Interactions in Written Language: Trade-offs between Spelling Accuracy and Lexical or Syntactic Complexity

Les interactions en langage écrit : des compromis entre l'orthographe et la complexité lexicale ou syntaxique

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ABSTRACT

Trade-offs occur when increasing complexity in one language subsystem leads to decrements in performance in another. Although evidence for trade-offs in spoken language exists, there has been little documentation of such interactions in the written language of children. The purpose of this longitudinal study was to examine the potential trading relationship between spelling accuracy and measures of word and syntactic complexity in written samples of school-aged children in kindergarten through grade one. All journal entries written by eleven typically developing students during two school years (kindergarten through first grade; four sampling periods) were collected. The children were enrolled in a single school in Nova Scotia. The relationship between written word complexity and spelling accuracy was analyzed as was the relationship between syntactic complexity and spelling accuracy. Written word complexity was defined as the number of syllables in a word (one, two, three or more). Syntactic complexity was defined by T-unit length in morphemes and number of clauses per T-unit. Results provided evidence for an inverse relationship between word complexity and spelling accuracy throughout the period sampled. As well, in Kindergarten spelling accuracy decreased as syntactic complexity of written utterances increased; but this pattern was reversed by first grade. Clinical implications are discussed.

ABRÉGÉ

Il se produit des compromis lorsqu'une complexité croissante dans un sous-système du langage entraîne des décroissances de rendement dans un autre. Quoiqu'il existe des preuves de compromis en langage parlé, il existe peu de documentation sur de telles interactions dans le langage écrit des enfants. Le but de cette étude longitudinale était d'examiner le rapport d'échange potentiel entre l'orthographe et les mesures de complexité lexicale et syntaxique relativement à des échantillons écrits d'enfants d'âge scolaire, du préscolaire et de première année. Toutes les inscriptions faites par onze élèves à développement typique au cours de deux années scolaires (préscolaire et première année; quatre périodes d'échantillonnage) ont été recueillies. Les enfants étaient inscrits à la même école de Nouvelle-Écosse. Le rapport entre la complexité lexicale et l'orthographe a été analysé, ainsi que le rapport entre la complexité syntaxique et l'orthographe. La complexité lexicale était définie comme étant le nombre de syllabes d'un mot (une, deux, trois ou plus). La complexité syntaxique était définie comme étant la longueur d'unité-T des morphèmes et le nombre de propositions par unité-T. Les résultats ont fourni des preuves de rapport inverse entre la complexité lexicale et l'orthographe pour toute la période d'échantillonnage. En outre, l'orthographe chez les élèves au préscolaire diminuait à mesure qu'augmentait la complexité syntaxique des expressions écrites : mais cette tendance était renversée en première année. On étudie les incidences cliniques.

KEY WORDS: literacy • written language • child development • resource allocation

Limited capacity information processing models, such as that proposed by Bock (1982), have become popular in recent years with researchers interested in child language development and disorders (Kamhi, 1992). These models predict and explain observed interactions between language subsystems during children's spoken sentence formulation. The processes proposed to contribute to the formulation of language vary across models. For Bock (1982), referential, semantic, syntactic, phonological, phonetic, and motor-assembly subsystems or "arenas" are conceptualized as drawing from the same finite pool of processing capacity during sentence formulation. According to Bock, controlled (conscious) processing requires a capacity investment and thus places greater demands upon the system. When processing demands are high in one arena, performance in others may be affected. For example, increasing the syntactic complexity of a sentence may result in a breakdown or simplification of phonological performance, referred to as a "trade-off".

Trade-offs have been studied in the spoken language of children. Several researchers have documented that phonetic accuracy decreases as morphosyntactic or semantic complexity increases in the spontaneous utterances of typically developing two- to three-year-olds (Camarata & Leonard, 1986; Camarata & Schwartz, 1985; Donahue, 1986; Kamhi, Catts, & Davis, 1984; Matthei, 1989; Nelson & Bauer, 1991). Similarly, Panagos and colleagues found such trading relationships in the imitated utterances of four- to six-year-old children with articulation disorders (Panagos, Quine, & Klich, 1979). Again,

as syntactic complexity increased (i.e., progression from noun phrase, to declarative sentence, to passive sentence), the phonetic complexity of individual words tended to decrease. Word complexity has also been shown to interact with phonetic accuracy in the spoken imitations of both typically developing (Prelock & Panagos, 1989) and phonologically impaired (Panagos et al., 1979) children. Specifically, phonetic errors were found to be more frequent in multisyllabic as opposed to monosyllabic words. Masterson and Kamhi (1992) examined the interaction between syntax and phonology in both the imitated and spontaneous utterances of three participant groups between six and nine years of age: typically developing, language learning disabled, and reading disabled. In spontaneous speech, utterances classified as syntactically simple (one clause) tended to be phonetically complex, while utterances that were phonetically simple contained a wider variety of clause structures. In imitated speech, increases in either the phonetic or syntactic complexity of the target sentence were accompanied by decreases in intelligibility and more syntactic errors. All participant groups showed similar patterns of trading relationships.

While trading relationships between syntactic or word complexity and phonetic accuracy have been documented in the spontaneous and imitated speech of groups of children, findings also suggest that they are not present for all children or on all tasks. In a study of typically developing two-year-olds (Nelson & Bauer, 1991) for example, trade-offs were evident in the spontaneous speech of some but not all of the participants. Kamhi et al. (1984), using an elicited imitation task with typically developing children 22 to 34 months of age, found no evidence for trade-offs between syntactic complexity and phonetic accuracy.

The absence of trade-offs in contexts where they might be expected has been attributed in part to a mismatch between the developmental abilities of the children studied and task demands (Kamhi, 1992; Masterson, 1997; Masterson & Kamhi, 1992). That is, the difficulty of a task will vary for children of different developmental levels. Thus, there should also be a developmental shift in the locus of observable interactions. This is, of course, not a new idea. Bloom, Lightbown, and Hood (1974) noted that 20- to 28-month-old children who were typically developing used familiar (previously spoken) words more often in more complex, newly emerging, syntactic constructions and unfamiliar words more often in less complex syntactic frames. As well, older typically developing children make significantly fewer lexical and phonetic errors when attempting the same multisyllabic words than do their younger counterparts (Prelock & Panagos, 1989).

The above discussion suggests that the 'stress-points' which would reveal trading relationships change with age. It may also be true that, overall, a child who reaches a high level of language proficiency will experience fewer instances in which resources are limited enough to impact performance, although adult data attest to the fact that interactions continue to occur even in proficient speakers of a language. Concepts of controlled versus automatic processing are invoked by interactionist models to explain how resource constraints may vary over time for a given task (e.g., Berninger & Swanson, 1994; Bock, 1982). Automatization of consciously controlled processes occurs within specific task contexts as a task becomes familiar and well practiced. As automatization takes place, the system is thought to be 'freed' to devote more capacity to those processes that require more conscious control. Consequently, trade-offs should be less frequent as a task or behaviour becomes automatized and more frequent in tasks or behaviours that are newly acquired.

As with spoken language, interactionist perspectives are evident in models of writing. One model of particular interest here because of its databased nature and developmental focus is Berninger and Swanson's (1994) modification of the skilled writing model of Hayes and Flowers (1980). Berninger and Swanson suggest that, in the early elementary school years, the writing process (i.e., written translation of thoughts) involves two interacting but dissociable components: transcription (handwriting and spelling), which emerges earliest, and text generation (composition quality at word, sentence, and discourse levels). They claim that early elementary school children rarely use a third component of the writing process—the review and revision of written words and sentences.

Berninger and her colleagues have demonstrated that the handwriting and spelling abilities of elementary school children are constrained by a number of factors: the ability to visually analyze and manually produce geometric forms; the ability to remember and write letters; knowledge of letter-sound correspondences; and compositional fluency (i.e., the number of words produced in a designated time). One might also predict interactions between transcription (e.g., spelling accuracy) and text generation levels (e.g., word or sentence complexity) of the model. To our knowledge, such interactions have not been investigated.

The present study seeks evidence for interactions between measures of word (number of syllables) or sentence (utterance length, clause structure) complexity and spelling accuracy. Spelling accuracy is hypothesized to interact with syntactic and word complexity for a number of reasons. First, it is now widely believed that reading and writing are language-based activities (Catts, 1993; Gillam & Johnston, 1992). Such a belief presupposes that some levels of representation are shared across spoken and written modalities. Second, current process models emphasize that phonological information is accessed during both reading and writing activities (Dickinson, Wolf, & Stotsky, 1993), though there is controversy regarding whether the same representation is accessed in each (Roeltgen, 1992). Third,

phonological and spelling abilities are related. This is evident in the child's developing knowledge and use of phoneme-grapheme correspondences to create phonologically plausible spellings (Bradley & Bryant, 1985; van Kleeck, 1990). Finally, as previously discussed, phonological abilities have been shown to interact with word and sentence complexity in spoken language.

Spelling accuracy develops over the elementary school years. Phonologically plausible spelling errors emerge early, are prevalent in the written texts of first and second graders (Roeltgen, 1992), but plateau in frequency by fourth grade (Oerlemans & Dodd, 1993) as orthographic strategies become more common (Frith, 1985) and reduce dependence upon letter-sound correspondence strategies. Phonologically plausible spellings are accurate to the extent that orthographic structure is consistent with phonological structure, which is often not the case. Orthographic strategies result as a child notes orthographic-phonological irregularities and remembers conventional spellings. From first through fourth grades spelling accuracy improves without becoming adult-like (Gentry, 1982; Henderson & Templeton, 1986).

Thus, phonological knowledge acquired in the spoken mode is accessed during reading and writing activities, and is incorporated into a spelling strategy with increasing facility as a child's writing skills develop. It might be reasonable to assume that the ability to relate phonological and orthographic information in a spelling task may break down if the complexity of the word or sentence being attempted is high. Therefore, spelling accuracy should be a viable measure to tap interactions between written language processes.

The purpose of the present investigation, then, was to extend the research on subsystem interactions to the written modality by longitudinally examining potential interactions between word or sentence complexity and spelling accuracy in the written journal entries of elementary school children. Two academic years of journal entries (i.e., kindergarten and first grade) were analyzed for eleven typically developing children. In studying the same task (journal writing) over a two-year period, we hoped to reveal when changes in patterns of trading relationships take place for a given set of measures. The specific questions posed in this study were:

1. Will spelling accuracy decrease as word or sentence complexity increases?
2. If so, do the patterns of interaction change over time?

Method

Participants

Eleven children (seven girls, four boys) participated in the investigation. The mean age of the children was 5;5 (years; months, SD = 0.21 years) at the beginning of the study. All the children were from monolingual, English-speaking homes. There was no reported history of hearing, speech, language, or learning problems. All children attended the same Nova Scotian public elementary school.

Data Collection

Two consecutive academic years (i.e., kindergarten and first grade) of journal entries were collected for every child. Journal entries were written during class time on a daily to weekly basis throughout each academic year. The classroom teachers followed a whole language approach to teaching literacy skills. Consequently, the approach concentrated primarily upon self-expression and creativity rather than on accuracy of form in writing. The topics the children chose to write about were self-selected. The children were not provided with formal spelling instruction during either academic year. In the event that they were unable to spell a word and asked for help during the journal writing activity, the teacher instructed them to sound out the word to the best of their ability or to refer to the written displays in the classroom. To aid in the identification of the adult form of words that a child had attempted to write, parents were asked to provide a written interpretation of all journal entries that were difficult to decipher.

Time periods. Journal entries from four time periods were analyzed: (a) Time 1 = kindergarten, September to January; (b) Time 2 = kindergarten, February to June; (c) Time 3 = first grade, September to January; and (d) Time 4 = first grade, February to June.

Data Coding

The two consecutive years of journal entries collected for each child served as the database for the study. Referring to both parent interpretations and the raw data from the journal entries, each written sample was glossed orthographically using conventional spelling. Thus, each intended or target word could be compared to the word as the child rendered it.

Spelling accuracy. Spelling accuracy was determined at the word level. A word was considered misspelled if it deviated from conventional spelling. The presence of one or more spelling error(s) in a given word constituted a single misspelling. Orthographic errors (e.g., letters written backwards) and morphological errors (e.g., 'goed' for went) were disregarded.

Word complexity. Each written word was first categorized into one of three levels of word complexity: (a) words containing one syllable, (b) two syllables, or (c) three or more syllables. Words that could not be deciphered were excluded, as were abbreviations (e.g., Mrs., Tues.) and ordinal numbers (e.g., 1, 10).

The proportion of misspelled to total words was calculated for each of the three levels of word complexity, individually for every time period. Proportions were calculated in two ways: with and without the inclusion of proper nouns. This was done because it was expected that the spellings of proper nouns might be memorized more often and therefore spelled more accurately than other words. T-test, $t(11) = -5.180$; $p = 0.000$, confirmed

this expectation.

Utterance segmentation. Each journal entry was segmented into component Terminable Units (T-units). A T-unit consisted of "a main clause with all subordinate clauses or nonclausal structures attached or embedded within" (Scott, 1988, p. 55). Any main clause beginning with a coordinating conjunction was identified as a new T-unit "unless a co-referential subject deletion in the second clause occurred" (p. 55). For example, the written utterance, "Bill went to the store (1) and he bought some milk (2)" is comprised of two T-units while the utterance, "Bill went to the store and bought some milk", is one T-unit. Main clauses were segmented as separate T-units (e.g., "I love mom"). Abandoned utterances (e.g., 'When we came back from the lobster place"...), uninterpretable utterances (i.e., utterances which contained one or more words which were unidentifiable), and utterances without a main verb (e.g., "mom") were not included.

Number of morphemes per T-unit. The number of morphemes per T-unit was calculated using the conventions cited by Miller (1981). Additionally, the following were counted as single morphemes: ordinal numbers (e.g., 1, 2); holidays and days of the week (e.g., Mother's Day, Monday); abbreviations for the days of the week (e.g., Mon., Tues.); proper names (e.g., John Brown); place names (e.g., United States, Metro Center); movie and book titles (e.g., 'Three Men and a Baby"); and the numeric representation of time (e.g., 10:00). Each part of a date (i.e., day, month, year) was considered to be a separate morpheme.

Number of words per T-unit. The number of words in a T-unit was counted. The items previously defined as single morphemes were also counted as single words, with the exception of numbers written as digits. These were not included because a determination of spelling error could not be made.

Number of clauses per T-unit. Since increasing T-unit length in morphemes does not linearly reflect increasing syntactic complexity, the number of clauses per T-unit was also tabulated.

Measures of T-unit complexity. Four categories of T-unit length were compared: T-units of three and four; five and six; seven and eight; and nine or more morphemes. Two clause categories were identified: T-units with one clause and T-units with more than one clause. For each participant, the mean proportion of misspelled words per T-unit was calculated for every category of T-unit length and clausal complexity within each time period.

Reliability

Interjudge reliability was calculated for 10% of the data using a second trained coder. At the word level, reliability measures were obtained for presence or absence of a misspelled word and classification into word complexity categories. Percent agreement for identification of misspelled words was 87%. Percent agreement for classification into word complexity categories was 99%, 97%, and 91% for words containing one syllable, two syllables, and three or more syllables respectively. At the T-unit level, reliability measures were obtained for T-unit segmentation as well as calculations of the number of morphemes and clauses per T-unit. Point-to-point agreement was 97% for T-unit segmentation 88% for the number of morphemes, and 94% for the number of clauses per T-unit.

Table 1. Mean, Standard Deviation, and Range for Number of Analyzable Words in Written Samples, as a Function of Word Complexity and Time.

Word Complexity	Time Period			
	1	2	3	4
1 syllable				
M	103.18	494.09	931.09	983.73
SD	78.54	331.86	727.68	866.18
Range	18-278	127-1114	308-2647	266-3085
2 syllables				
M	18.09	81.32	159.91	205.73
SD	9.85	63.24	121.83	184.35
Range	7-34	24-215	31-215	31-426
3 or more syllables				
M	4.25	15.27	30.82	36.27
SD	3.92	10.21	21.88	36.43
Range	0-11	2-36	12-85	8-138

Notes. Time period 1 = kindergarten, September to January; Time 2 = kindergarten, February to June; Time 3 = grade one, September to January; and Time 4 = grade one, February to June. Proper nouns excluded.

Results

The alpha-level for each omnibus test was preset at $p < .05$ (1-tailed). The alpha-level for post-hoc comparisons was adjusted using a modified Bonferoni technique (Hochberg, 1988).

Table 2. Group Means (and Standard Deviations) of Proportion of Misspelled Words as a Function of Time and Word Complexity (1, 2, and 3 or more syllables).

Time Period	Word Complexity		
	1	2	3+
1	.18 (.12)	.38 (.26)	.48 (.34)
2	.18 (.10)	.48 (.25)	.49 (.29)
3	.20 (.13)	.49 (.23)	.60 (.21)
4	.19 (.19)	.36 (.21)	.54 (.27)

Notes. Time period 1 = kindergarten, September to January; Time 2 = kindergarten, February to June; Time 3 = grade one, September to January; and Time 4 = grade one, February to June.

Table 3. Mean (and Standard Deviation) Number of T-units, MLT-unit, and Proportion of Clauses per T-unit as a Function of Time.

Time Period	No. of T-units	MLT-unit	Proportion of Clauses
1	31.2 (20.0)	5.15 (0.71)	1.01 (0.02)
2	104.4 (59.2)	6.27 (0.90)	1.05 (0.04)
3	161.8 (124.4)	6.79 (0.63)	1.07 (0.06)
4	203.9 (177.0)	7.71 (0.44)	1.11 (0.10)

Notes. Time period 1 = kindergarten, September to January; Time 2 = kindergarten, February to June; Time 3 = grade one, September to January; and Time 4 = grade one, February to June.

Analyses of Word Complexity

Analyses were restricted to data with proper nouns excluded. The corpus of analyzable words within each time period is presented in Table 1. As shown, the children wrote more words in each syllable category as time progressed. They also wrote far fewer two and three syllable than one syllable words. A word complexity (3) by time (4) analysis of variance was performed on the proportion of words with spelling errors. In Time 1, 2 of the 11 participants did not produce any words containing three or more syllables. These children were excluded from this analysis. Analysis of the data for the remaining nine children revealed a significant main effect for word complexity, $F(2,16) = 30.51$; $p = 0.000$. In general, the mean proportion of misspelled words increased as word complexity increased (Table 2). Post-hoc paired comparisons found that significantly more words were misspelled when the target words contained two rather than one syllable, or three rather than two syllables. Thus, at each level, as word complexity increased spelling accuracy decreased, lending support for a trading relationship between these two factors. Neither the effect of time nor the interaction reached significance.

In the data of individual participants, the mean proportion of misspelled words increased across word complexity conditions in every time period for nine of the eleven children. For the other two, in the first two time periods the number of three-syllable words attempted was very small. For these children, as they attempted more three-syllable words in times 3 and 4, the predicted trading relationship emerged in their data also.

Analyses of T-Unit Complexity

Descriptive statistics for the corpus of data are provided in Table 3. As shown, the mean values for total number of T-units, MLT-unit, and proportion of clauses produced per T-unit increased over the time periods sampled.

T-unit length in morphemes. A length (4) by time (3) analysis of variance with repeated measures for T-unit length in morphemes and time was performed on the mean proportion of misspelled words. In Time 1, five of the 11 participants did not produce T-units of nine or more morphemes. For this reason, analyses were conducted on the last three time periods only, when data for all 11 participants were available. There was a significant main effect of length only, $F(3, 10) = 3.33$, $p = .033$. The mean proportion of misspelled words increased with T-unit length. The interaction approached significance, $F(6, 60) = 2.05$; $p = .073$. Table 4 presents the raw data as a function of T-unit length and time and the overall means illustrating the main effect.

To examine the main effect more closely, post-hoc paired contrasts of morpheme length conditions were performed. A significant difference in the proportion of words with spelling errors was found when comparing T-units of 3 to 4 morphemes in length with T-units of nine or more morphemes ($p = .01$). Pairwise comparisons of other length conditions did not reach significance.

T-unit length in clauses. Data from Time 1 were not included in this analysis as well because only one of the eleven participants used multiclausal T-units during the first time pe-

Table 4. Mean Proportion of Misspelled Words (and Standard Deviation) in Each Time Period as a Function of T-unit Length.

Time Period	T-unit Length (in morphemes)			
	3-4	5-6	7-8	9 or more
1	.18 (.09)	.24 (.19)	.23 (.19)	.41(.26)
2	.19 (.12)	.21 (.12)	.26 (.12)	.29 (.12)
3	.22 (.14)	.24 (.14)	.24 (.12)	.23 (.12)
4	.20 (.11)	.20 (.14)	.25(.17)	.18 (.10)
Total	.20 (.09)	.22 (.12)	.25 (.10)	.25 (.11)

Notes. Time 2 = kindergarten, February to June; Time 3 = first grade, September to January; and Time 4 = first grade, February to June. Only six children in Time 1 produced T-units of nine or more morphemes; otherwise, N = 11.

riod. A clause (2) by time (3) analysis of variance with repeated measures for number of clauses and time was performed, again using the proportion of misspelled words per T-unit as the dependent measure. There was a significant main effect for clause, $F(1,10) = 8.78$; $p = .014$. More spelling errors were observed in T-units containing multiple clauses. A significant interaction of clause and time, $F(1,2) = 5.35$; $p = 0.014$, was also obtained. Table 5 shows the raw data as a function of clause and time.

Post-hoc comparisons further investigated the interaction. In Time 2 only, there was a significantly greater proportion of misspelled words in T-units with two or more clauses than in T-units of one clause ($p = .001$).

Individual differences. The data for each participant were examined to determine whether individual differences in the relationship between spelling accuracy and syntactic complexity were evident. For the length in morphemes data, more spelling errors in the longest versus the shortest T-units were produced by ten of the 11 children during Time 2, eight of 11 during Time 3, and only one of 11 during Time 4.

For the clausal data, all 11 children showed the predicted interaction in Time 2. In Times 3 and 4, only six of the 11 children continued to spell less accurately in T-units containing more clauses. Five children consistently showed such a trading relationship across all three time periods. Thus, for both measures, the predicted interaction was most strongly evident in Time 2.

Table 5. Mean Proportion of Misspelled Words (and Standard Deviation) in Each Time Period as a Function of the Number of Clauses in a T-unit.

Time Period	Number of Clauses	
	One	Two of more
1	.21 (15)	—
2	.21 (11)	.34 (.13)
3	.24 (.13)	.25 (.13)
4	.19 (.11)	.22 (.14)

Notes. Time 1 = kindergarten, September to January; Time 2 = kindergarten, February to June; Time 3 = first grade, September to January; and Time 4 = first grade, February to June. Only one child produced T-units containing more than one clause in Time 1, therefore this cell is left blank.

Discussion

This longitudinal study explored the relationship between spelling accuracy and word complexity (as measured by number of syllables contained within a word) or syntactic complexity (as measured by T-unit length and number of clauses). Two consecutive years of children's written journal entries were analyzed.

Evidence for a trading relationship between word complexity and spelling accuracy was found: as the complexity of a word increased the accuracy with which it was spelled tended to decrease regardless of the time period sampled. A trading relationship between spelling accuracy and syntactic complexity was also revealed in the writing samples of the children studied. For both measures of syntactic complexity (i.e., length in morphemes and number of clauses), the proportion of misspelled words increased as the T-unit complexity increased. For the majority of children, trade-offs between spelling and syntax were most evident in kindergarten.

Word Complexity

The reduction in spelling accuracy observed when word complexity increased in these written samples is somewhat analogous to findings reported by Panagos et al. (1979) and Prelock and Panagos (1989) for spoken language. In these latter studies, increasing word complexity was associated with decreasing phonetic accuracy of spoken words. Prelock and Panagos (1989) reported that this effect was present for younger ($M = 4;1$) but not older ($M = 5;8$) groups of children, suggesting a developmental change in the pattern of interactions. The mean age of

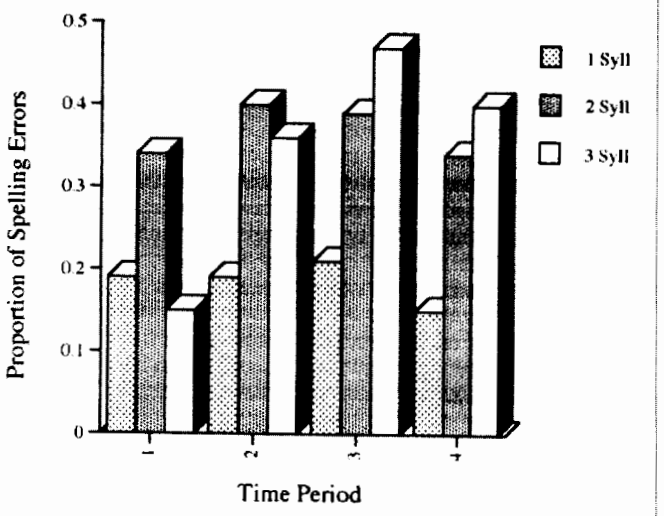
participants at the onset of the present study (5;5) was comparable to Prelock and Panagos' older group, suggesting that the impact of increasing word complexity is mediated by the mode of communication at this age. For five-year-olds, writing in journals is a relatively new activity that would require more controlled processing while, no doubt, a degree of automaticity has been achieved in speaking words of comparable complexity.

Of interest was the finding that the relationship between spelling accuracy and word complexity remained stable over time. In the early period of reading and writing development, children are often thought to focus attention primarily upon lower level coding processes (Dickinson et al., 1993) while higher level linguistic processes constrain writing more in the intermediate grades (Berninger & Swanson, 1994). If this is so, interactions between word complexity and spelling ability might be expected to diminish steadily in the primary grades with little residual effects notable by third or fourth grade. For our measure of word complexity, however, such a prediction was not upheld, at least for the first two years of school.

It is possible that more misspellings were observed in words with a greater number of syllables for other reasons. Perhaps the finding was an artifact of the measure we used. That is, perhaps the children had more opportunity to misspell longer as opposed to shorter words and, consequently longer words contained a higher proportion of spelling errors. To examine this possibility, the data were reanalyzed using only those spelling errors that occurred in syllables receiving primary stress. For any given word, then, one syllable was being considered for spelling errors. Figure 1 presents the results of this post-hoc analysis. As shown, the interaction of spelling accuracy and word complexity remains, but for Times 3 and 4 only. Note that the proportion of spelling errors in the syllable receiving primary stress in one and two syllable words is relatively consistent across time. However, this proportion increases in three-syllable words to a high of .47 in Time 3. An examination of the raw data suggests that the low proportion of spelling errors in three syllable words during Times 1 and 2 is related to both the small sample sizes at these times and the overrepresentation of a small subgroup of words, particularly "yesterday' and "tomorrow". These two words tended to be spelled correctly, perhaps because they were posted somewhere in the room. In Times 3 and 4, the majority of children were using a larger repertoire of words containing three or more syllables, which resulted in a more representative analysis. These post-hoc data, then, are consistent with the findings of our initial analysis and support the notion that the presence of a trading relationship between spelling accuracy and word complexity, at least in the final two time periods studied.

Another alternative explanation is that multisyllabic words are inherently less likely to be accurately spelled when using phonologically plausible spelling strategies. If this is the case,

Figure 1. Proportion of misspelled syllables receiving primary stress, as a function of time and word complexity (words containing 1, 2, or 3 or more syllables).



the fact that our children demonstrated more spelling errors in multisyllabic words through the first grade may not reflect a trading relationship. Examination of the syllable data, however, did not reveal any obvious differences between levels of word complexity in this regard. As well, we are not aware of any literature that suggests that orthographic spelling strategies are more applicable in the stressed syllables of multisyllabic as compared to monosyllabic words. Consequently, we feel that this possibility does not explain our findings.

Individual differences. As in previous studies of spoken language (Kamhi et al., 1984; Nelson & Bauer, 1991), individual differences were evident in this study also. Performance patterns supported the presence of trade-offs between written word complexity and spelling accuracy for the majority of the children studied. However, for two children this was not the case. It has been proposed (Vihman, 1993) that children differ in their tolerance for variability or inaccuracies in their speech. By analogy, some of the individual variability noted in these writing samples might be explained by differences in levels of tolerance for spelling accuracy. As well the two children who diverged from the usual pattern in this study also attempted to write a restricted set of three syllable words. As the children attempted more trisyllabic words, the predicted pattern emerged.

Syntactic Complexity

The predicted relationship between spelling accuracy and syntactic complexity was present for both measures of syntax. Spelling errors increased with T-unit length. Thus, while children were attempting to write increasingly longer T-units throughout the period of the study, the longer T-units appear to have stressed their processing systems. Though not significant,

the trend was for this tradeoff to be most evident in Time 2. Spelling errors were also more frequent in T-units that contained more than one clause. Here, the difference reached significance in the second sampling period (second half of kindergarten) only. The frequency of occurrence of T-units containing more than one clause increased over the two year period as well, although overall frequency remained quite low.

The question arises as to why trade-offs were apparent only in the first academic year, particularly for the clausal measure. Bock (1982) suggests that automaticity is an important factor in sentence formulation and a developmental endpoint in the progression from more controlled processing. From Bock's perspective, as a specific task becomes more automatic, trade-offs are less likely to occur. Such a developmental progression towards automaticity in writing may explain the disappearance of tradeoffs in Times 3 and 4. Perhaps by the time the children entered first grade their exposure to and familiarity with journal writing resulted in enough facility with syntactic and spelling skills that trade-offs between spelling accuracy and syntactic complexity became less evident.

Alternatively, the absence of a trading relationship between spelling accuracy and syntactic complexity of written language in later time periods may be a function of the choice of linguistic measures employed in this investigation. The specific linguistic measures employed in a study have been found to effect whether trading relationships in children's spoken language will be identified (Masterson & Kamhi, 1992). Perhaps our measures of syntactic complexity were refined enough to identify syntactic constraints upon spelling in kindergarten children, but did not index development adequately to note the same relationships in first graders. If so, a more developmentally appropriate or sensitive measure of either written syntax or spelling ability might better reveal the presence of such a trading relationship in the writing samples of the first grade children.

Individual differences. For the children who did evidence trade-offs, the time course for the resolution of the trading relationship of interest varied. This suggests that the developmental timeline for various writing processes differed across children resulting in task performances that may have been more automatized for some than for others. Indeed, children also differed in the average length of their journal entries (# of T-units). This might suggest that the more prolific are also the more proficient writers.

It is interesting to note that, while the relationship between spelling accuracy and syntactic complexity seemed to resolve in kindergarten, a trading relationship between spelling accuracy and word complexity continued through first grade for these same children. The disparity between the two analyses in terms of when trading relationships resolve may reflect developmental differences in the acquisition of various components of the writing process. This finding seems contrary to conventional wisdom—in the early period of reading and writing development, children are often thought to focus primarily upon lower level encoding and decoding processes (Dickinson et al., 1993). Consequently, word-level impacts upon spelling ability might be expected to resolve prior to utterance-level effects. Much of the existing literature, however, has studied children in phonics-oriented reading programs where writing was often introduced after a certain facility with reading had been achieved and where the "focus of instruction for beginning reading has been the letters, sounds, words, and punctuation that comprise the pages of text" (Sawyer, 1991, p. 1). In contrast, the children in the present investigation were enrolled in a program which focused upon the concurrent development of reading and writing skills and stressed the importance of conveying meaning over the accurate production of form. Therefore, the observation that these children resolved interactions at the utterance level before the word level may reflect their experience with a language curriculum with this focus.

Methodological Considerations

The present analyses reflect children's performance following editing behaviours. Compared to spoken language, the written signal is quite tractable and can be more elaborately modified. In the journal entries of the children studied here editing occurred, albeit infrequently, as evidenced by erasures of original text. Others have also reported that editing is infrequent at these ages (Berninger & Swanson, 1994). In part, editing infrequency can be attributed to the nature of the task which was to write about events, thoughts, and feelings. While the children knew that their teacher would read the journal entries, they were not expected to make multiple drafts or clean copies.

In the present study we chose to analyze words occurring in a naturalistic written context. While this decision has the advantage of allowing for greater generalizability to other writing contexts, it also imposes limitations. Most obviously, the ability to dictate which words will be used by a child is lost. In her recent review of the literature on spoken language interactions, Masterson (1997) noted that trading relationships are often most observable in imitative (i.e., highly controlled) speaking conditions. Given this, a fuller explication of the relationship between spelling and language variables such as word complexity awaits experimental studies that compare the ability to accurately spell the same sequence of letters in words of increasing length.

Clinical Implications

The results of this study can serve as a reminder to teachers and speech-language pathologists working with children in the early stages of literacy development that spelling accuracy is expected to decrease as word complexity or syntactic complex-

ity increases, at least when children are required to write about meaningful events. The teachers of the children we studied seemed to have an intuitive understanding of these interrelationships. By encouraging the children to write about their experiences without placing an emphasis on correct spelling it appeared that the teachers were willing to accept decreased spelling accuracy so that the children could develop creative writing skills. Thus, these children attempted both multisyllabic words and long, multiclausal sentences.

While the present study included only children who were typically developing, the findings may have implications for assessment and intervention with children who are experiencing literacy learning difficulties. When assessing children's written language abilities, it is important to remember that there is a dynamic relationship between task demands and child performance. The degree of complexity of an attempted word or sentence may have overflow effects on a child's performance at other levels in written tasks (e.g., complexity of the ideas conveyed, spelling accuracy, etc.). Thus, exploring a child's performance while systematically varying the complexity of various components of the task may be particularly revealing. Lahey and Bloom (1994), among others, have discussed in some detail how assumptions of limited capacity processing systems lead to such an assessment approach—one that seeks to define a child's range of performance. Of course, future studies must examine interactions in the writing of language-impaired children directly.

Conclusion

The current investigation constitutes an initial attempt to investigate the interrelationships between syntactic complexity or word complexity and the accuracy of spelling. The results provide preliminary evidence for how various aspects of written language impact upon each other in the context of a developing written language system. The participant pool in these studies is quite small. Consequently, these findings await replication. As well, it will be necessary to further elaborate how the various components of written language are interrelated, for example, discourse type and syntactic complexity.

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