM and 77.83% for CNH-LM). This difficulty with possessive inflection, evidenced in this study by low accuracy as well as low attempted productions, is consistent with previous morphosyntax research of CHL (McGuckian & Henry, 2007).

Additionally, CHL did not differ from age- or language-matched peers on any free morpheme, with the exception of irregular third person singular. For this tense morpheme, CHL performed substantially below both the age-matched and language-matched comparison groups. Many similarities on production of free morphemes were observed across groups. For example, CHL appear to produce articles, prepositions, irregular past tense verbs, and uncontractible copulas at accuracy levels that do not differ from their peers with normal hearing. This relative proficiency with free morphemes is also consistent with the previous work of McGuckian and Henry (2007).

Finally, CHL differed from CNH matched on expressive language on only two morphemes – regular past tense and irregular third person singular. Both of these morphemes mark tense, but they differ on duration. Regular past tense is marked with a single phoneme or unstressed syllable, whereas irregular third person singular is marked by a monosyllabic word. The language-match comparison appears to lend support to extending the Extended Optional Infinitive Account to CHL (Rice & Wexler, 1996; Rice et al., 1995).

Types of Inaccurate Productions

The second research question addressed the types of inaccurate morphosyntax productions of CHL. Findings generally suggested that, similar to children with normal hearing, inaccurate bound morpheme productions were overwhelmingly errors of omission (Leonard et al., 1992; Leonard et al., 1997; Rice & Wexler, 1996; Rice et al., 1998); errors of commission were rare across groups for bound morphemes. For four of the five morphemes on which CHL exhibited lower accuracy than comparison groups, errors of omission were more common that errors of commission. The exception to this was irregular third person singular, for which errors of commission were, unsurprisingly, more common than errors of omission. Overwhelmingly, these errors were productions of *have* for *has, do* for *does,* and *say* for *says.*

Theoretical Explanations of Morphosyntax in CHL

The final research question addressed the validity for CHL of two long-standing theoretical accounts of morphosyntax in SLI. To address this question, three bound morphemes were compared due to their differing linguistic and perceptual features. The regular plural morpheme represented –duration and –tense, the regular third person singular morpheme represented –duration and +tense, and the irregular third person singular morpheme represented +duration and +tense.

As previously described, the two theoretical accounts lead to differing, but not mutually exclusive, predictions. First, the Extended Optional Infinitive Account would predict that tense morphemes would result in lower accuracy than nontense morphemes (Rice & Wexler, 1996; Rice et al., 1995). Second, the Surface Account would predict that short duration would result in lower accuracy for CHL than comparison groups (Leonard et al., 1992; Leonard et al., 1997).

In this comparison, the CHL scored lower on both tense morphemes than regular plural. Consistent with Norbury et al. (2001), this finding supports the Extended Optional Infinitive Account of morphosyntax weakness for CHL, suggesting that tense presents particular difficulty in grammatical morpheme production for this population. Additionally, CHL scored lower than CNH-AM and CNH-LM on the nontense but short duration morpheme. Diverging from Norbury et al.'s conclusion that weak perceptual salience is not a factor in morphosyntax production in CHL, this finding in the present study suggests a role for perceptual features in morphosyntax weakness of CHL and supports the Surface Account. Norbury et al. included only mild-moderate hearing loss in their sample, and the average thresholds placed hearing acuity within the range that the bound morphemes of interest would be audible, even without amplification. This difference in the make-up of the hearing loss groups across the two studies may explain these discrepant findings.

Limitation and Future Directions

The primary limitation of the present study was that it characterized morphosyntax production of preschool CHL at one point in time. Future research should address the research questions posed herein with a longitudinal design to explore the acquisition of morphosyntax over time for CHL. Such work also would allow for further exploration of the validity of the Extended Optional Infinitive and Surface Accounts to explain morphosyntax weakness of CHL. Work that includes older CHL is particularly needed. Additionally, future work should address the present limitation of the number of opportunities each participant had to produce each grammatical morpheme of interest. Work that compares production in spontaneous language to production in elicited tasks is particularly warranted.

Implications

These findings have important implications for practitioners and researchers. For practitioners, the findings highlight the importance of monitoring the acquisition of morphosyntax in preschool CHL. The CHL in this study presented with greater than 80% accuracy, a common clinical benchmark, on only one grammatical morpheme – present progressive. In contrast their age-matched peers presented at below 80%

accuracy on only two grammatical morphemes – irregular past tense and uncontractible copula. The accuracy data for CHL reported herein can be used as guidelines for selecting a developmentally appropriate order of intervention targets. For example, it may be more effective to target regular plurals, at 70% accuracy, for CHL before targeting regular or irregular third person singular, both at approximately 40 – 45% accuracy.

For researchers, the findings represent the extension of two long-standing theoretical accounts of morphosyntax in SLI to explain morphosyntax weaknesses of a group of CHL relative to children with normal hearing. As has been reported previously in other areas of language (e.g., nonword repetition; Briscoe, Bishop, & Norbury, 2001), considering language production of CHL, for whom relatively little research has been reported, in light of findings from studies of children with SLI, for whom much research has been reported, appears to be a reasonable place to start. This work also highlights the importance of considering morphosyntax production of CHL relative to both age- and language-matched comparison groups and relative to both tense and nontense features. Previous research had largely focused on only one of these dimensions, making it difficult to draw comprehensive conclusions about morphosyntax production and weakness for CHL.

Taken together, the findings of the present study support a unified theoretical account of morphosyntax weakness in CHL in which both tense and duration of morphemes play a role in morphosyntax production accuracy. The findings further support the conclusion that tense plays a more substantial role than duration in explaining the morphosyntax weaknesses in CHL. Finally, these results are consistent with analyses of morphosyntax production in other clinical populations, pointing to a broadly-based tense-marking deficit that is universal across populations, as well as secondary population-specific deficits – in this case, speech perception-based deficits for CHL.

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References

Bedore, L., & Leonard, L. (1998). Specific language impairment and grammatical morphology: A disciminant function. *Journal of Speech, Language, and Hearing Research, 41*, 1185-1192. doi:10.1044/jslhr.4105.1185

Bishop, D. (1994). Grammatical errors in specific language impairment: Competence or performance limitations? *Applied Psycholinguistics, 15*, 507-550. doi:10.1017/S0142716400006895

Briscoe, J., Bishop, D., & Norbury, C. (2001). Phonological processing, language, and literacy: A comparison of children with mild-to-moderate sensorineural hearing loss and those with specific language impairment. *Journal of Child Psychology and Psychiatry, 42*, 329-340. doi:10.1111/1469-7610.00726

Brown, L., Sherbenou, R., & Johnsen, S. (2010). *Test of Nonverbal Intelligence* (4th ed.). Austin, TX: Pro-Ed.

Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.

Conti-Ramsden, G. (2003). Processing and linguistic markers in young children with specific language impairment (SLI). *Journal of Speech, Language, and Hearing Research, 46*, 1029-1037.

Evans, J., & Craig, H. (1992). Language sample collection and analysis: Interview compared to free play assessment contexts. *Journal of Speech and Hearing Research, 35*, 343-353.

Eyer, J., & Leonard, L. (1994). Learning past tense morphology with specific language impairment: a case study. *Child Language Teaching and Therapy, 10*, 127-138. doi:10.1177/026565909401000201

Fletcher, P., & Peters, J. (1984). Characterizing language impairment in children: An exploratory study. *Language Testing, 1*, 33-49. doi:10.1177/026553228400100104

Hadley, P. (1998). Language sampling protocols for eliciting text-level discourse. *Language, Speech, & Hearing Services in Schools, 29*, 132-147. doi:10.1044/0161-1461.2903.132

Hresko, W., Reid, D., & Hammill, D. (1999). *Test of Early Language Development* (3rd ed.). Austin, TX: ProEd.

Laws, G., & Bishop, D. (2003). A comparison of language abilities in adolescents with Down syndrome and children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 46*, 1324-1339. doi:10.1044/1092-4388(2003/103)

Leonard, L. (2014). *Children with specific language impairment* (2nd ed.). Cambridge, MA: MIT Press.

Leonard, L., Caselli, M. C., Bortolini, U., McGregor, K., & Sabbadini, L. (1992). Morphological deficits in children with specific language impairment: The status of features in the underlying grammar. *Language Acquisition, 2*, 151-179. doi:10.1207/s15327817la0202_2

Leonard, L., Eyer, J., Bedore, L., & Grela, B. (1997). Three accounts of the grammatical morpheme difficulties of English-speaking children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 40*, 741-753. doi:10.1044/jslhr.4004.741

Marchman, V., Wulfeck, B., & Weismer, S. (1999). Morphological productivity in children with normal language and SLI: A study of English past tense. *Journal of Speech, Language, and Hearing Research, 42*, 206-219.

Masterson, J., & Kamhi, A. (1991). The effects of sampling conditions on sentence production in normal, reading-disabled, and language-learning disabled children. *Journal of Speech and Hearing Research, 34*, 549-558.

McGuckian, M., & Henry, A. (2007). The grammatical morpheme deficit in moderate hearing impairment. *International Journal of Language and Communication Disorders, 42*(S1), 17-36. doi:10.1080/13682820601171555

Miller, J., & Iglesias, A. (2012). Systematic analysis of language transcripts (SALT), Research Version 2012. Madison, WI: SALT Software.

Moeller, M. P., Tomblin, J. B., Yoshinaga-Itano, C., Connor, C. M., & Jerger, S. (2007). Current state of knowledge: Language and literacy of children with hearing impairment. *Ear & Hearing, 28*, 740-753. doi:10.1097/AUD.0b013e318157f07f

Nicholas, J., & Geers, A. (2017). Sensitivity of expressive linguistic domains to surgery age and audibility of speech in preschoolers with cochlear implants. *Cochlear Implants International, Online First*, 1-12. doi:10.1080/14670100.2017.1380114

Norbury, C., Bishop, D., & Briscoe, J. (2001). Production of English finite verb morphology: A comparison of SLI and mild-moderate hearing impairment. *Journal of Speech, Language, and Hearing Research, 44*, 165-178. doi:10.1044/1092-4388(2001/015)

Oetting, J., & Rice, M. (1993). Plural acquisition in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 36*, 1236-1248. doi:10.1044/jshr.3606.1236

Rice, M., Warren, S., & Betz, S. (2005). Language symptoms of developmental language disorders: An overview of autism, Down syndrome, fragile X, specific language impairment, and Williams syndrome. *Applied Psycholinguistics, 26*, 7-27. doi:10.1017.S0142716405050034

Rice, M., & Wexler, K. (1996). Toward tense as a clinical marker of specific language impairment in English-speaking children. *Journal of Speech and Hearing Research, 39*, 1239-1257.

Rice, M., Wexler, K., & Cleave, P. (1995). Specific language impairment as a period of Extended Optional Infinitive. *Journal of Speech and Hearing Research, 38*, 850-863.

Rice, M., Wexler, K., & Hershberger, S. (1998). Tense over time: The longitudinal course of tense acquisition in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 41*, 1412-1431.

Roberts, J., Rice, M., & Tager-Flusberg, H. (2004). Tense marking in children with autism. *Applied Psycholinguistics, 25*, 429-448. doi:10.1017.S0142716404001201

Svirsky, M., Stallings, L., Lento, C., Ying, E., & Leonard, L. (2002). Grammatical morphologic development in pediatric cochlear implant users may be affected by the perceptual prominence of the relevant markers. *Annals of Otology, Rhinology, & Laryngology, 111*, 109-112.

Tomblin, J. B., Harrison, M., Ambrose, S., Walker, E., Oleson, J., & Moeller, M. P. (2015). Language outcomes in young children with mild to severe hearing loss. *Ear & Hearing, 36*, 76S-91S. doi:10.1097/AUD.0000000000000219

Werfel, K. (2017). Emergent literacy skills in preschool children with hearing loss who use spoken language: Initial findings from the ELLA study. *Language, Speech, & Hearing Services in Schools, 48*, 249-259. doi:10.1044/2017_LSHSS-17-0023

Werfel, K., & Douglas, M. (2017). Are we slipping them through the cracks? The insufficiency of norm-referenced assessments for identifying language weaknesses in children with hearing loss. *ASHA Perspectives: SIG 9 Hearing and Hearing Disorders in Childhood*, Manuscript in press.

Werfel, K., Hendricks, A., & Schuele, C. M. (2017). The potential of past tense marking in oral reading as a clinical marker of SLI in school-age children. *Journal of Speech, Language, and Hearing Research*, Manuscript in press.

Windsor, J., Scott, C., & Street, C. (2000). Verb and noun morphology in spoken and written language of children with language learning disabilities. *Journal of Speech, Language, and Hearing Research, 43*, 1322-1336.

Table 1.

Demographic Information by Group

Construct	CHL (n = 18) Mean (SD) min - max	CNH-AM (n = 18) Mean (SD) min - max	CNH-LM (n = 18) Mean (SD) min - max	*p*
Age (months)	52.61 (5.00)	50.61 (4.71)	49.72 (4.10)	.168
	45 - 62	45 - 61	45 - 58	
Maternal Education	16.31 (2.99)	16.53 (2.27)	16.25 (2.93)	.951
(years)	12 - 22	12 - 21	12 - 22	
Nonverbal IQ	112.39 (12.56)	113.50 (9.76)	112.71 (11.59)	.955
	95 - 137	93 - 131	93 - 131	
Omnibus Language [a]	98.72 (19.46)	112.50 (11.77)	104.83 (15.35)	.040
	61 - 125	88 - 130	77 - 130	
Gender	10 boys	11 boys	11 boys	.926
Percent Non-White	22%	18%	19%	.521

Note: CHL = children with hearing loss; CNH-AM = children with normal hearing-age match group; CNH-LM = children with normal hearing-language match group. [a]CHL differed from CNH-AM but not CNH-LM. *p* values represent ANOVA significance

Table 2.

Language Sample Standard Measures by Group

Construct	CHL (n = 18) Mean (SD) min – max	CNH-AM (n = 18) Mean (SD) min – max	CNH-LM (n = 18) Mean (SD) min – max	*p*
MLUm[a]	4.37 (1.64)	5.82 (1.41)	5.22 (1.57)	.025
	2.21 – 8.29	3.36 – 8.94	3.01 – 8.94	
NDW	146.44 (46.22)	183.50 (40.51)	170.33 (53.15)	.065
	76 - 238	121 - 258	76 - 276	
TNW	413.22 (194.09)	525.89 (158.80)	497.72 (198.84)	.174
	144 - 885	264 - 844	211 - 877	
Length - Time	13.07 (0.72)	12.76 (0.93)	12.92 (1.28)	.643
	12.17 – 14.47	11.75 – 15.23	11.75 – 16.53	
Length –Utterances	99.00 (24.14)	98.78 (16.79)	103.06 (26.85)	.821
	47 - 144	64 - 128	64 - 161	

Note: CHL = children with hearing loss; CNH-AM = children with normal hearing-age match group; CNH-LM = children with normal hearing-language match group. [a]CHL differed from CNH-AM but not CNH-LM.

Table 3.

Percent Correct Productions of Brown's Morphemes by Group

Construct	CHL Mean (SD) min – max	CNH-AM Mean (SD) min – max	CNH-LM Mean (SD) min – max	*p*
Present Progressive	100.00 (0.00) --	93.06 (16.12) 50 – 100	95.59 (13.22) 50 – 100	.258
Regular Plural[a]	68.35 (38.54) 0 – 100	96.24 (7.41) 75 – 100	91.06 (23.94) 0 – 100	.014
Regular Past Tense[a]	37.58 (39.04) 44 – 100	83.47 (23.17) 40 – 100	77.44 (31.13) 0 – 100	.003
Regular Third Person Singular[a]	41.53 (34.94) 0 – 86	80.61 (25.42) 0 – 100	66.33 (37.12) 0 – 100	.006
Preposition *in*	83.64 (28.40) 25 – 100	90.39 (23.95) 0 – 100	94.12 (24.25) 0 – 100	.152
Preposition *on*	84.79 (29.24) 0 – 100	91.87 (15.02) 50 – 100	94.44 (13.73) 50 – 100	.514
Articles	87.30 (20.04) 44 – 100	92.17 (19.11) 17 -100	87.46 (22.47) 17 – 100	.108
Irregular Past Tense	63.48 (27.19) 0 – 100	76.57 (26.84) 0 – 100	78.76 (25.52) 0 – 100	.162
Irregular Third Person Singular[a]	44.27 (45.00) 0 – 100	82.48 (22.35) 50 – 100	88.01 (19.11) 50 – 100	.013
Contractible Copula	73.11 (26.19) 21 – 100	88.61 (17.76) 28 – 100	88.45 (19.23) 30 – 100	.066
Uncontractible Copula	71.79 (36.89) 0 – 100	79.65 (23.95) 0 – 100	80.81 (33.16) 0 – 100	.492
Contractible Auxiliary	55.55 (44.52) 0 – 100	86.86 (25.11) 25 – 100	80.53 (25.56) 25 – 100	.098

Note: CHL = children with hearing loss; CNH-AM = children with normal hearing-age match group; CNH-LM = children with normal hearing-language match group. [a] CHL differed from both control groups.

Table 4.

Omission and Error Percent of Brown's Morphemes of Lower CHL Accuracy by Group

Construct		**CHL Mean (SD) min – max**	**CNH-AM Mean (SD) min – max**	**CNH-LM Mean (SD) min – max**	***p***
Regular Plural	Omission[a]	29.47 (38.51) 0 - 100	3.54 (7.23) 0 – 25.00	8.95 (23.94) 0 - 100	.010
	Error	0.42 (1.73) 0 – 7.14	0.00 (0.00) --	0.00 (0.00) --	.347
Regular Past Tense	Omission[a]	62.46 (39.00) 0 - 100	14.51 (21.22) 0 – 55.56	18.68 (30.54) 0 - 100	.003
	Error	0.00 (0.00) --	2.00 (5.61) 0 – 20.00	3.85 (13.87) 0 – 50.00	.452
Regular Third Person Singular	Omission[a]	60.46 (36.70) 14.29 - 100	16.92 (25.57) 0 - 100	31.62 (37.91) 0 - 100	.002
	Error	0.57 (2.27) 0 – 9.09	1.78 (4.13) 0 – 12.50	1.25 (3.66) 0 – 12.50	.606
Irregular Third Person Singular	Omission	2.08 (8.33) 0 – 33.33	8.33 (15.21) 0 – 50.00	3.57 (13.36) 0 – 50.00	.147
	Error[a]	53.65 (45.23) 0 - 100	9.19 (16.49) 0 – 50.00	8.42 (15.85) 0 – 50.00	.004

Note: CHL = children with hearing loss; CNH-AM = children with normal hearing-age match group; CNH-LM = children with normal hearing-language match group. [a]CHL differed from CNH-AM and CNH-LM.

Morpheme	Code	Example
Bound Morphemes		
Present Progressive	/ing	They/'re [conaux] **come/ing** tomorrow.
Regular Plural	/s	I still like **movie/s**.
Possessive Inflection	/z	My **cat/z** name is Sassy.
Regular Past Tense	/ed	I **watch/ed** it before.
Regular Third Person Singular	/3s	He **dive/3s** in the ocean.
Free Morphemes		
Preposition *in*	in	He dive/3s **in** the ocean.
Preposition *on*	on	It/'s [concop] **on** the ground.
Articles	a an the	**a** flower. I want **an** octopus. You kick **the** ball.
Irregular Past Tense	[ptirr]	I **saw [ptirr]** that.
Irregular Third Person Singular	[3irr]	He **says** hello.
Contractible Copula	[concop]	I **am [concop]** not in a grade yet.
Uncontractible Copula	[unconcop]	It **was [unconcop]** my dad/z house.
Contractible Auxiliary	[conaux]	They/**'re [conaux]** come/ing tomorrow.
Uncontractible Auxiliary	[unconaux]	We **were [unconaux]** hope/ing for snow.

Figure 1. Coding Scheme for Brown's Grammatical Morphemes

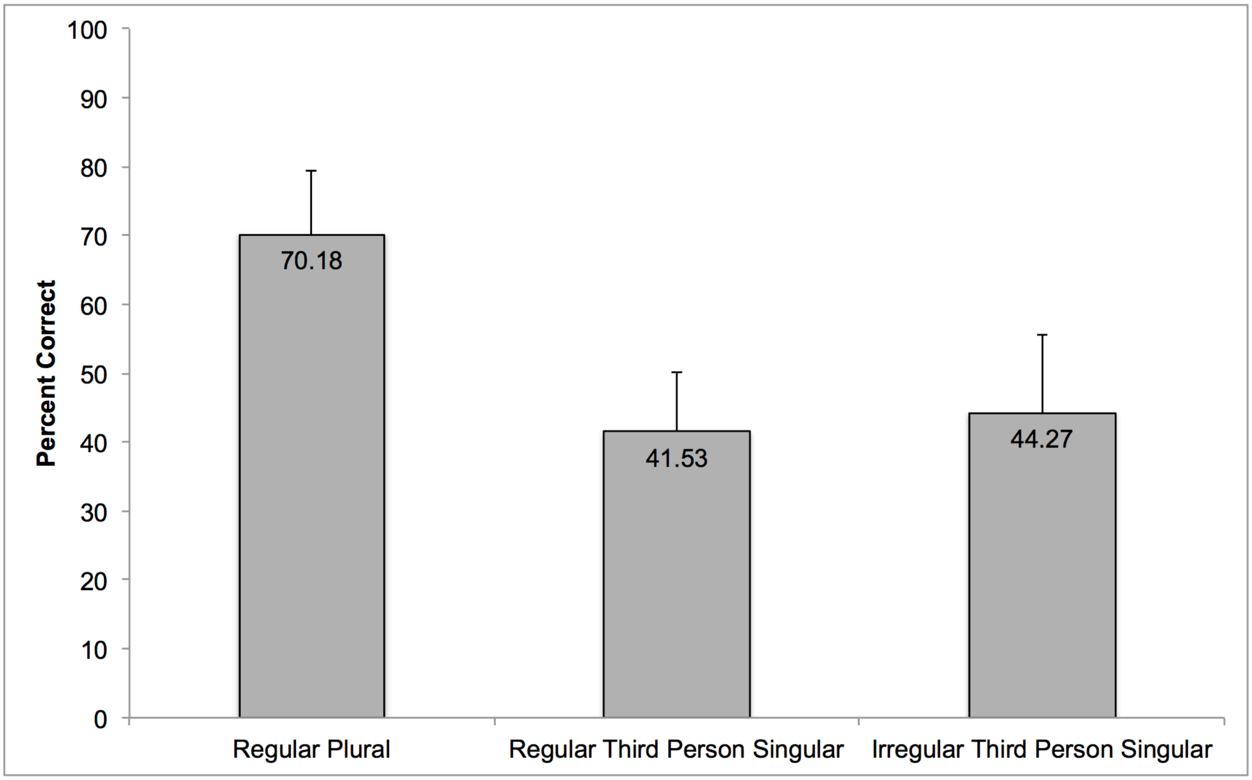

Figure 2. Percent Correct of CHL on Tense versus Nontense Morphemes

Appendix A

SALT Explore List Used in Study Analysis

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[ptirr]
[concop]
[unconcop]
[conaux]
[unconaux]
[err]