

Grammar Checking in Language Arts

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Sentence Composition

- Education Program for Gifted Youth (EPGY) at Stanford
- Language Arts and Writing for Grades 2–6
- Now used in remedial coursework
- Goal: to help students improve writing skills
- Exercise-based course with automatic immediate feedback



Exercise design

- Present a few sentences of context
- Ask a question
- Provide a set of (fully inflected) words, listed by part-of-speech
- Ask the student to compose an answer as a complete sentence
- Evaluate the answer, and if incorrect, identify error where possible
- Ask the student to try again once





3.G.14.01

Sentence Composition

Write a complete sentence that answers the question by clicking on words from the lists.
To remove a word from your answer, click and drag it out of the box. Use RESET to remove all your words.

Ricky stores his toys in his closet.

Where are Ricky's toys?

<u>Verb</u>	<u>Noun</u>	<u>Article</u>	<u>Preposition</u>	<u>Pronoun</u>	<u>Contraction</u>
are	Ricky's	the	in	it	Ricky's
be	desk			they	
	closet			his	
	garden				
	toys				

Some correct student answers

*Ricky stores his toys in the closet.
Where are Ricky's toys?*

Ricky's toys are in the closet

Ricky's toys are in his closet

they are in his closet

they are in the closet

his toys are in the closet

they are in Ricky's closet

the toys are in Ricky's closet

the toys are in the closet

Ricky's are in the closet

his toys are in Ricky's closet

Ricky's toys are in Ricky's closet

Ricky's toys are in the toys closet



Some correct student answers

226	Ricky's toys are in the closet
170	Ricky's toys are in his closet
21	they are in his closet
21	they are in the closet
19	his toys are in the closet
11	they are in Ricky's closet
5	the toys are in Ricky's closet
4	the toys are in the closet
3	Ricky's are in the closet
1	his toys are in Ricky's closet
1	Ricky's toys are in Ricky's closet
1	Ricky's toys are in the toys closet



Some incorrect student answers

closet

garden Ricky's they his at

his toys in the closet

in in in in Ricky's in Ricky's Ricky's

in his closet

in his toys closet

in Ricky's closet

in Ricky's closet his toys are

in the closet

Ricky's

Ricky's are his closet

Ricky's are his toys in his closet

Ricky's are the closet at

Ricky's closet

Ricky's closet toys

Ricky's closet toys are in it

Ricky's desk are toys



More incorrect student answers

Ricky's desk be they Ricky's Ricky's

Ricky's desk closet garden toys his they Ricky's it are

Ricky's desk in the closet

Ricky's in garden they

Ricky's in the closet

Ricky's in the garden

Ricky's garden toys

Ricky's his desk closet

Ricky's his toys in his closet

Ricky's in

Ricky's in the closet

Ricky's Ricky's

Ricky's Ricky's Ricky's they Ricky's his they

Ricky's Ricky's Ricky's Ricky's Ricky's Ricky's Ricky's Ricky's Ricky's

Ricky's Ricky's Ricky's Ricky's Ricky's Ricky's

Ricky's they in the toys

Ricky's toys



More incorrect student answers

Ricky's toys are closet

Ricky's toys are closet in

Ricky's toys are his closet

Ricky's toys are his in closet

Ricky's toys are his the closet

Ricky's toys are in

Ricky's toys are in closet

Ricky's toys are in garden

Ricky's toys are in his

Ricky's toys are in his desk they are the garden

Ricky's toys are in the

Ricky's toys are in the desk

Ricky's toys are the in closet

Ricky's toys are in the garden

Ricky's toys his in the closet

Ricky's toys in are closet

Ricky's toys in are his closet



More incorrect student answers

Ricky's toys in closet
Ricky's toys in his closet
Ricky's toys in the closet
Ricky's toys in the desk
Ricky's toys in the garden
Ricky's toys the in closet
Ricky's toys toys
the garden Ricky's his
the toys are in Ricky's
the toys in Ricky's closet
they are in closet
they in Ricky's closet
they Ricky's Ricky's toys closet
toys Ricky's



Syntactically incorrect student answers

60	in his closet
34	in Ricky's closet
34	closet
32	in the closet
28	Ricky's toys in his closet
25	Ricky's
15	Ricky's toys in the closet
15	Ricky's toys are in closet



Approach

- Use DELPH-IN resources: ERG, PET
- Build on Arboretum, Checkpoint: 'mal-rules', error diagnosis
- Parse each novel input and return derivation tree
- Check for `root_robust`, and if so, find `..._rbst` node
- Look up robustness symbol in error code table
- Present appropriate message to student



Example derivation

```
(704 sb-hd_mc_c 1.03 0 6 [root_robust_s]
  (701 sp-hd_n_c -0.3986 0 3
    (700 sp-hd_hc_c -1.308 0 2
      (699 hdn_bnp-pn_c -1.935 0 1
        (226 n_sg_ilr -2.096 0 1
          (32 ricky_n1/n_-_pn_le 0 0 1 []
            (31 "ricky" 0 0 1 <0:1>))))
          (33 apostrophe_s_2_lex/n_-_cl-poss_le 0.08115 1 2 []
            (30 "'s" 0 1 2 <1:2>)))
        (111 n_pl_olr 0.8421 2 3
          (76 toy_n1/n_-_c_le 0 2 3 [n_pl_olr]
            (26 "toys" 0 2 3 <2:3>))))
      (387 hd-cmp_u_c 0.6226 3 6
        (85 be_c_are/v_prd_are_le 0.1223 3 4 [] (27 "are" 0 3 4 <3:4>))
        (369 hd-cmp_u_c 0.2548 4 6
          (101 in/p_np_i-reg_le -0.1285 4 5 [] (28 "in" 0 4 5 <4:5>))
          (234 bare_np_sg_rbst 0.3833 5 6
            (121 n_sg_ilr 0.3833 5 6
              (110 closet_n1/n_-_c_le 0 5 6 []
                (29 "closet" 0 5 6 <5:6>))))))))))
```

Extensions to ERG

- [GENRE *robust*] value on signs; `root_robust` start-symbol
- Mal-rules for inflection, syntax
 - e.g. 3sg present tense verb without -s; bare-sg-NP
- Mal-types for lexicon
 - e.g. subj-equi with base VP: **Ricky likes go to the park*
- Restrictions on lexical types
 - e.g. block use of determiners with proper names
 - *The Ricky goes to the park*
- Restrictions on constructions
 - e.g. block noun-noun compound rules
 - *Ricky's closet toys are in the closet*
- Restrictions on lexicon: masking unwanted ambiguity
 - e.g. block verb *flower*



Some numbers

- 30,000-item test set of correct and incorrect answers
 - Correct answers identified: 99%+
 - Syntactically incorrect answers identified: 95%



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 - 5,000 by March 2010
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- Number of sentences composed by students
 - 100,000 per week in March
 - 500,000 per week in May
- Number of sentences parsed by PET with ERG
 - 30,000 per week in March
 - 150,000 per week in May



Nice properties of this application

- Limited vocabulary
- Wide syntactic variation
- Short utterances
- Demand for precise determination of grammaticality
- Low tolerance for false negatives (rejecting good input)
- Need for linguistic analysis of error(s)
- Slow but steady increase in complexity of inputs



An example from Grade 5

*Abigail didn't want to go hiking with her parents because she felt too tired and wanted to rest instead.
Why didn't Abigail want to go hiking?*



An example from Grade 5

Abigail didn't want to go hiking with her parents because she felt too tired and wanted to rest instead.

Why didn't Abigail want to go hiking?

She was tired.



An example from Grade 5

Abigail didn't want to go hiking with her parents because she felt too tired and wanted to rest instead.

Why didn't Abigail want to go hiking?

She was tired.

She was too tired.



An example from Grade 5

Abigail didn't want to go hiking with her parents because she felt too tired and wanted to rest instead.

Why didn't Abigail want to go hiking?

She was tired.

She was too tired.

She was too tired to.



An example from Grade 5

Abigail didn't want to go hiking with her parents because she felt too tired and wanted to rest instead.

Why didn't Abigail want to go hiking?

She was tired.

She was too tired.

She was too tired to.

She was too tired to go.



An example from Grade 5

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Why didn't Abigail want to go hiking?

She was tired.

She was too tired.

She was too tired to.

She was too tired to go.

She was too tired to hike.



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She was tired.

She was too tired.

She was too tired to.

She was too tired to go.

She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.



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She was too tired.

She was too tired to.

She was too tired to go.

She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.



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She was too tired to.

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She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.

She didn't want to because she was too tired.



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She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.

She didn't want to because she was too tired.

She didn't want to go because she was too tired.

She didn't want to hike because she was too tired.



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She was too tired to.

She was too tired to go.

She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.

She didn't want to because she was too tired.

She didn't want to go because she was too tired.

She didn't want to hike because she was too tired.

She didn't want to go hike because she was too tired..



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She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.

She didn't want to because she was too tired.

She didn't want to go because she was too tired.

She didn't want to hike because she was too tired.

She didn't want to go hike because she was too tired..

She didn't want to go hiking because she was too tired.



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She was too tired to.

She was too tired to go.

She was too tired to hike.

She was too tired to go hike.

She was too tired to go hiking.

She didn't because she was too tired.

She didn't want to because she was too tired.

She didn't want to go because she was too tired.

She didn't want to hike because she was too tired.

She didn't want to go hike because she was too tired..

She didn't want to go hiking because she was too tired.

Abigail was too tired.



More variants

She didn't because she was tired.
She didn't because she was too tired.
She didn't because she was too tired to go hiking.
She didn't because she was too tired to hike.
She didn't want to because she was tired.
She didn't want to because she was too tired.
She didn't want to because she was too tired to.
She didn't want to because she was too tired to go hiking.
She didn't want to because she was too tired to hike.
She didn't want to go because she was tired.
She didn't want to go because she was too tired.
She didn't want to go because she was too tired to.
She didn't want to go because she was too tired to hike.
She didn't want to go because she was too tired to go hiking.
She didn't want to go because she was too tired to hike.
She didn't want to go because she was tired.
She didn't want to go because she was too tired.
She didn't want to go because she was too tired to.
She didn't want to go because she was too tired to go hiking.
She didn't want to go hike because she was tired.
She didn't want to go hike because she was too tired.
She didn't want to go hiking because she was tired.
She didn't want to go hiking because she was too tired.
She didn't want to go hiking because she was too tired to.
She didn't want to go hiking because she was too tired to go.
She didn't want to go hiking because she was too tired to go hiking.
She didn't want to hike because she was tired.
She didn't want to hike because she was too tired.
She didn't want to hike because she was too tired to.
She didn't want to hike because she was too tired to go hiking.
She didn't want to hike because she was too tired to hike.



Next steps

- Checking semantic correctness via MRS matching
Normalizing via MRS mapping rules (paraphrasing)
- Generation of corrected answers after second try
- Extension to paragraph composition (given a topic)
- Use of speech input and output for tutorial dialogues

