Grammatical Relationships for non Linguists

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ABSTRACT

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INTRODUCTION
Web search engines are quite effective at searches that are best expressed as keyword or (increasingly) natural language queries, but intuitive interfaces are still lacking for making syntactically structured queries. Our goal is to build useful interfaces to aid humanities scholars search and analyze written literature; however, this group is often skeptical of digital tools, primarily because they are often difficult to use, according to a recent large survey [**?**]. Another survey found that 50% of linguists who wished to make very technical linguistic queries cannot program [**?**]. But most existing interfaces for structured querying require complex syntax that is akin to programming, thus reducing the likelihood that the target users will be willing or able to use the tool.

To address this gap, we conducted an experiment to investigate how grammatical relationships between words in English can be made more recognizable to ordinary people. Following the principle of recognition over recall, as well as other earlier results on query by example, we hypothesized that examples would help people identify grammatical relationships more accurately rather than technical names.

Our results confirm that showing examples significantly improves the accuracy with which grammatical relationships are recognized. Participants identified grammatical relationships more accurately in all cases when they were shown examples of words or phrases that matched. Our findings also suggested that different types of relations benefited differently from words and phrases.

Intuitive interfaces for syntactic queries can be useful not just for scholarly work but also for developing complex patterns for recognizing entities in text, such as medical terms [], product names [] and names of organizations [].

RELATED WORK
In the linguistics literature, several tools have been developed recently for querying large collections of syntactically parsed data. The SketchEngine [] requires the user to build a tree or else modify a lisp s-expression.

EXPERIMENT 1: DO EXAMPLES HELP?

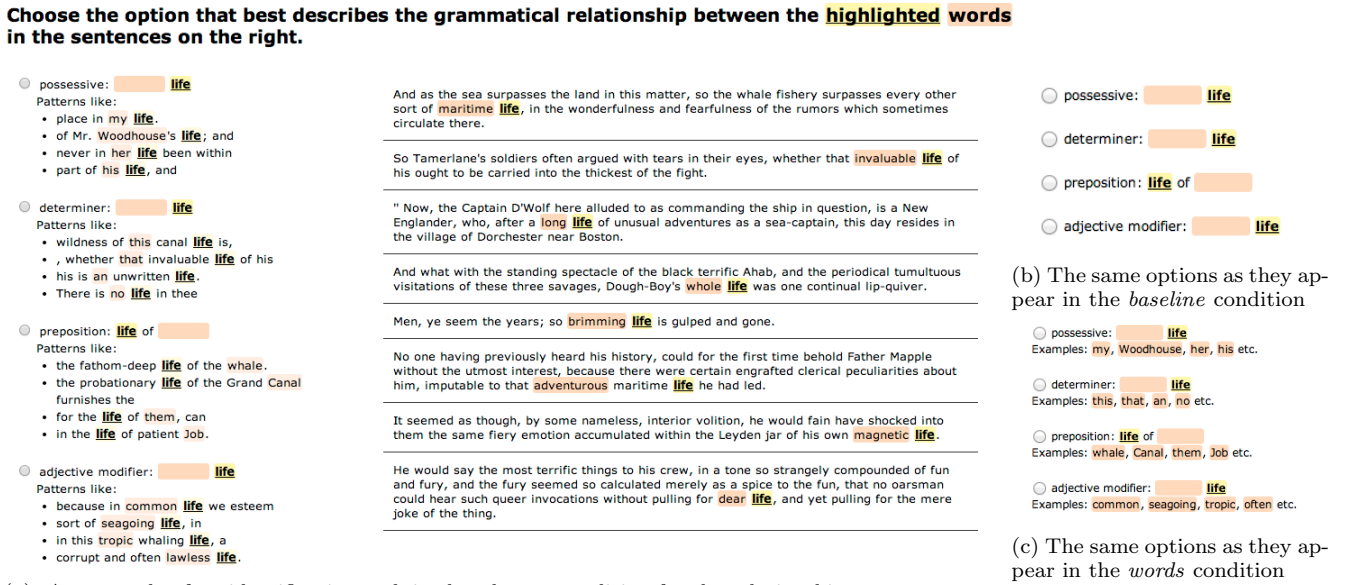
Hypothesis
Our experiment's goal was to find out whether grammatical relationships could be made more recognizable by showing examples of their usage. We tested two types of examples: a list of matching words and a list of matching phrases containing the relationship. These alternatives correspond to the explicitly visible and implicitly-inferred portions of a grammatical relation. The words are explicitly visible in the text, but the grammatical relationship is implicitly inferred from contextual information such as the part of speech of the verb, the relative ordering, and any accompanying words.

Our hypothesis was the following:

> H1. Grammatical relations can be made more recognizable by showing examples of words or phrases that match.

To test it, we presented participants with a series of identification tasks. In each task (Figure 1(a)), they were shown a list of sentences in which a particular grammatical relationship existed between two highlighted words. They were asked to identify which relationship it was from a list of four options. Using a between-subjects design, we tested different strategies for presenting these options. Our goal was to see whether participants to whom we showed example usages identified the relationships more accurately than those to whom we did not.

Variables
Presentation
We presented the choices in three different ways. The **baseline** presentation was a short label using linguistic terminology (Figure 1(b)), the **words** presentation was the short label accompanied by a list of words that matched (Figure 1(c)), and the **phrases** presentation was the short label accompanied by a list of phrases in which that relationship surfaced (Figure(1(a)). Figure



(a) An example of an identification task in the *phrases* condition for the relationship `amod(life, ___)` (where different adjectives modify the noun 'life'). The correct answer is 'adjective modifier' (4th option), and the remaining 3 options are distractors.

(b) The same options as they appear in the *baseline* condition

(c) The same options as they appear in the *words* condition

Figure 1: The way the choices appeared in the three experiment conditions.

1 shows what the three conditions of this identification task looked like for the `amod(life, ___)` task.

Relation Type

English grammatical relationships have two dimensions of variability that our study design had to account for: different characteristics, and the fact that they involve words with two different functions.

First, grammatical relationships are not all the same, they vary in how familiar they are, the distance they span, and the variability of the wording with which they surface. Some relationships, such as the adjective modifier, are taught in schools, whereas others are not. Some, such as adverbial relations, are distinctive because adverbs usually end in 'ly'. Clausal complements and conjunctions can link words across whole sentences, whereas noun compounds only operate over adjacent words. Prepositional relationships used a fixed set of prepositions to link two word, but adverbial clauses can appear in almost any form.

Because of this variability, we had to test a number of different types grammatical relationships. We tested two main categories of relationships:

1. Clausal or long-distance relations:

   advcl Adverbial clause: *she **said** it while **smiling***

   xcomp Open clausal complement: *I **learned** to **sing***

   ccomp Clausal complement: *I **thought** that I **knew** it*

   rcmod Relative clause modifier: *the **cat**, which we **rescued**, slept*

2. Other relations:

   nsubj Subject of verb: ***he threw** the ball*

   dobj Object of verb: *he **threw** the **ball***

   amod Adjective modifier ***red ball***

   prep_in Preposition (in): *the **water** in the **bucket***

   prep_of Preposition (of): *the **piece** of **cheese***

   conj_and Conjunction (and) ***mind** and **body***

   advmod Adverbial modifier: *she **said** it **slowly***

   nn Noun compound: ***Mr. Brown***

Words

The second dimension of variability is that a relation links two words that have different functions. In the verb-subject relationship "***he threw***", "he" is a noun and "threw" is a verb. When presenting a participant with a list of sentences containing the relationship, we therefore have several options: we could keep the relationship the same and vary the two words that are linked, we could keep the relationship and one word the same, and vary the second, or we could keep all three the same.

We decided on the middle approach – to fix the relationship as well as one of the words, but to test each relationship 4 times, with different words in the two different roles. For example, the verb-subject relation `nsubj` was tested in the following four forms:

1. `nsubj(Ahab, ___)`: the sentences each contained 'Ahab', highlighted in yellow, as the subject of different verbs highlighted in pink.

2. `nsubj(captain, ___)`

3. `nsubj(___, said)`: the sentences all contained the verb 'said', highlighted in yellow, but with different subjects, highlighted in pink.

4. `nsubj(___, stood)`

Task Variables

The tasks were all generated using the Stanford Parser on the text of *Moby Dick* by Herman Melville. When parse errors appeared, we corrected them by hand.

To maximize coverage, yet keep the number of tasks reasonable (around 7 or 8 minutes), we divided the relations above into 4 task sets of 3 relations each. Each relation was tested with 4 different words, making a total of 12 tasks per participant.

The tasks were presented in the same order, and the choices were also presented in the same order: the only variation between participants was the way in which those choices were displayed. In each task, there was a 'query' word and a relationship. The participants were shown list of 8 sentences containing that relationship between the query word and other words. The query word was highlighted in yellow and the matching word in pink (Figure 1(a)). Their task was to identify the relationship from list of 4 choices.

To make sure that the participants could not simply guess the right answer by pattern-matching, we ensured that there was no overlap between the list of sentences shown, and the examples shown in the choices as words or phrases.

Participants

There were 400 participants in total, split randomly across the 4 task sets and the 3 presentations. The ability to issue grammatical search queries is relevant to many fields outside linguistics and language study. We therefore wanted to avoid having any specific backgrounds overrepresented. To achieve this, we chose Amazon's Mechanical Turk crowdsourcing platform as a source of study participants.

Participants were paid 50 cents for completing the task, with an additional 50-cent bonus if they correctly identified 10 or more of the 12 relationships. They were informed of the possibility of the bonus before starting the task.

Screening

As is difficult to ensure the quality of effort from participants from Mechanical Turk, we included a multiple-choice screening question, 'What is the third word of this sentence?" Those that answered incorrectly were eliminated.

Results

Our results (Figure 2) confirm H1: examples improve the recognizability of grammatical relations. Participants in the **baseline** condition were significantly worse at identifying the relations than participants in conditions that showed examples (**phrases** and **words**).

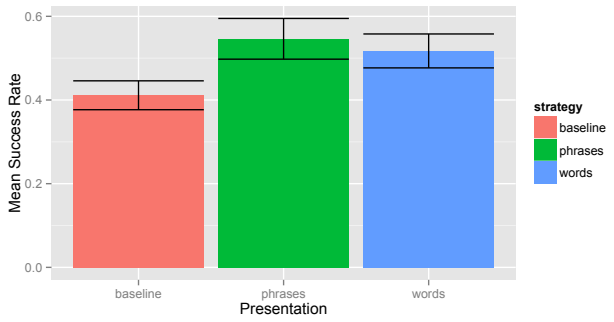


Figure 2: Average recognition success rates for the three different presentations.

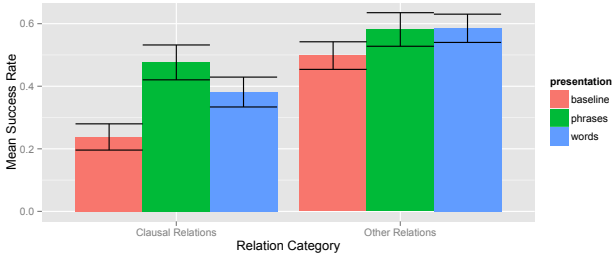


Figure 3: Average recognition success rates for the three categories of relations, by presentation.

The average success rate (where success means that the participant correctly identified the relation) in the **baseline** condition was 41%, which is significantly[1] less accurate than in the two example-showing conditions: **words**: 52%, ($p = 0.00019$), and **phrases** condition : 55%, ($p = 0.00013$).

The difference between the two types of examples, **phrases** and **words**, was not significant overall, but the data revealed an interesting fact when they were compared across the different types of relations (Figure 3). In all cases, the baseline performs worse that an example-showing presentation. However, the three different categories of relations behaved very differently with respect to whether phrases or words was better.

For the clausal relations, which operate over longer distances in sentences, the data confirmed what one might intuitively expect. Phrases, which show the usage context, significantly improved recognizability compared to the list of words or the baseline labels. The average success rate is 48% for **phrases**, which is significantly more than **words**: 38%, (p = 0.017), or **baseline**: 24%, ($p = 1.9 \times 10^9$).

For the other relations, there was no real difference between **phrases** and **words**, although they were both still

[1] Using the Wilcoxson signed-rank test, an alternative to the standard T-test that does not assume samples are normally distributed.

significantly better than the baseline (words: $p = 0.0063$, phrases: $p = 0.023$).

DISCUSSION