AWLL-13 2021

Hebrew affix spelling in children with developmental dyslexia

Rachel Schiff[1] and Dorit Ravid[2]

[1]Bar Ilan University [2]Tel Aviv University

Spelling knowledge

- Lexical in nature
  - Part of language users' knowledge about words and patterns of similarities that link words together
- Spelling performance improves over many learning trials from repeated encounters with written texts, as patterns are learned as generalizations over memories of words

Learning to spell

- Regarded as part of the acquisition of “lexical quality” in a particular language, and good spellers have qualitative lexical representations (Perfetti, 2007)
- The more a person knows about a word in terms of its lexical semantics, phonology, morphology, and syntax, the more “qualitative” its representation and retrieval
- A stable orthographic representation (= correct spelling) is an important signal of a word’s lexical quality
- Spelling promotes abstract, dense representations of the linguistic components of words (Ravid & Tolchinsky, 2002)

Learning to spell

- Studies of spoken language acquisition underscore the role of statistical properties of the ambient language such as type and token frequency, transparency, regularity, consistency, salience, and neighborhood density (MacRoy-Higgins et al., 2013; Nation, 2013; Ambridge et al., 2015)
- In learning to spell, learners would be looking for similar consistent and meaningful statistical patterns in the visual representation of word-internal units that they have mapped out for spoken language (Levin et al., 2001; Ravid, 2012; McCutchen and Stull, 2015; Northey et al., 2016; Treiman, 2018a; Treiman et al., 2019).

Morphology in learning to spell

- In many languages, morphology constitutes the architecture of hidden units mediating the complex and often opaque relationships between phonology and orthography
  - Sandra, 2018 (review): Alphabetical orthographies may ignore finer morpho-phonological distinctions to express the meaningful generalizations of the morphological system

Three knowledge domains necessary to spelling acquisition

(i) How phonological segments map onto graphemes

(ii) The specific properties of the orthographic system

(iii) The nature of the morphological segments represented by the orthography

To this end

- Young spellers need to keep track of multiple co-occurrences of different units, monitoring the frequencies, regularities and consistent behavior of phonemes and morphemes in words, and how they are expressed in the specific orthographic patterns of their language

Which brings us to the topic of the current study

Exploring the effect of developmental dyslexia on Hebrew affix spelling

Developmental Dyslexia

- Developmental dyslexia / reading disability is characterized as a specific functional failure to acquire the age-appropriate reading skills in otherwise normally developing children
- Individuals with DD typically exhibit difficulty in single word recognition, poor performance in non-word repetition and non-word reading, and persisting difficulties in phonological word decoding
- A core problem in developmental dyslexia is phonological; but recent studies suggest that it involves deficiencies in several additional linguistic domains
- Languages with rich and complex morphologies such as Hebrew pose a greater challenge for individuals with dyslexia

Previous studies on dyslexic learners

- Showed deficiency in morphological skills, lower ability to make use of morphological cues in morphological tasks and in spelling tasks
- Had deficient morphological processing compared to normal readers, were less sensitive to the internal structure of words and had difficulty breaking words up into morphological segments.
- Ravid & Schiff, 2013; Schiff & Ravid, 2004; 2007; 2013 (Eds); Schiff et al., 2016; Schiff et al., 2019

A major challenge in spelling Hebrew

- Extensive neutralizations of historically distinct phonological classes and individual phonemes have resulted in homophony (Bolozky, 1997; Ravid, 2005)
- For example, *k* is expressed by both ק (historically emphatic *q*) and כ (which currently represents the stop *k* and the spirant *x*)

Homophonous affix spelling

- Low type frequency of affix letters
  - Only 11 of the 22 alphabet letters serve in affix letters
- Very high token frequency as grammatical morphemes with 20 affixes 20 affix roles, both derivational and inflectional
  - E.g., temporal / agreement markers, markers of nominal and verb patterns
- Mapping complexity reduced in affix spelling, as only one of the two possible graphemes serves as an affix letter
- For example, of the two letters ת ,ט representing *t*, only ת represents affix roles
- Therefore, a large part of the homophonous challenge to spelling affix letters disappears (Gillis and Ravid, 2006)

Therefore

- Identifying the morphological role of the homophonous letter as an affix versus root letter is critical in achieving correct spelling (Ravid, 2012)
- Root letters typically congregate in the center of the written Hebrew word, whereas affix letters take peripheral positions in the outer envelope of the word.
  - For example, the written string **ובמכתבים** ‘and-in-the-letter-s, the bolded letters at both sides of the root כתב‘write’ represent the affixal roles of conjunction, preposition, pattern prefix and plural suffix.
- The small number of affixes (low type frequency), their ubiquity in the language (high token frequency), and their distinct peripheral positions all serve as reliable morphological pointers to affix morphology.

However

- Not all affixes are easy to identify as such, since the boundaries between root and affix sites might be blurred
- This can happen, for example, in words with irregular roots such as *to'élet* תועלת 'benefit' where the root is not entirely consonantal, so that the first ת might be interpreted as a root letter
- Frequency and coherence (= consistency) of linguistic units, especially in specific sites, might hinder or promote a successful mapping of the morphology-phonology-orthography link
  - For example, *v* is more likely to be an affix at the beginning of the word (the conjunction ve-), and less to at the end of a word, where it has few roles, e.g., representing an allomorph of the 3rd person posses

Schiff, R., Rosenshtok, S., & Ravid, D. (2020) Morpho-orthographic complexity in affix spelling in Hebrew: A novel psycholinguistic outlook across the school years. *Frontiers Psychology*, 11:868

- Investigated the role of five morpho-orthographic factors in learning to spell homophonous affix letters in Hebrew

1. Morpho-orthographic transparency – demarcation of the envelope
2. Affix letter prevalence – category size
3. Morphological competition by other affixes
4. Overtness of the phonological-orthographic link
5. Phono-morpho-orthographic consistency – a strong generalization that tends to be over-extended to incorrect sites

Schiff, R., Rosenshtok, S., & Ravid, D. (2020) Morpho-orthographic complexity in affix spelling in Hebrew: A novel psycholinguistic outlook across the school years. *Frontiers Psychology*, 11:868

- Participants were 83 monolingual Hebrew-speaking 2nd, 4th, 7th, and 10th graders
- The research instrument was a spelling task of 244 words containing affix letters in 56 morphological categories, both inflectional and derivational
- Correct spelling increased across grade levels
- Younger spellers were mostly assisted by morpho-orthographic demarcation, category size, and phonological overtness – while spelling in higher grade levels was more affected by morpho-orthographic generalizability
- Thus, knowledge of how morphological roles are deployed in the orthography emerges as the most significant factor that affects learning to spell affix letters in Hebrew

Hebrew affix spelling in children with developmental dyslexia

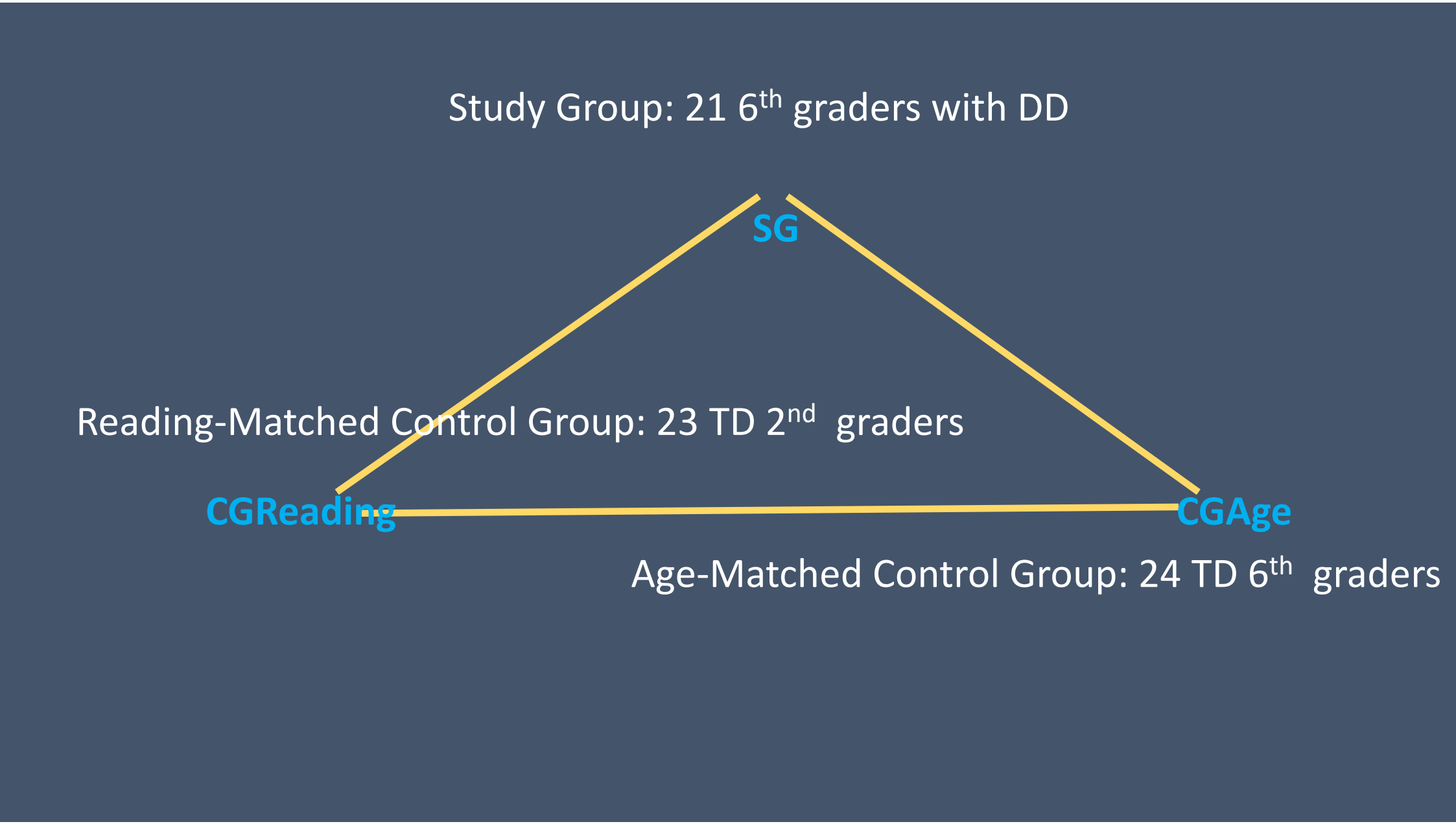
The current study

Aims

- To explore whether the performance of 6th grade dyslexic children, chronological age matched controls and reading-level matched controls on the affix spelling task differs as a function of word frequency and the morpho-orthographic metrics of affix spelling

68 Hebrew speaking participants

- 21 6th graders with Developmental Dyslexia
  - Study Group
- 23 2nd graders with typical development
  - Age-matched control group
- 24 6th graders with typical development
  - Reading-matched control group


Study Group: 21 6th graders with DD
SG
Reading-Matched Control Group: 23 TD 2nd graders
CGReading
CGAge
Age-Matched Control Group: 24 TD 6th graders

Information about participants

- The three groups did not differ on the verbal and the non-verbal intelligence tests
- TD 6th graders > TD 2nd graders and > DD 6th graders on reading accuracy of non-pointed words
- But 6th graders with DD and TD 2nd graders were reading matched

The affix letter spelling task

- The same instrument as the one used in Schiff, Rosenshtok, & Ravid, 2020
- A spelling task of 244 words containing affix letters covering all 56 affixal morphological categories, both inflectional and derivational
- Examples of categories

1. Prefixal conjunction *ve* 'and' spelled ו והלך 'and-went'
2. The tense/person prefix *t-* spelled ת תדבר 'you will speak'
3. The nominal pattern suffix *t-* spelled ת משמרת 'shift'
4. The suffixal *-xa* indicating second person masculine אתך 'with-you

Procedure

A spelling-to-dictation task administered orally and individually, presented in the context of a short sentence

Participants wrote only the target word, which was repeated at the beginning and end of each sentence

- For example: *mishkéfet, yesh la-yéled mishkéfet; tixtevu mishkéfet* ‘goggles, the boy has goggles; please write: goggles’

Coding

1. Word frequency

- Half of the words (112) were of high frequency and half (112) were of low frequency as assessed by 10 judges on a scale of 1-5
- 1-2 low frequency; 4-5 high frequency

2. Affix complexity

- As assessed by the five morpho-orthographic criteria of homophonous affix spelling
  - Each affix was assigned binary values regarding each of the five criteria

Presenting group results by word frequency and by each of the five criteria

Results

1. Demarcation: Transparency of the affix envelope

The degree to which it is possible to clearly demarcate the central root morpheme from the affixal periphery

תרדמה *tardema* ‘slumber’ Clearly demacated

תועלת *to'élet* ‘benefit’ Not clearly demarated

Means (and SD) of the success scores (%) of spelling function by word frequency, group and transparency of the affix envelope

Demarcation by group and word frequency

		Non-demarcated envelope		Demarcated envelope	
Word frequency	Group	Mean	SD	Mean	SD
Non-frequent words	Second – TD (n = 23)	44.44%	13.10	82.43%	9.06
	Sixth – TD (n = 24)	77.69%	13.88	96.23%	2.94
	Sixth – DD (n = 21)	42.75%	9.05	55.67%	14.46
Frequent words	Second – TD (n = 23)	51.14%	17.30	83.53%	10.56
	Sixth – TD (n = 24)	86.90%	11.52	97.75%	2.76
	Sixth – DD (n = 21)	53.51%	10.64	62.76%	14.67

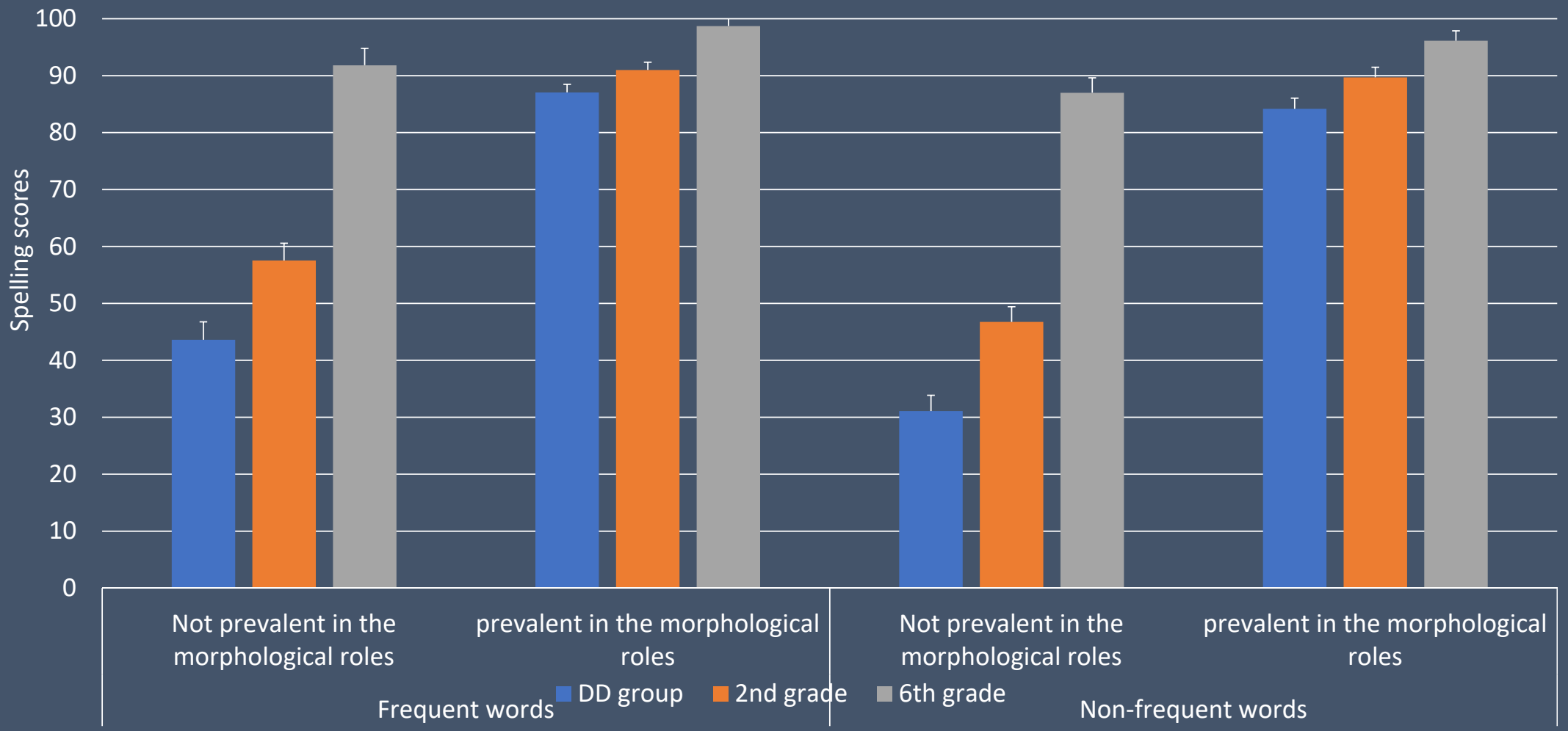
1. Reading matched TD 2nd graders > 6th graders with DD
2. Demarcated envelope
   TD 6th > TD 2nd > DD 6th
3. Non demarcated envelope
   TD 6th > TD 2nd = DD 6th
4. Larger difference between demarcated / non-demarcated envelope in rare words

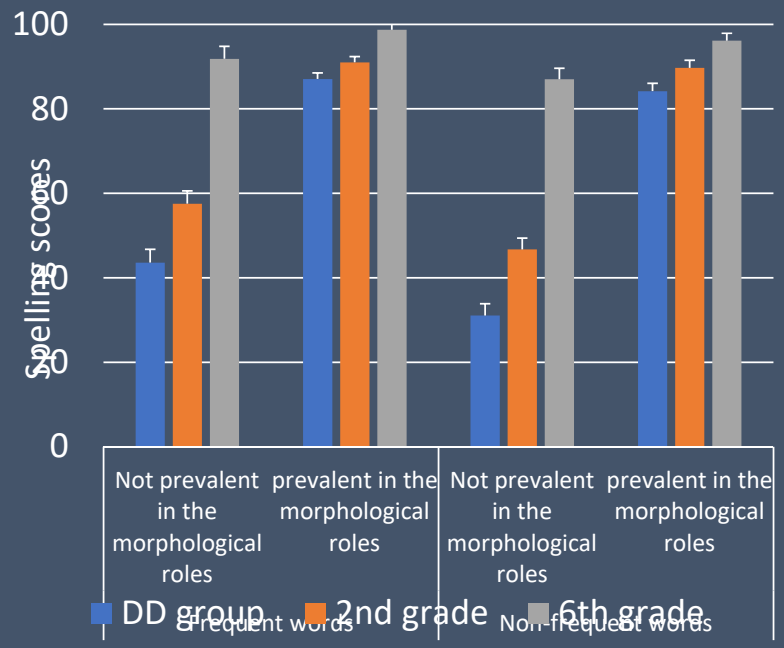
2. Affix letter prevalence: Category size

- The frequency of the letter in its morphological and orthographic roles. The number of morphological affix roles of the letter, their variety and prevalence
- ת *t* prevalent as prefix and suffix, with 11 inflectional and derivational roles
- כ k ¬ x non-prevalent with two affix roles, both inflectional, with further constraints due to morpho-phonological behavior

Based on the analysis in Ravid, 2012

Affix letter prevalence by group and word frequency





Reading matched TD 2nd graders > 6th graders with DD

Frequent and rare words, prevalent affix: TD 6th > TD 2nd = DD 6th

Frequent and rare words, non-prevalent affix: TD 6th > TD 2nd > DD 6th

Affix letter prevalence by group and word frequency

3. Affixal competition

Competition between phonologically similar affixes with close morphological affixal roles

ה and י are competitors, both serving as temporal (past and future tense respectively) prefixes in *hitpa'el*

h*itkadem* 'advanced' התקדם

y*itkadem* 'will advance, 3rd Sg' יתקדם

Table 2
Means (and SD) of the success scores (%) of spelling function by word frequency, group and morpho-phonological competition

Affixal competition by group and word frequency

		No-competitors		Competitors	
Word frequency	Group	Mean	SD	Mean	SD
Non-frequent words	Second – TD (n = 23)	88.48%	6.23	59.57%	10.76
	Sixth – TD (n = 24)	94.89%	4.00	88.68%	8.26
	Sixth – DD (n = 21)	59.29%	10.40	33.10%	11.23
Frequent words	Second – TD (n = 23)	90.35%	7.96	64.08%	15.98
	Sixth – TD (n = 24)	96.94%	3.21	93.05%	5.92
	Sixth – DD (n = 21)	72.95%	13.31	51.75%	14.27

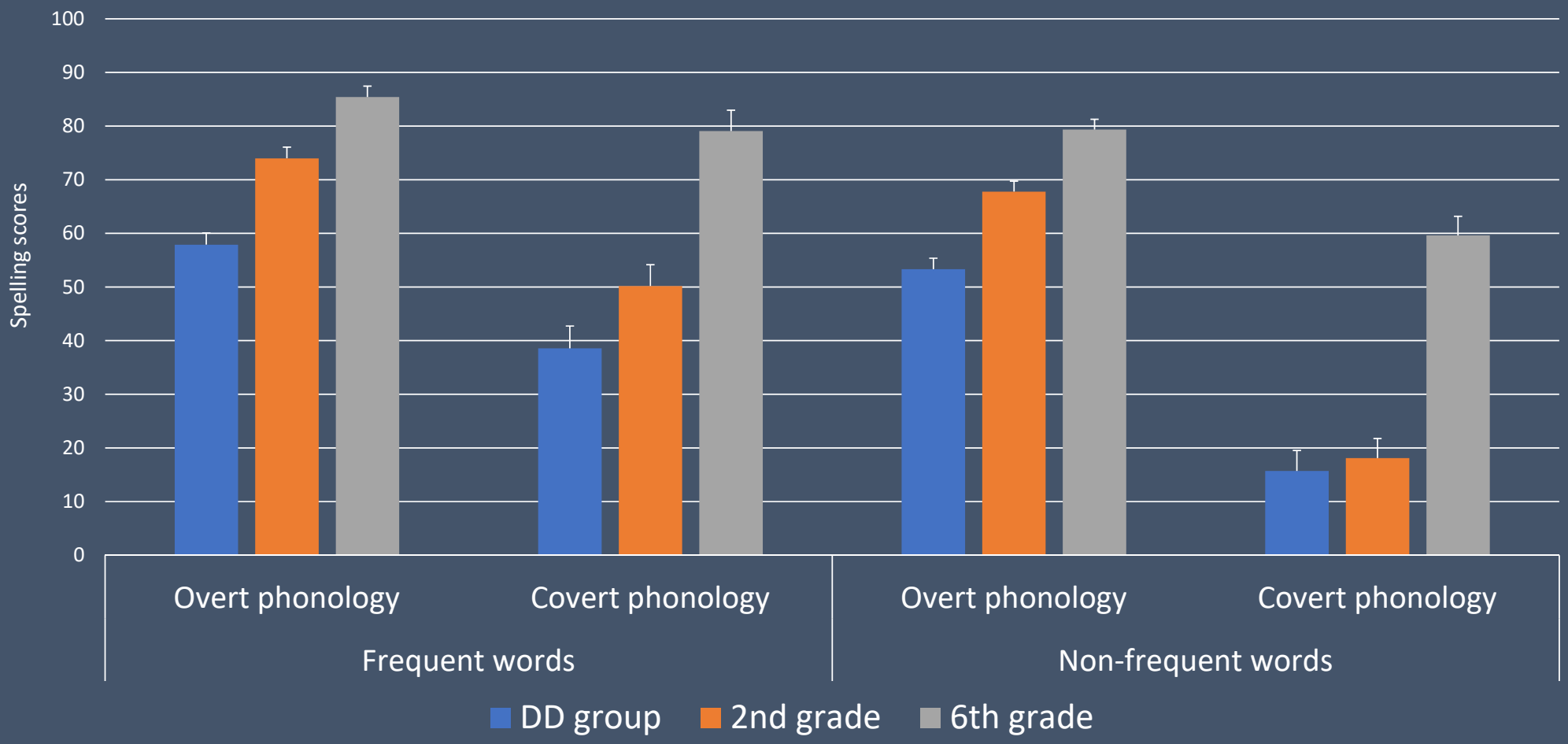
Affixal competition by group and word frequency

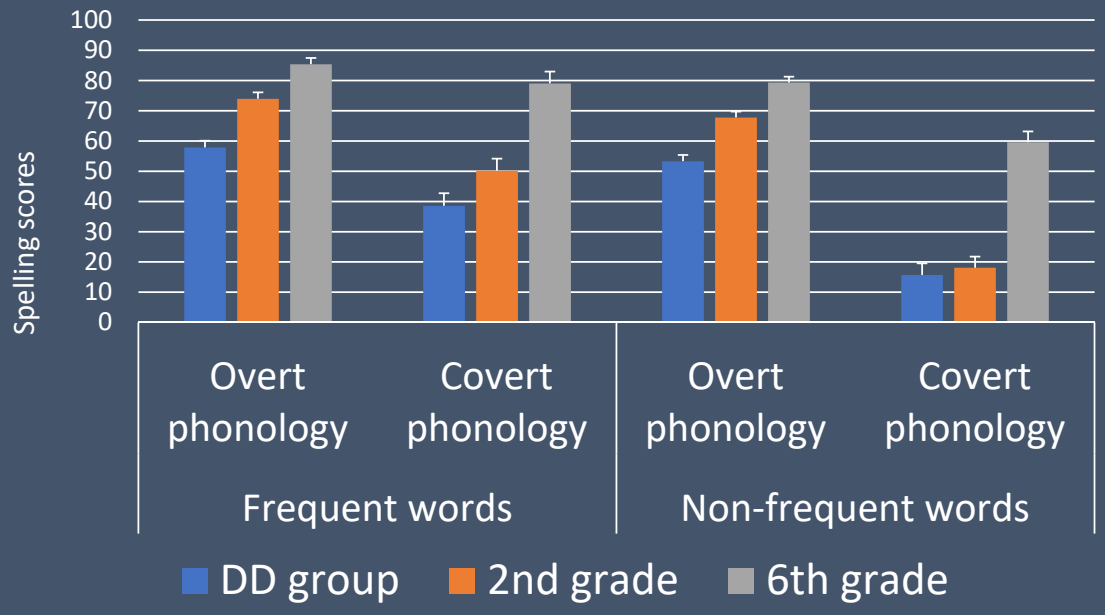
- Reading matched TD 2nd graders > 6th graders with DD
- TD 6th > TD 2nd > DD 6th with and without affixal competition, with frequent and rare words
- All three groups perform better in the absence of competition, but effect size is larger in the DD group
- The discrepancy between frequent and rare words is larger in DD 6th and TD 2nd than in the TD 6th
- In rare words the discrepancy is larger between the presence and absence of competition

4. Overtness of the phonological-orthographic link

- The link is overt if the letter represents a phonological segment
- The link is covert where the orthographic segment does not represent a phonological unit (only a morphological unit)
- The possessive suffix *-av* ‘his’ יו- is spelled with ו which does not link to any phonological segment normally related to it (*i, y*)

(C)overt phonological linkage by group and word frequency





Reading matched TD 2nd graders > 6th graders with DD

Frequent and rare words, overt phonology: TD 6th >TD 2nd > DD 6th

Frequent and rare words, covert phonology: TD 6th >TD 2nd = DD 6th

(C)overt phonological linkage by group and word frequency

5. Phono-morpho-orthographic consistency Strong over-extended generalization

- The degree of consistency in spelling patterns, yielding strong generalizations that tend to be over-extended
- The prevalent link between a final feminine -*a* spelled by ה
  - Feminine *malk***a** מלכה 'queen', *sgur***a** סגורה 'closed', *lakx***a** לקחה 'took'
- Generalization: Open syllables at the end of a word should be 'closed' in writing by one of the אהוי letters, especially ה
  - Seemingly violated in *katávta* כתבת 'you,masculine wrote'

Table 5
Means (and SD) of the success scores (%) of spelling function by word frequency, group and phono-morpho-orthographic consistency

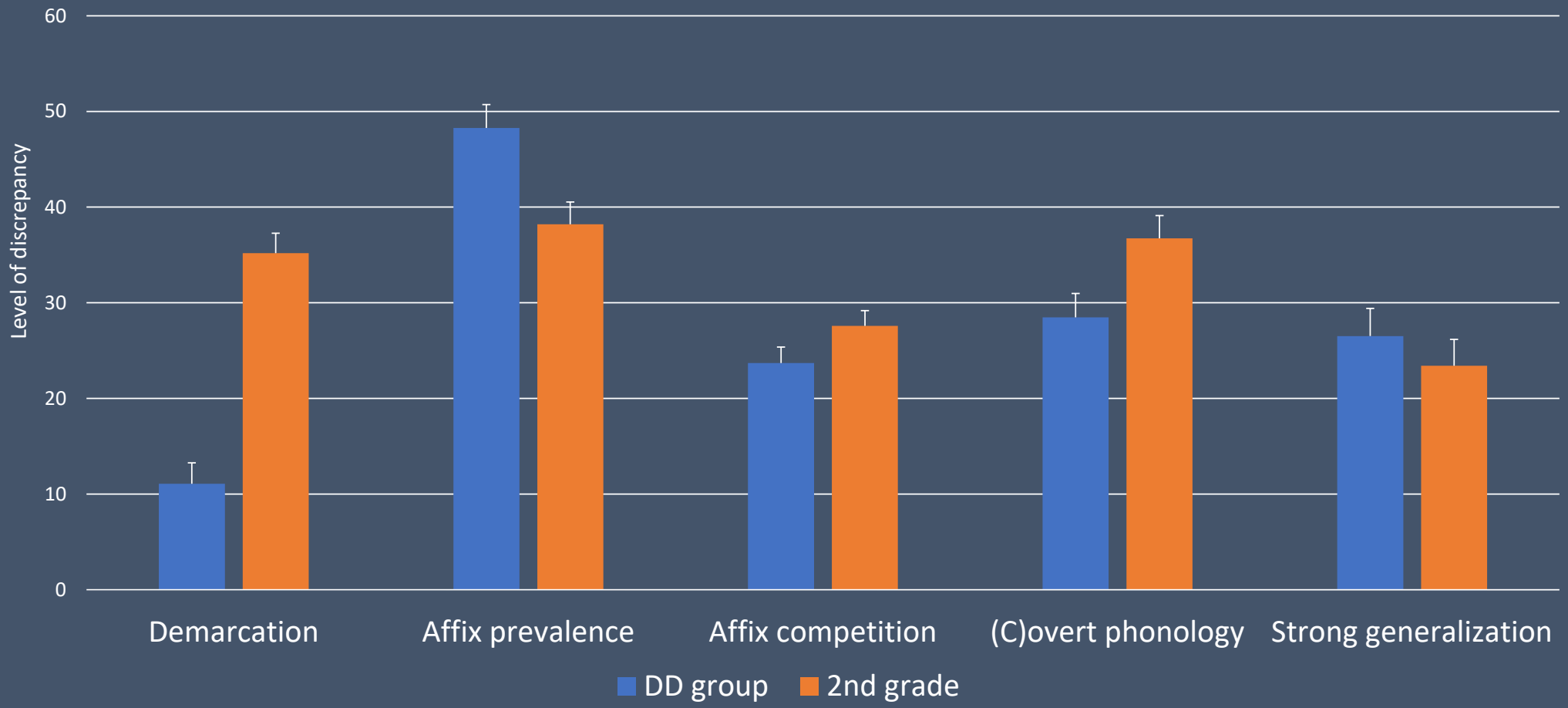
Strong overextended generalization by group and word frequency

		No powerful generalization		Powerful generalization	
Word frequency	Group	Mean	SD	Mean	SD
Non-frequent words	Second – TD (n = 23)	51.70%	12.71	78.43%	9.00
	Sixth – TD (n = 24)	92.28%	5.93	93.67%	5.32
	Sixth – DD (n = 21)	29.41%	19.14	58.54%	9.45
Frequent words	Second – TD (n = 23)	61.04%	20.22	81.13%	10.22
	Sixth – TD (n = 24)	95.86%	6.24	96.15%	3.14
	Sixth – DD (n = 21)	41.33%	21.53	65.24%	11.13

Strong overextended generalization by group and word frequency

- Reading matched TD 2nd graders > 6th graders with DD
- TD 6th > TD 2nd > DD 6th in both conditions – with and without extension of strong generalization
- TD 2nd and DD 6th do better when no extension of strong generalization, but this is no longer significant in TD reading-matched 6th
- TD 6th > TD 2nd > DD 6th in frequent and rare words
- The discrepancy between frequent and rare words is largest in DD 6th
- In rare words the discrepancy is larger between the conditions ofwith and without extension of strong generalization

Comparison of reading matched 2nd graders and the DD 6th graders on the five criteria



Comparison of reading matched 2nd graders and the DD 6th graders on the five criteria

The discrepancy between the existence and the absence of the criterion among the DD group was significantly lower than in the reading age matched TD 2nd grade students on demarcation and overt phonology

- TDs rely more on affix envelope transparency and overtness of the phonological-orthographic principle

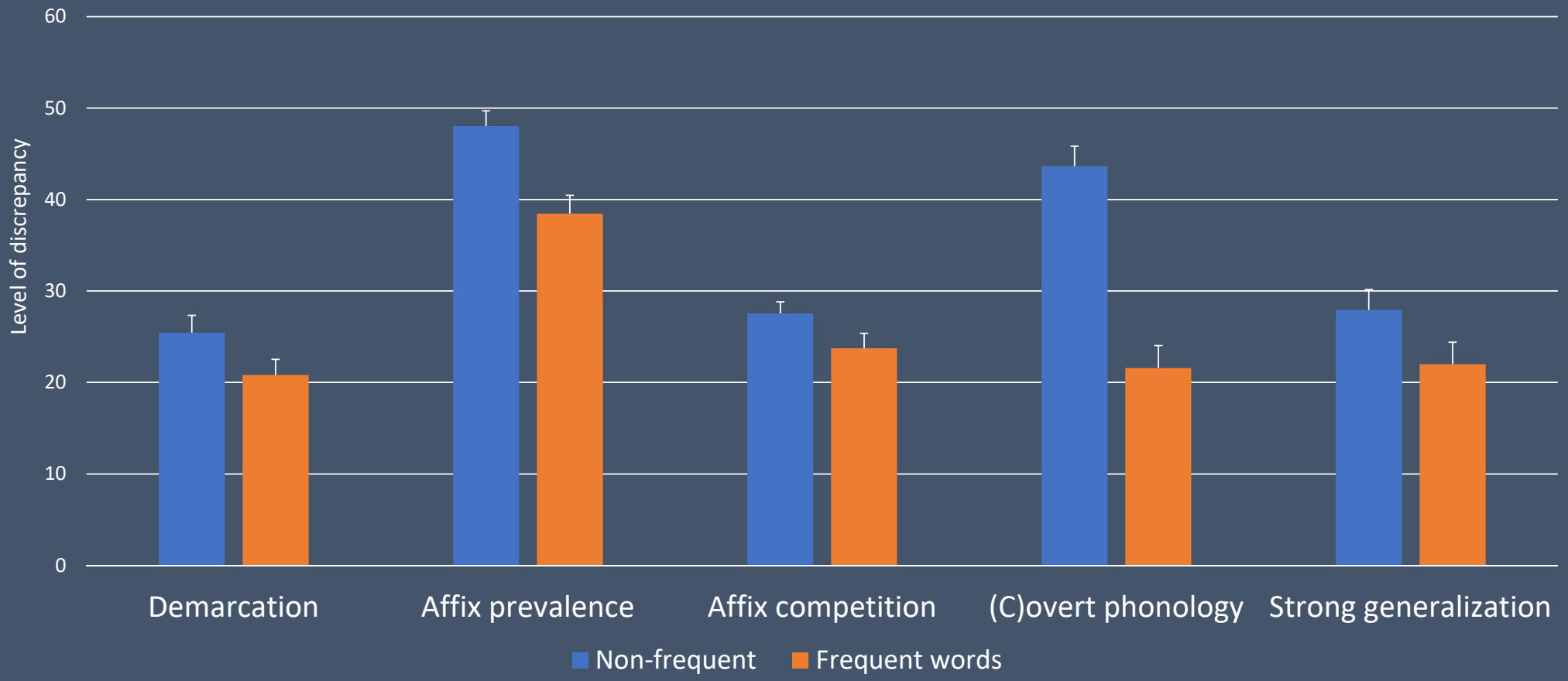
The discrepancy between the existence and the absence of the criterion among the DD group was significantly higher than among the reading age matched TD students on affix letter prevalence

DD 6th graders rely more on affix letter prevalence

No significant differences between the two groups were found in the discrepancy etween the existence and the absence of morpho-phonological competition and the strong overextended generalization criterion

no difference in the level of reliance

Comparison of frequent and rare words on the five criteria



Comparison of frequent and rare words on the five criteria

The level of discrepancy between the existence and the absence of the criterion is greater in non-frequent words compared to frequent words across all five morpho-orthographic criteria

The effect size of the differences was greater in the categories of affix letter prevalence and overt phonology compared to demarcation of the affix envelope, affixal competition and strong overextended generalization

Discussion
Summary, conclusions

The five factors affecting the development of Hebrew affix spelling

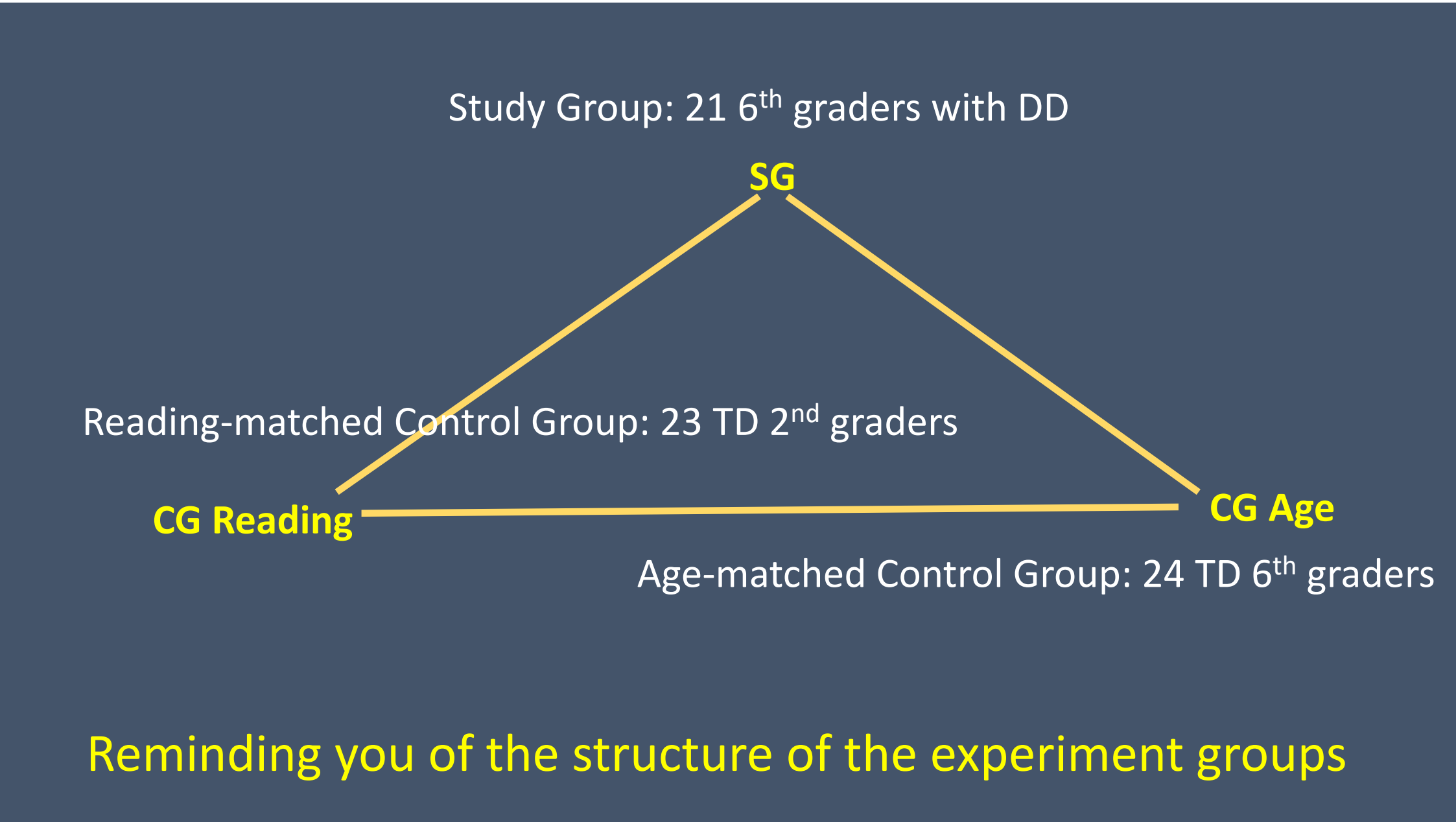
- Results of the current study support and complement the results of Schiff et al., 2020 (*Frontiers Psychology*)
- Spelling of an affix is adversely affected
  - In the absence of affix envelope transparency (demarcation) which obscures the identity of the affix as such
  - When the affix letter is not prevalent in terms of morphological roles, orthographic prevalence, orthographic sites = small category size
  - When the affix faces competition from another affix in a similar role in the same morphological environment
  - When affix letters do not reflect conventional phonological values
  - And when a strong generalization is (seemingly) violated, therefore is overextended overextended

Affix complexity

Overcoming affix complexity

- Require a deep familiarity with Hebrew morphological inflectional and derivational classes, its orthographic principles and the complex ways in which the orthography maps onto phonology and morphology
  - Which comes with age and schooling in typically developing children
- The challenges of affix complexity are exacerbated when it is part of rare words
- Frequency affects all aspects of language learning (Ambridge et al., 2015)

Affix spelling in 6th graders with developmental dyslexia (DD) discussion



Reminding you of the structure of the experiment groups

6th grade children with developmental dyslexia

- Consistently perform worse than typically developing 2nd graders on all five criteria of affix spelling
  - These two groups are reading-matched
- The spelling affix task is diagnostic of children with developmental dyslexia

6th grade children with developmental dyslexia

1. Do not make efficient use of root / affix envelope
   TRANSPARENCY
   Less than TD 2nd graders when demarcated, same as TD 2nd graders when non-demarcated

2. Adversely affected by non-prevalence of affix
   CATEGORY SIZE
   Same as TD 2nd graders when prevalent, less than TD 2nd graders when non-demarcated; also seen in overall comparison

6th grade children with developmental dyslexia

3. Struggle more than other groups to differentiate between phonologically and morphologically similar temporal verb pattern affixes

GRAMMATICAL SPECIFICITY

- All three groups perform better in the absence of competition, but effect size is larger in the DD group
- The discrepancy between frequent and rare words is larger in DD 6th and TD 2nd than in the TD 6th

6th grade children with developmental dyslexia

4. Do not make efficient use of overt phonology-orthography linkage, and struggle with covert phonology as much as TD 2nd graders

LINKING THE THREE COMPONENTS OF SPELLING KNOWLEDGE

5. Like younger, reading-matched 2nd graders, overextend strong generalization of closing open syllable –a with ה, ignoring gender information, especially in rare words

ORTHOGRAPHIC SPECIFICITY

The study

- Offers a window on the struggle of children with DD to keep track of multiple co-occurrences of different units, to monitor the frequencies, regularities and consistent behavior of phonemes and morphemes in words, and how they are expressed in the specific orthographic patterns of Hebrew
- and on their inability to develop LEXICAL QUALITY IN SPELLING in elementary school

THANK YOU

FOR LISTENING

Example

- Berg and Aronoff, 2017 – a corpus study of written English across a millennium (750–1700 AD) traces the emergence of affix spelling from variegated beginnings to clear morphological marking of nouns, adjectives, and verbs – e.g., the –OUS adjectival suffix.
- The authors remark that “Crucially, this is information that the phonological system does not provide – it is a distinct feature of the writing system” (p. 45), in which the spelling distinguishes homophonous suffixes or word endings and allows readers to access lexical and syntactic information directly from the orthographic representations