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Research Article

Changing the Subject: The Place of Revisions in Grammatical Development

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Purpose: This article focuses on toddlers' revisions of the sentence subject and tests the hypothesis that subject diversity (i.e., the number of different subjects produced) increases the probability of subject revision.
Method: One-hour language samples were collected from 61 children (32 girls) at 27 months. Spontaneously produced, active declarative sentences (ADSs) were analyzed for subject diversity and the presence of subject revision and repetition. The number of different words produced, mean length of utterance, tense/agreement productivity score, and the number of ADSs were also measured.
Results: Regression analyses were performed with revision and repetition as the dependent variables. Subject diversity significantly predicted the probability of revision, whereas the number of ADSs predicted the probability of repetition.
Conclusion: The results support the hypothesis that subject diversity increases the probability of subject revision. It is proposed that lexical diversity within specific syntactic positions is the primary mechanism whereby revision rates increase with grammatical development. The results underscore the need to differentiate repetition from revision in the classification of disfluencies.

Sentence production often appears effortless and automatic for adults. However, phenomena such as tip of the tongue (Brown & McNeill, 1966; Burke, MacKay, Worthley, & Wade, 1991), lexical exchanges, and morpheme stranding (García-Albea, Del Viso, & Igoa, 1989; Garrett, 1975) reveal that sentence formulation or production is a multileveled, multiphasic process. Syntactic frames are independent of content words such as nouns and verbs (Bock & Levelt, 2002; Levelt, 1989, 1999). The process of integrating words into a syntactic frame is called grammatical encoding.

We also know that sentence production develops. Initially, much of what children say is based on memorized rote combinations and item-specific formulae (MacWhinney, 1982). Rispoli and Hadley (2011) called this mode of production "direct activation" and hypothesized that children shift from direct activation to grammatical encoding between the second and third birthdays. Supporting evidence for this transition can be seen when two types of disfluency are differentiated: stalls and revisions (Rispoli, 2003; Rispoli, Hadley, & Holt, 2008). Stalls are repetitions and filled or silent pauses that occur after a speaker has begun to articulate the words of a sentence. However, stalls do not alter the choice of morphemes originally planned for the sentence. Revisions, on the other hand, replace a speaker's choice in a sentence with an alternative. It is easy to overlook a revision, because the actual alteration is often accompanied by pause and/or repetition. For this reason, much research has lumped stall and revision together under the term "maze" (Loban, 1976). This is unfortunate, for evidence indicates that stalls and revisions are qualitatively different.

Previous research has linked revision, but not stalls, to general measures of grammatical development. Rispoli (2003) showed in a cross section of 56 toddlers, 22–48 months old, that the rate at which sentences were stalled was unrelated to age, mean length of utterance (MLU; Brown, 1973), or Index of Productive Syntax (IPSyn) score (Scarborough, 1990). In stark contrast, the rate at which sentences were revised was indeed related to MLU and IPSyn, indicating that only revisions were related to differences in grammatical development. Longitudinal data provide converging evidence. Rispoli et al. (2008) studied the sentence production of 20 toddlers from 21 to 33 months old. They found significant individual differences among children in the percentage of active declarative sentences (ADSs) with stalls at 27 months old but no systematic pattern of developmental change in the percentage of stalled sentences with age. The average stall percentage for the group remained steady at approximately 9.5% of ADSs,

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but the stall percentage increased for some children, decreased for other children, and stayed essentially the same for still others. In marked contrast, the average percentage of ADSs with revisions was approximately 1% at 27 months old, with no significant individual differences among children. Moreover, a significant linear increase was observed for the group as a whole, from 1% at 27 months old to approximately 4% at 33 months old. In summary, the evidence indicates that stalls are unrelated to grammatical development and may reflect random characteristics of an individual's sentence production, whereas revisions reflect a general characteristic of developmental change in sentence production.

Revision reveals a difference between the syntactic frame a speaker is producing and the morpheme alternatives that can fill positions in that frame. In essence, when a speaker revises, morpheme options must be available. Consider the examples in 1(a)–(c) from three children at 27 months old.

1. (a) (can you have) can you go to sleep? (11B)[1]
   (b) I can't get the baby (off) out. (30B)
   (c) (he) she eat apple. (21B)

In each example, we see that one member of a lexical category is replaced by another without alteration of syntactic structure. In 1(a), the verb *have* is replaced by the verb *go*; in 1(b), the verb particle *off* is replaced by the verb particle *out*; and, in 1(c), the subject pronoun *he* is replaced by the subject pronoun *she*. To revise, a pool of lexical candidates must be available to the speaker, such that the speaker can use other members of the pool to replace the word that was originally produced without alteration of the syntactic structure. These revisions reveal the presence of framelike syntactic structure and substitutable alternatives within a lexical category. In other words, revisions reveal something about the grammar. Toddlers who revise are producing language with a difference between syntactic structures and the morphemes that can be placed in these structures. Revisions such as 1(a)–(c) are indicators of syntactic development.

An important trend in language development is the ever increasing lexical diversity a child exhibits within the bipartite "subject + predicate" clause structure (Lieven, Salomo, & Tomasello, 2009; Pine & Lieven, 1993). Lexical flexibility of syntactic structure is precisely what is needed for the revisions presented in 1(a)–(c). Therefore, it seems highly likely that an increase in the lexical flexibility of syntactic structure may explain the developmental trend in revision rate observed in the third year of life (Rispoli, 2003; Rispoli et al., 2008). Let us for the moment accept the logic that revisions reveal syntactic structure frames containing positions for lexical categories whose members are syntactically equivalent. Then, observing a subject revision would provide us with important information about the status of subject in a child's syntax as it is used in sentence production. Specifically, it would tell us that lexical items can be substituted for one another within the subject position and that these alternatives are syntactic equivalents. Moreover, until the child produces a diverse range of pronouns and nouns in the subject position of his or her sentences, we should not expect to observe a subject revision in a child's sentence production, because revising presupposes a candidate pool of syntactically equivalent words.

As clause structure becomes more flexible, all lexical categories in clause structure can become the sites of revision. However, subject revisions may be easier to observe than revisions in other parts of clause structure. This is because the subjects of declarative sentences are clause initial and disfluencies decrease in frequency as articulation moves onward into the sentence (Rispoli, 2003). The initial position of the subject may force the toddler's sentence production to commit early to a choice of subject (Clark & Wasow, 1998) and consequently increase the risk of altering that choice later on, before the sentence has been fully produced. Although this hypothesis has not been proven, it provides a starting point for a developmental investigation of revision that is limited to a specific position in clause structure.

Subject revision is taken to be an outward manifestation of internal grammatical knowledge, specifically the representation of a subject constituent distinct from the predicate in clause structure, a constituent that contains a node for the lexical categories of pronoun and noun. Accordingly, the purpose of this article was to test the hypothesis that lexical diversity in one critical position in clause structure, the sentence subject, predicts whether subjects can be revised by the child. It is predicted that the revision of sentence subjects in a language sample will be positively related to the diversity of subjects produced by the child. It is predicted that this relationship is not reducible to the general aspects of linguistic development, utterance length, and vocabulary size as well as specific aspects of morphosyntactic development such as growth in tense or agreement. The specificity of this prediction is important. The prediction differentiates between the opportunity to revise and the probability of revision. The opportunity to revise arises whenever a subject is produced, but the probability should rise with the diversity of those subjects. Thus, mere recycling of the same subject (e.g., *I want, I need, I get*) should not increase the probability of revision. A corollary to this prediction is that the repetition of the subject should be unrelated to subject diversity. Repetition does not constitute an alteration of morpheme selection. Therefore, repetition is not dependent on having morpheme alternatives for a given syntactic position.

The specific investigative approach of the current study uses language samples from a large database of children all at the same age, 27 months. This is the age that prior longitudinal research has pinpointed as the emergence of revision in ADSs (Rispoli et al., 2008). From these

[1]Child participants in the Champaign cohort are designated by a serial number followed by either B (boy) or G (girl). Child participants in the DeKalb cohort are designated M (male) or F (female) followed by a serial number.

samples, subject diversity (i.e., the number of different subjects) of the child's ADSs is used to predict whether the child produces a subject revision at some point during the language sample. At the same time, subject diversity is expected to be unrelated to the presence of subject repetition in the language sample.

Method

Database

The current study is based on a secondary data analysis of two longitudinal cohorts used previously in studies of language development conducted in DeKalb-Sycamore (DeKalb) and Urbana-Champaign (Champaign). Details of participant recruitment, data collection, and transcription procedures for the DeKalb cohort can be found in Rispoli et al. (2008) and Rispoli, Hadley, and Holt (2009, 2012). Note that Rispoli et al. (2008) treated general ADS revision and stall rates longitudinally, whereas the current study uses data from the DeKalb cohort from a single time point (27 months) and focuses solely on subject revision. For details of participant recruitment, data collection, and transcription procedures of the Champaign study, the reader is directed to Hadley, Rispoli, Holt, Fitzgerald, and Bahnsen (2014).

The two cohorts were combined for this study, because the dependent variables, subject revision and repetition, were presumed to be rare. Recall that, at 27 months old, 1% of ADSs were found to be revised, but the rate of subject revision was unknown. Similar procedures for the transcription of disfluency were used in both the DeKalb and Champaign cohorts. Therefore, it was considered advantageous to combine all of the typically developing children from both cohorts.

Participants

The participants were 61 children (32 girls, 29 boys) at 27 months old. The parents of all prospective participants were initially interviewed by telephone when their children were between 18 and 21 months old. During the interview, screening questions were asked concerning the child's medical and developmental history to determine if children were developing typically. Parents were asked if the child was born preterm, had any neurological disorders, had hearing loss or excessive otitis media leading to the insertion of pressure equalizing tubes, or had a health event that had led to hospitalization. The parent was also asked whether the child began walking or talking after 15 months old and had a spoken vocabulary of at least 10 words by 18 months old. Only parents who answered all questions as indicating typical development and affirmed that the nuclear family members were native monolingual speakers of English were invited to participate.

During the course of the longitudinal studies, all parents filled out the MacArthur–Bates Communicative Development Inventory: Words and Sentences (Fenson et al., 2007) when their children reached 30 months old. Children were selected for the current study if parents reported MacArthur–Bates Communicative Development Inventory scores for their children exceeding the 10th percentile. Of the 61 children, 52 were White, five were Black, and four were biracial (three White/Black and one White/Asian). With regard to socioeconomic status (SES), data on the level of maternal education were collected for the Champaign cohort, but not for the DeKalb cohort. Twelve of the mothers in the Champaign cohort had attained graduate degrees, 21 had attained bachelor's degrees, seven had attended college for fewer than 4 years, and two completed high school but did not attend college.

Procedure

Language Samples

Children and their parents interacted in a playroom with a standard set of toys that included a kitchen table with plates and utensils, a Fisher-Price family and playground (DeKalb) or farm (Champaign), and other toys depicting popular movie and television characters. Children and their parents were told to "have fun and play as you would at home." Language samples for the DeKalb cohort were based on 60 min of parent–toddler play. Language samples for the Champaign cohort were divided into two 30-min sampling contexts. The first 30 min were based on parent–toddler play. In the second 30 min, a research assistant (RA) joined the parent–toddler dyad as a conversation partner. The introduction of the conversation partner was designed to increase the opportunities children had to produce tense and agreement morphemes.

Transcription

Digital recordings of all language samples were transcribed by student RAs trained in child language transcription. Transcribers were trained for approximately 20 hr and were required to complete three consecutive training transcripts of 80% morpheme-by-morpheme reliability. Initial transcription was performed within 2 weeks of recording and, whenever possible, by an RA who was present at data collection. Systematic Analysis of Language Transcription (SALT; Miller & Iglesias, 2012) software and conventions were used for transcription. Handwritten context notes augmented the audio recordings of the DeKalb cohort. Video recordings augmented the transcription of the Champaign cohort. Transcribers were instructed to listen to an utterance three times. If the utterance or part of the utterance remained unintelligible after three listening passes, the utterance or parts of the utterance were deemed unintelligible. Transcribers were also responsible for transcribing mazes and false starts. Mazes are sentence disfluencies offset by parentheses in SALT format. False starts or "abandoned utterances" are incomplete beginnings of structured utterances that are not completed by the child but immediately followed by a new utterance. If the false start was followed in less than 3 full s, transcribers were instructed to make the false starts into mazes with the following child utterance. Transcribers were instructed to listen to these disfluencies

no more than three times. If the words in a maze were not understood after three listens, they were to be transcribed as unintelligible.

Transcript Reliability

After the initial transcription, all transcripts underwent an additional listening pass by a second RA to provide consensus reliability (cf. Eisenberg, Guo, & Germezia, 2012; Shriberg, Kwiatkowski, & Hoffman, 1984). On the consensus pass, the second RA marked as unintelligible any word in the SALT transcript that she could not confirm. All mazes in child utterances were reviewed during the consensus pass. The consensus transcriber had to agree with the original transcriber that there was a disfluency in which at least one full word was produced. After the transcript underwent the consensus process, utterance codes were added to exclude imitations, exact immediate self-repetitions, and routine expressions (e.g., counting, nursery rhymes, and lyrics) from further analyses. Word spellings and word variants were standardized to ensure that measures of lexical diversity were not inflated (e.g., *yep*/*yea*/*yes* and *duck*/*ducky* were counted as a single word; Hadley et al., 2014).

Measures

Number of Different Words

The number of different words (NDW) produced by the child was used as a general measure of the child's lexical diversity. This estimate was based on the first 30 min of parent–toddler play for both cohorts, because in the Champaign study, the parents and children interacted as a dyad in the first 30 min. The number of utterances contained in the first 30 min ranged from 103 to 339 (M = 197), enough to detect between-child differences in NDW. Different regular inflectional forms of a word (e.g., *go, goes, going*) were counted as the same root word for the calculation of NDW. Irregular stem differences (e.g., *break* vs. *broke*) were counted as different lexical items, following Huttenlocher, Haight, Bryk, Seltzer, and Lyons (1991).

MLU: Morphemes

The measure of utterance length was calculated by SALT. The calculation was based on the same 30 min used for the calculation of NDW.

Tense/Agreement Productivity Score

The tense/agreement productivity (TAP) score was chosen as a measure of morphosyntactic development. Unlike general measures of grammatical development, it focuses on a highly important grammatical subsystem of English—that of tense and agreement—and is related directly to the production of well-formed sentences. Unlike percent correct measures, the TAP score is a type-based (i.e., eliminates repetitions) diversity measure of five tense/agreement morphemes: copula BE, auxiliaries DO and BE, and the verb *–s* and *–ed* affixes. As a score, it ranges from 0 to 25. The TAP filters out high-frequency combinations of BE and DO contracted to pronouns (e.g., *it's, he's*) to counter inflation from rotes and limited scope formulae. It has been shown to be a good indicator of a child's developmental level (Guo, Van Horne, & Tomblin, 2011; Hadley et al., 2014) and to differentiate typically developing preschool children from preschoolers with specific language impairment (Gladfelter & Leonard, 2013). For details of how TAP is calculated from a language sample and for scoring reliability, the reader is directed to Hadley and Short (2005), Rispoli et al. (2009), and Hadley et al. (2014). TAP scores for the children in this study have been reported in either Rispoli et al. (2009) or Hadley et al. (2014). Full 60-min samples were used to calculate TAP score.

ADSs

The total number of ADSs from the full 60 min of language sampling was calculated for every child. Because ADSs are a subset of the utterances produced by the children, it was deemed important to use the maximum transcript length for the ADS sample. ADSs were operationalized as a statement with an overt subject preceding a verb. Verb phrases lacking subjects were excluded (cf. *I get it* vs. *get it*).

Subject Diversity

The subjects of all ADSs were examined for unique nouns and pronouns in subject position. Repetitions of the same noun or pronoun were not counted. If the subject was a noun, only the head noun was counted as the type, regardless of modification by plural form, preceding determiner, or adjective (e.g., *sheep ~ sheeps, the cow ~ this cow, orange juice ~ apple juice*). When the child varied between a correct nominative case subject pronoun and a pronoun case error (e.g., *me want ~ I want*), the child was given credit for only one subject type rather than two.

Subject Disfluencies

All utterances with mazes were extracted from the transcripts with SALT. Coders examined all of the utterances with mazes for sentences with ADS structure. If the utterance was found to contain an ADS, it was then determined whether the maze contained a revision or repetition of the subject. Revisions were identified and operationalized as having a word within a maze preceding the subject that was then replaced by the sentence subject of the final fluent portion of the utterance. Examples are given in 2(a) and (b) in which we see pronouns replacing pronouns and nouns replacing pronouns. Naturally, nouns could replace nouns, as in 2(c). Existential pronouns *there* and *here* were considered subject pronouns, as in 2(d). Having a verb in the maze was not a criterion for classifying a disfluency as a subject revision. However, as seen in Item 2, if there was a verb found in the maze, that same verb had to be repeated in the final fluent portion of the sentence, thus retaining the syntactic frame for the subject. Verb inflection may have been changed, however, as with the copula BE in example 2(d). The dropping of a word from the noun phrase in the maze or the addition of a word to the noun phrase subject in the

final fluent portion was also considered a revision. Examples are given in 2(e) and (f).

2. (a) (we got) I got take.
   (b) (he say) the farmer says it's ok.
   (c) (mommy likes) bear likes it.
   (d) Mommy, (there's) these are the same.
   (e) (this little orange one this) this little one go in the big purple one.
   (f) and (the bunny go) the bunny rabbit goes here.

Subject repetitions were identified and operationalized as a having a word within a maze preceding the sentence subject that was then repeated as the sentence subject of the final fluent portion of the utterance. The pronoun, noun, or complete noun phrase within the maze had to be repeated without revision in the subject of the fluent portion, as in examples 3(a) and (b). To be more conservative and to be more readily perceivable, the repetition had to contain the whole word. Therefore, partial word repetitions as in 3(d) were not considered subject repetitions. The repetitions had to be limited to the subject. If a verb, adverb, negative, or other whole word followed the subject in the maze and then was repeated outside the maze, then the repetition was not considered a discreet subject repetition and was not counted, as in 3(e). The only exception was when a form of BE was contracted to the subject in the maze, as in 3(c), because, together, the subject and contracted BE form create a phonological word.

3. (a) (she) she can stay out here.
   (b) (the tractor) the tractor go here.
   (c) (I'm I'm) I'm going to the fields.
   (d) *(shee*) sheeps are gonna come in there. (*not considered a subject repetition)
   (e) *(I need) I need another orange one. (*not considered a subject repetition)

Classification of the Child

Both subject revision and subject repetition at 27 months old are relatively rare. Therefore, dependent measures were the presence or absence of either subject revision or repetition. Children were classified into four categories: (a) no revision or repetition, (b) subject revision only, (c) subject repetition only, and (d) both revision and repetition.

Coding Reliability

To check the reliability of the ADS tallies, the transcripts of 12 randomly chosen children (representing 20% of the sample) were independently coded by an RA who was not involved in the original coding of ADSs. Children's spontaneously produced statements were identified by SALT and saved as a separate file. The RA then identified and tallied all the ADSs. Her tallies were then compared with the original tallies for these children. The values were highly correlated, $r = .97$, indicating that the coding procedure produced consistent results in estimating child ADS output, despite some differences in ADSs due to human error. The unique subjects of these 12 children were also identified and tallied by the independent coder. The number of different subjects tallied in the independently coded sample and the original were also very similar, $r = .94$, indicating that the measure of number of different subjects in ADSs was also consistent across the two coders.

A check on the reliability of disfluency coding was performed by asking whether children were classified in an independently coded subsample in the same way as they were in the original. The transcripts of 20 children, representing 33% of the sample, were randomly selected. Using SALT, all fully intelligible utterances with mazes were retrieved. An independent coder examined all disfluent utterances and identified ADS clauses. He then identified subject revisions and repetitions. Next, the independent coder classified the children into four categories based on the presence or absence of revision and repetition. These new classifications were compared with the original classifications, resulting in a Cohen's $\kappa = .92$. This indicates that procedures for identifying disfluency types were replicable and led to a similar child classification.

Results

Descriptive Statistics of the Sample

The language abilities of the 61 children in this study spanned the full range of typical development. Table 1 reviews the descriptive statistics for language measures. This large range of abilities allowed age to be held constant while asking how subject diversity related to subject revision and subject repetition. A series of independent-samples t tests revealed no significant differences in NDW, MLU, TAP, number of ADSs, subject diversity, and subject revisions and repetitions between sexes or cohorts. The largest t statistic in the comparison of boys versus girls was $t(59) = -1.596$, $p = .116$. The largest t statistic in the comparison of the DeKalb versus Champaign cohort was $t(59) = -1.482$, $p = .144$.

Recall that there was a difference in the sampling procedures used for the two cohorts. Whereas the entire 1-hr sample in the DeKalb cohort was parent–child interaction, a conversation partner RA was added to the

Table 1. Descriptive measures of vocabulary and language production.

Measure	Range	*M*	*SD*
NDW	58–188	118.36	33.76
MLU	1.46–4.10	2.48	0.63
TAP	0–19	5.97	5.19
ADS	11–184	66.30	41.52
Subjects	2–40	11.93	6.68
Revisions	0–4	0.69	0.98
Repetition	0–7	1.30	1.68

Note. ADS = active declarative sentence; MLU = mean length of utterance; NDW = number of different words produced; TAP = tense/agreement productivity score.

latter half hour of the Champaign cohort. The objective of the conversation partner was to increase the opportunities children had to produce tense and agreement morphemes. Despite this difference in procedure, the TAP score did not significantly differ between the two cohorts at 27 months old, $t(59) = 0.457$, $p = .827$. The difference in procedure did not affect the proportion of children who had either a subject revision or repetition in his or her sample. Eight of the 19 children (42%) in the DeKalb cohort had subject revisions, and 19 of the 42 children (45%) in the Champaign cohort had subject revisions, $\chi^2(1) = 0.05$, $p = .820$. Seven of the children in the DeKalb cohort (37%) had subject repetitions, and 17 of the children in the Champaign cohort (40%) had subject repetitions, $\chi^2(1) = 0.07$, $p = .788$. Thus, it is clear that the difference in procedure had no effect on the independent and dependent variables.

The NDW children produced ranged from 58 to 188 ($M = 118.36$, $SD = 33.7$). Their MLUs ranged from 1.46 to 4.10 ($M = 2.48$, $SD = 0.62$). All of these children had MLUs higher than −1.5 *SDs* from the predicted MLU of mean = 2.23 and $SD = 0.510$ provided in Miller and Chapman (1981). The TAP of these children ranged from 0 to 19 ($M = 5.97$, $SD = 5.19$). All children produced ADSs, ranging from 11 to 184 in 1 hr. The average number of ADSs produced was 66.30 ($SD = 41.5$). In these sentences, the children produced from 2 to 40 different subjects ($M = 11.93$, $SD = 6.68$).

Subject Disfluencies

Subject revisions were observed in 27 of the 61 children, representing 44% of the total sample. Forty-six subject revisions were observed. Sixteen of the 27 children produced a single subject revision in 60 min, and nine children produced multiple revisions. The distribution of the frequency of subject revision can be seen in Table 2. The distribution was not normal, mean = 0.63, $SD = 0.992$, with a skewness of 1.563 ($SE = 0.306$). Therefore, the subject revision variable was dichotomized into the simple presence or absence of subject revision. Because subject revisions were rare, a complete list of the subject revisions found in these language samples is provided in the Appendix.

Subject repetitions were observed more frequently than subject revisions. Thirty-seven children produced at least one subject repetition, representing 61% of the total sample. As can be seen in Table 2, the frequency of subject repetition was also not normally distributed, with a skewness of 1.621 ($SE = 0.306$), despite the fact that most children repeated a subject at least once. Fifteen children exhibited one sentence with subject repetition, and 22 children had multiple subject repetitions. The subject repetition variable was dichotomized as well into the presence or absence of subject repetition.

Twenty-seven children exhibited subject revision. Thirty-four children exhibited subject repetition. As can be seen in Table 3, 21 of the 27 children exhibiting subject revision also exhibited subject repetition. Among the 34 children who did not exhibit a subject revision, about half (16) exhibited subject repetition. Chi-square test of association confirmed a significant association between these two types of disfluency, $\chi^2(1) = 5.95$, $p < .05$.

As noted, there were 46 subject revisions found in the language samples (Appendix). Thirty revisions (65%) involved pronoun replacements (e.g., 25G *[we got] I got take.*). This is to be expected, as pronouns are more frequent than nouns. Most of the pronoun replacements, 25 of the 30, involved a third-person pronoun, either in the maze or the fluent end product of the utterance (e.g.,12G *[everybody] they say hold on tight*). Sixteen revisions involved a noun. Nine of these involved a switch either from a noun to a pronoun or the reverse. Only seven of the revisions had a noun in the maze and a noun as the final product.

Zero-Order Correlations

There were 10 zero-order relationships of potential interest involving the four control variables (NDW, MLU, TAP, and ADSs) and the independent variable of interest (subject diversity) with the two dependent variables (subject revision and subject repetition). To avoid Type 1 error, a Bonferroni correction was applied to alpha, $p = .05 / 10 = .005$. As can be seen in Table 4, three of the four control variables were related to subject revision. The correlation of NDW with subject revision was $r = .546$, $p < .001$. The correlation of MLU with subject revision was $r = .556$, $p < .001$. The number of ADSs the children produced was related to subject revision, $r = .592$, $p < .001$. TAP, however, was not related to subject revision, $r = .307$, $p > .005$. The independent variable of interest, subject diversity, was also related to revision, $r = .577$, $p < .001$. None of the correlations with subject repetition were significant, given the alpha correction of $p < .005$.

Regression Analysis

To determine which variables were the best predictors of the presence of subject revision, a logistical regression

Table 2. Frequency of subject disfluencies.

	Number of disfluencies				
Disfluency	**0**	**1**	**2**	**3**	**≥ 4**
Revisions	34	16	7	2	2
Repetitions	24	15	11	4	7

Table 3. Frequency of children with subject revision and subject repetition.[a]

	Repetition	
Revision	**0**	**+**
0	18	16
+	6	21

[a] $\chi^2(1) = 5.95$, $p < .05$.

Table 4. Zero-order correlations of language production measures.

Measure	Revisions	Repetitions
NDW	.546*	.303
MLU	.556*	.354
TAP	.307	.328
ADS	.592*	.385
Subject diversity	.577*	.326

Note. ADS = active declarative sentence; MLU = mean length of utterance; NDW = number of different words produced; TAP = tense/agreement productivity score.

*$p < .005$.

was conducted. The independent variables in this regression were MLU, NDW, TAP, ADS, and subject diversity (Table 5). Control variables were forced to enter in the first block, NDW, MLU, TAP, and ADS. In the second block, subject diversity was allowed to enter in a stepwise forward conditional manner (p to enter = .05). The initial probability of subject revision was 44.3%, exp(B) = 0.794. The first block of the regression produced a significant model, accounting for approximately 38% of the variation in subject revision, Cox & Snell $R^2 = .384$, $\chi^2(3) = 28.614$, $p < .001$. Subject diversity also entered the model as a significant predictor of subject revision, Wald(1) = 4.343, $p < .05$ ($B = 0.309$, exp(B) = 1.363). The change in the model was significant, change in −2 log likelihood $df(1) = 5.756$, $p < .05$. The overall model accounted for almost 44% of the variation in subject revision, Cox & Snell $R^2 = .438$, $\chi^2(4) = 35.119$, $p < .001$.

A second logistic regression was then performed in which all variables competed for entry in a single block (p to enter = .05). In this second regression, only subject diversity significantly predicted the likelihood of subject revision, Wald(1) = 6.833, $p < .01$ ($B = 0.317$, exp(B) = 1.373). For every different subject, there was a 1.373 unit of change in the odds of having a subject revision. The model predicts that a child with 13 subjects would have a .50 probability of exhibiting a subject revision, a 1:1 odds ratio. A child with eight subjects would have an approximately .11 probability of exhibiting a revision, an odds ratio of about 1:8. A child with 18 subjects would have an approximately .87 probability of exhibiting a revision or an odds ratio of about 7:1.

Table 5. Results of regression, dependent variable = subject revision.

Block	Variables	Cox & Snell R^2	Wald	p
Block 1		.384		
	NDW		0.041	.302
	MLU		0.287	.592
	TAP		0.019	.889
	ADS		2.364	.124
Block 2		.438		
	Subject diversity		4.343	.037

Note. ADS = active declarative sentence; MLU = mean length of utterance; NDW = number of different words produced; TAP = tense/agreement productivity score.

Table 6 presents the actual data, with children grouped by the number of different subjects that they were observed to produce and the percentage of the children within the group who were observed to produce a subject revision. The predicted changes in probability correspond well to the data in Table 6. None of the children with seven or fewer different subjects produced subject revision, and the model predicts that a child with seven subjects would have a .05 probability of exhibiting a revision. In Table 6, 85% of the children who produced 16 or more subjects exhibited subject revision, and the model predicts that a child with 18 subjects will have a .87 probability of exhibiting a revision. In addition, the four children who produced 20 or more different subjects all produced a subject revision, and the model predicts that a child with 20 different subjects would have a .93 probability of exhibiting a subject revision.

Two logistical regressions with the presence of subject repetition as the dependent variable were conducted, paralleling the regression analyses performed for subject revision. The initial probability of subject repetition was .61%, $B = 0.433$, exp(B) = 1.542 (Table 7). The first block of the regression produced a significant model Cox & Snell $R^2 = .191$, $\chi^2(3) = 12.92$, $p < .05$. Subject diversity failed to enter in Block 2. In a second logistical regression, all variables competed in a single block. In this second regression, only the number of ADSs significantly predicted a change in the likelihood of subject repetition, Wald(1) = 7.739, $p < .01$ ($B = 0.025$, exp(B) = 1.025). For every ADS, there was a 1.025 unit of change in the odds of having a subject repetition. A child with 46 ADSs had a .50 probability of exhibiting a repetition. The child with the fewest sentences (11) still had an approximately .30 probability of exhibiting a repetition, and indeed, a repetition was observed in a child who produced only 13 sentences. It should be noted that the sample size of 61 children provided an observed power for testing the relationships of all independent variables with subject revision and repetition of greater than 0.999.

Summary of Results

To summarize, this sample of children displayed wide variation in language production ability. After controlling for NDW, MLU, TAP, and the number of ADSs produced

Table 6. Observed percentage of children with subject revision.

	Number of different subjects				
Children	0–7	8–9	10–12	13–15	16–40
N	12	11	12	13	13
– revision	12	10	6	4	2
+ revision	0	1	6	9	11
% children + revision	0	9	50	69	85

Table 7. Results of regression, dependent variable = subject repetition.

Block	Variables	Cox & Snell R^2	Wald	*p*
Block 1		.191		
	NDW		0.061	.805
	MLU		0.149	.699
	TAP		1.730	.188
	ADS		2.103	.147

Note. ADS = active declarative sentence; MLU = mean length of utterance; NDW = number of different words produced; TAP = tense/agreement productivity score.

through a regression analysis, it was found that subject diversity significantly predicted subject revision. In contrast, using the same regression procedures, it was found that subject diversity did not predict subject repetition. In fact, unlike revisions, subject repetitions were more closely related to the number of ADSs the children produced.

Discussion

Subject Revision, Repetition, and Diversity

Revision of the subject was predictable in our toddler language samples. It was uniquely related to the lexical diversity exhibited for the syntactic position of subject. In this research, the empirical link between subject diversity and subject revision was compared with a phenomenon that appears to be similar on the surface, namely, the repetition of the subject. Despite their surface similarity, revision and repetition are very different phenomena. It is true that revision and repetition were associated with each other, as most of the children who revised subjects also repeated them in other ADSs. However, it was subject revision, not repetition, that was predicted by subject diversity. General measures of language development, MLU and NDW, were related to subject revision. On the other hand, a specific measure of morphosyntactic development, TAP, was not related to subject revision. Further analysis revealed that the relationships between the general language variables and subject revision were indirect. Crucially, when MLU, NDW, TAP, and the number of ADSs were controlled, subject diversity predicted subject revision. In summary, the data point to a unique relationship between subject revision and subject diversity, one that can help us understand how it is that, in Rispoli (2003) and Rispoli et al. (2008), revision was related to grammatical development.

The direct comparison of subject revision and repetition helped to clarify relationships between developmental variables and subject disfluency phenomena. Subject repetition was related to the volume of sentences the child produced. That is, the likelihood of observing subject repetition was best, albeit weakly, influenced by the number of ADSs produced. Consider 40B, who produced 91 ADSs. With this sheer volume of sentences produced, it is not surprising that subject repetition was observed, *(I) I want pretzel*. However, 40B produced only five different subjects: *I, mommy, baby, it,* and *bear*. Despite this volume of ADSs, 40B was not observed to produce a subject revision.

Subject revision was rare. The average number of subject revisions produced was 0.69. In contrast, the average number of ADSs produced by the children was 66.3. This corresponds roughly to a probability of a subject revision occurring in one of every hundred sentences, a rate consistent with ADS revision rate reported in Rispoli et al. (2008). However, the probability of revising differed markedly for children who reached a sufficient level of subject diversity. For example, Child M17 produced 10 different subjects and produced 14 different ADSs. One of those 14 sentences contained a subject revision. This represents a rate almost seven times higher than the average. By comparing individual children such as M17 and 40B, the unique relationship between subject diversity and subject revision becomes readily apparent. Unlike repetitions, revision was not an artifact of opportunity, that is, the number of ADSs produced by the child. Revision had a unique relationship with subject diversity.

Ever increasing, structurally specific, lexical diversity is fundamental to the shift from direct activation to grammatical encoding posited in Rispoli and Hadley (2011). The greater the diversity of words filling a syntactic position, the lower their frequency. The lower the frequency of the words in the utterance, the lower the likelihood of direct activation. It is clear that subject diversity, which is a type of structurally specific lexical diversity, increases with grammatical development. For the DeKalb and Champaign cohorts combined, subject diversity rose from 21 to 33 months old: 21 months old, mean = 2.27 (*SD* = 3.68); 24 months old, mean = 5.46 (*SD* = 3.99); 27 months old, mean = 11.93 (*SD* = 6.68); 30 months old, mean = 13.87 (*SD* = 4.45); and 33 months old, mean = 16.53 (*SD* = 5.04). In this cross-section at 27 months old, subject diversity was highly related to MLU, $r = .792$, $p < .001$; NDW, $r = .686$, $p < .001$; and TAP, $r = .519$, $p < .001$. Despite the relatedness of subject diversity to these developmental measures, subject diversity was still the strongest predictor of subject revision.

Factors Contributing to Revisions and Revising

Let us consider why the relationship between structurally specific diversity and revision arises. During development, when the lexical pool of candidates for subject becomes dense enough, lexical retrieval may produce an initial word choice that does not fit the intention of the speaker. This might result from interference, whereby a subject with prior activation could interfere with the retrieval of the next subject. Consider the following example from 08G. For ease of presentation, the interfering subject is underlined and the final subject is in italics.

> 4. C dad, <u>you</u> can take your baby home (so <u>you</u> can go hmm) so *Nina* can go nightnight.

This child was advanced for her age, with an MLU of 3.29. She produced 18 different subjects and 104 ADSs.

In this example, she used the name given to one of the dolls in the playroom, *Nina,* as her final choice of subject but had difficulty suppressing the prior activation of *you*. Multiclausal sentences of this nature were comparatively rare in these language samples. Prior activation could also arise from a prior sentence. Consider this example from child F04. She was also advanced for her age, with an MLU of 3.78, producing 118 ADSs and 22 different subjects. In this example, the child and her mother were playing with a Fisher-Price family.

5. M that's the baby.
   C yeah.
   C (and her) and her mommy goes in the house.
   C (her mom) *the little girl* don't want to.

Interference could have had specific environmental sources as well. Consider the following example from 19G, a girl with an MLU of 2.88 who produced 104 sentences with 16 different subjects. She was working with her mother on a puzzle in which a bear is pictured with a friendly snake at his feet. One piece of this puzzle contained one of the bear's feet and the snake's tail together.

6. C it go right there.
   C (it's sk* snakes go right where) his feets go right there.

Multiple sources of interference might have been at play in this example, with *it* being retained from the prior sentence and *snake* coming from the picture.

As intriguing as interference is as an explanation for subject revision, cursory examination of the data revealed many examples for which there was no specific identifiable source of interference. Consider Example 7 from Child 25G, a girl with an MLU of 2.84, who produced 102 sentences with 16 different subjects. The mother–child dyad was pretending to bathe a doll and shampoo the doll's hair. The cap of the toy shampoo bottle was not removable.

7. C get in bath.
   M clean her up?
   C yep.
   C xx xx.
   M put some shampoo in her hair.
   C (we got) I got take.
   M I don't know that it comes off.

An interference explanation in this case is possible, in that *we* refers to the mother–child dyad, which is constantly present in the environment. However, invoking a ubiquitous environmental element as a source of interference weakens our ability to pinpoint sources of interference. Moreover, the ubiquitous elements of the environment are usually unspoken, and so we are left with the question of why such a word would interfere at that one specific moment.

Example 7 from 25G reminds us that most of these children's subjects were pronouns. Research has established that the pronominal system of English is learned during the third year of life. Pronouns are related to one another by semantic and syntactic features that create a complex array of intersections (Fitzgerald, Rispoli, & Hadley, 2017). For example, *I* and *we* share the semantic feature of first person and the syntactic feature of nominative case but contrast in the semantic feature of number. It has been proposed that these features and their intersections form a network capable of spreading activation (Rispoli, 1994; Wisman Weil & Leonard, 2016). It seems plausible that activation spreading might have a role in pronoun replacements that were found in these subject revisions.

Enumerating all the proximal causes of individual subject revisions is beyond the scope of this study. Investigating potential causes of revision such as interference and activation spreading may be a fruitful topic for future research on the relationship between sentence production and grammatical development. Speaking more generally, it has been argued that, for children to revise in the middle of a sentence, they must be able to (a) monitor their own output and (b) have alternatives readily available (Rispoli et al., 2008). The current research has focused exclusively on the latter (b). To the author's knowledge, the self-monitoring abilities of children under the age of 3 years have not been the focus of concerted research. The results reported here indicate that the term *alternative* can be refined to mean something quite specific: morphemes within the defined positions of a syntactic frame. In contrast, it seems less useful to define alternative as general vocabulary.

Revising and Syntactic Development

The finding that subject revision has a specific relationship with subject diversity has significance for our understanding of syntactic development. Subject revision can be considered a form of psycholinguistic evidence that the child is formulating sentences with the grammatical relation of subject. When the children in this study produced a subject revision, the syntactic compatibility of the alternates was assured; all the members of the subject pool shared common syntactic specifications. All of the alternates in the revisions found in these data were either nouns or pronouns, all grammatically compatible with the subject role. Historically, the question of how and when children acquire subjects has been contested (Braine, 1992; Pinker, 1987; Rispoli, 1991). According to these data, a little under half of the 27-month-olds in this study produced sentences with a genuine subject position. It seems likely that, if a similar sample size of older children were sampled, perhaps at 30 or 36 months old, the percentage of children exhibiting sentence revision would be higher.

This study has provided new evidence from a source previously ignored that children develop an abstract clause structure with a distinct syntactic position for subject in the third year of life. By abstract clause structure, what is meant is the syntactic frame posited in Bock and Levelt (2002). This frame is clearly separate from the lexicon and is an essential component of grammatical encoding. Subject revisions are evidence that the subject is in a distinct position in the frame and that multiple lexical items are

being targeted for that position. In other words, the position in the frame exists independently of the morphemes filling it.

This in-depth look at the relationship between structurally specific lexical diversity and revision helps us explain a previous finding, that is, that revisions, but not stalls, are related to grammatical development (Rispoli, 2003; Rispoli et al., 2008). The explanation begins by understanding that revising increases as lexical diversity in clause structure increases. When toddlers first transition from the one-word stage, their lexicon is poorly integrated into nascent syntactic structures. This lack of integration is evidenced by the limited lexical diversity of their early word combinations (Lieven et al., 2009; MacWhinney, 1982; Pine & Lieven, 1993). As integration of the lexicon into syntactic structure progresses, the lexical candidate pools within a structure become denser. The ongoing increase in diversity specific to syntactic positions provides an explanation for why revision rates increase with grammatical development. Repetitions, on the other hand, are more related to the sheer number of sentences produced in a conversational sample. It is also likely that repetitions, which are a type of stall, are related to clause length (Rispoli et al., 2008). The number of sentences and the length of those sentences are more weakly related to the integration of the lexicon and syntax than the lexical diversity within syntactic positions. Therefore, a tighter relationship exists between revision and grammatical development. However, it is essential to understand that revision is the result of structurally specific lexical diversity, which itself is part of the shift from direct activation to grammatical encoding.

Clinical Applications and Considerations

This research underscores the crucial importance of differentiating revisions from stalls. Distinguishing the two has been useful in understanding the grammatical development of children who stutter. Data reported in Wagovich, Hall, and Clifford (2009) indicate that rates of sentence revision increase developmentally for children who stutter, just as they do for children who do not. In other words, revision is a developmental phenomenon attested in both populations. In this article, we have seen evidence that revision is a consequence of structurally specific lexical diversity. Therefore, the results of Wagovich et al. indicate that children who stutter integrate their vocabulary into syntactic structure in much the same way as children who do not stutter.

Whereas revisions seem to operate similarly in these two populations, it is still unknown whether stalls differentiate them. Note that a single-syllable word repetition has long been recognized as a stuttering-like disfluency (Ambrose & Yairi, 1999). The single-syllable word repetition is also a stall. Consider what we know about stalls in the development of sentence production. The evidence indicates that they neither increase nor decrease consistently with age or grammatical development but that they do increase with clause length (Rispoli et al., 2008). The same can be said for stuttering-like disfluencies (Wagovich et al., 2009; Zackheim & Conture, 2003). It is very likely that a single-syllable word repetition at the beginning of a sentence will be a subject repetition (e.g., *I, I, I, I…*). Children who stutter should exhibit higher stall rates than children who do not. This may be particularly true for rates of subject repetition. Excessively high subject repetition rates might differentiate children who stutter from children who do not at a relatively young age.

Researchers are beginning to explore disfluencies in children with autism spectrum disorder and attention-deficit/hyperactivity disorder (Kuijper, Hartman, Bogaerds-Hazenberg, & Hendriks, 2017) and even women who carry premutation *FMR1* (Sterling, Mailick, Greenberg, Warren, & Brady, 2013). Unfortunately, this research does not take into account sentence structure. The underlying assumption of the research seems to be that disfluencies represent deficits in organization and planning. It will be challenging to relate this recent research to studies such as this one, which view revision as a window to the development of syntax and sentence production. The largest difficulty may be due to a metaphor. The term *fluency* itself implies a flowing, liquid-like substance. This metaphor is essentially at odds with our model of sentence production (Bock & Levelt, 2002), which recognizes the internal structure of a sentence frame that in no real sense "flows." What is seen as fluidity from one perspective is actually the rapid integration of discrete parts from another perspective. Sentences do not flow like a liquid. Sentences are assembled. Future research in cross-population comparisons could benefit by paying attention to this assembly process—the syntactic structures produced and the integration of words into those structures.

As this research has shown, subject revisions are rare. Their infrequency probably makes them of limited value to the practitioner assessing a young child's grammatical development. However, subject diversity, which underlies subject revision, may well be of relevance. The findings of this study indicate that limited subject diversity is associated with slow grammatical development. The extent to which this early grammatical indicator foreshadows young children at risk for language disorders warrants further investigation.

Limitations

It should always be held in mind that there are limitations to this study. These include language variety, demographic composition, and the length of language sample. Let us discuss each of these in turn.

The participant families of this study were monolingual English speakers. The relationship between subject diversity and subject revision should be robust and will be found in development under a wide range of dialects, cross-linguistic and multilinguistic variation. Nevertheless, this prediction awaits future research in other dialects of English, other languages, and other conditions of multilingualism for confirmation.

Our sample consisted mainly of White middle-class families with college-educated parents. The literature reports that children of lower-SES families have slower vocabulary growth (Hart & Risley, 1995). If this same study were conducted with a sample of children of families of lower SES, we would not expect the same average and range of subject diversity among the children. The relationship between subject diversity and subject revision might not be observable until a later age.

The language samples in this research were 60 min long. If they had been longer, more subject diversity might have been observed and the children would have produced more sentences. However, even with more subject diversity and more sentences, no change in the essential relationships would be expected. If longer samples were collected, we would expect that revision would be related to the rate at which different sentence subjects are produced. Children with slow rates, at or about one different subject every 10 min, would not be expected to produce a subject revision, regardless of sample length. Subject repetitions should not be related to this rate. Rather, repetitions should increase in proportion to the number of sentences produced. Verification of these expectations is a pertinent question for future research.

Conclusion

This article sheds light on previous findings that revising in sentence production increases with level of grammatical development. Unlike previous studies that looked at revising throughout the sentence, the current research focused on a single syntactic position—that of the subject. It was found that the presence of subject revision in a child language sample was predicted by the lexical diversity of the subjects produced by the child. This finding provides an explanation for why revision rates should increase with development—because lexical diversity within individual syntactic constituents increases with development.

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Appendix (p. 1 of 2)

List of Subject Revisions

05G
(this one is) that's blue.
08G
(he needs) I need a spoon.
(so you can go hmm) so Nina can go nightnight.
11B
(he say) the farmer says it's ok.
and (the bunny go) the bunny rabbit goes here.
(this this one) this is the cow house.
(this little orange one) (this) this little one go in the purple one.
(that one is um) the yellow one is bear's.
(that horse) that fall down.
12G
(everybody) they say hold on tight.
19G
(its sk* snakes go right where) her feets go right there.
20G
(it it's) them's no match.
(these pieces) these not match.
21B
(he) she eat apple?

Appendix (p. 2 of 2)

List of Subject Revisions

25G
(we got) I got take.
(there's) something's in sink.
26B
(we have) him have shoes.
30B
(that) those are my puzzle.
35G
mommy, (there's) these are the same.
(he like he he like he he he) she like juice.
39B
(me) I get ball.
41G
and (this) it turn on.
(it's it's) that's red.
43B
(this) you blow some at me.
46G
(there is) here's mines.
(he don't) she don't have pants.
(she need) I need take these off her.
(he need th* she) she need these.
47B
(my) I gotta get too.
49G
(mommy likes) bear likes it.
(he's getting i*) she's getting in.
(he need) she need arm.
53G
(this take a b*) the baby's take a bath.
(him nee*) he need a nap.
57B
(um he too) (he's) daddy's fell down.
F01
(he) her crying in her highchair.
(Fern have) people have to get out this.
(I make a) that make a bagel.
F04
(her mom) the little girl don't want to do.
F15
(and she) and bear's gonna go on there.
F19
(he) Cname go church.
M04
(you have a) I have a light.
M11
(you) I broke that.
(I) you got it?
M13
(that) this one goes in here too.
M17
(this this one) (this piece) this piece open up down.