

Why the English Easiest Type Became the Hardest in Russian, or Russian Adults' Comprehension of *before* and *after* Sentences*

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Abstract. Thirty four Russian speaking adults were tested for their comprehension of four complex adverbial sentence types expressing the temporal order of events. Three hypotheses put forward in the literature and tested in English state respectively that: (i) adverbial clause placement, (ii) conjunction choice, and (iii) order of mention effect on participants' adverbial sentences comprehension. The results of the study demonstrated that none of the three hypotheses were relevant for Russian material. A new explanation was proposed.

Keywords: psycholinguistics, language comprehension, working memory, complex adverbial sentences, Russian.

1 Introduction

Comprehension of four English sentence types expressing the temporal order of events, as in example (1a-d) below, has been studied in children acquiring language (Clark 1971; Amidon and Carey 1972), aphasic adults (Ansell and Flowers 1982; Sasanuma and Kamio 1976), and normal adults (Clark and Clark 1968; Smith and McMahon 1970). These constructions can be associated with three variables at a time: (i) **syntax** - the adverbial clause precedes (1a, c, hereafter designated as 'Sub-Main' sentence) or follows (1b, d, 'Main-Sub' sentence) the main clause; (ii) **semantics** – adverb *before* (1a, d, hereafter designated as 'Before1' and 'Before2' respectively) or adverb *after* (1b, c, 'After1' and 'After2' respectively) is used; and (iii) **pragmatics** – the **order of mention** of the events in a sentence may coincide with the order of occurrence in the real world, (1c, d, **OOM** sentences), or may not coincide (1a, b, **NOOM** sentences).

- (1) a. Before the boy runs, the girl jumps.
b. The boy runs after the girl jumps.
c. After the girl jumps, the boy runs.
d. The girl jumps before the boy runs.

With respect to syntax, Clark and Clark (1968) argued that 'Main-Sub' sentences (right-branching with conjunction embedded) could be considered transformationally simpler than 'Sub-Main' sentences (left-branching with conjunction preposed). Some early experiments (Clark and Clark 1968; Smith and McMahon 1970) have really shown that on a sentence verbatim recall task normal adults made significantly fewer errors remembering the sense of 'Main-Sub' sentences, as in (1b, d), than of 'Sub-Main' sentences, as in (1a, c). However,

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studies of normal adults (Smith and McMahon 1970), kindergarten- and school-age children (Clark 1971; Natsopoulos and Abadzi 1986), and aphasics with relatively preserved auditory comprehension (Ansell and Flowers 1982) indicated that on a sentence comprehension task clause order did not significantly affect the comprehension accuracy.

As for semantics, Bever (1970) proposed that any sentence with *before* is easier to understand than any sentence with *after*. The hypothesis arises from the combination of two general principles of comprehension. The first principle states that the assertion of a sentence is the basis and the presupposition is organized as subsidiary to it; the second principle states that relations are organized by starting with the first event, so other events are subsidiary to the first. Thus, the *before*-sentences are easier than *after*-sentences because the assertion, which is in the main clause, also describes the first event, whereas in *after*-sentences the assertion describes the second event. Clark (1971), however, argued that sentences with *before* are easier than sentences with *after* because the term *before* is linguistically less complex than *after*. She proposed that the Semantic Feature Model could account for the acquisition of *before* and *after*. The model holds that word meanings are learned one feature at a time, with general features learned before specific features, and a feature's positive value learned before its negative value. In the temporal domain, the relevant features are 'Time', 'Simultaneous' and 'Prior'. Thus, Clark predicted that *before* was understood at an early age than *after*, since '+Prior' was learned before than '-Prior'. Without necessarily supporting the Semantic Feature Model, a number of studies supported Clark's finding that English children (Munro and Wales 1982, a.m.o.) and aphasic adults (Ansell and Flowers, 1982) produced more errors of temporal order on *after* than *before* sentences. However, Sasanuma and Kamio (1976) investigated comprehension of these sentence types in Japanese speaking aphasics. The authors reported that significantly more order errors occurred on *before* than *after* sentences. This result was contrary to what one would expect based on Clark's (1971) hypothesis. Moreover, Carni and French (1984) found out that performance of three- and four-year-olds English children was significantly better in response to *after*-question than *before*-questions. Rather than conclude that participants in this study understood *after* better than *before*, the authors suggested that since children have acquired the basic meanings of *before* and *after* by age three (or may be earlier, as Nelson (1982) argued), they lack the ability to apply this knowledge flexibly in a variety of situations.

The pragmatic order-of-mention hypothesis of Clark and Clark (1968) states as follows: When the order of mention of events in a sentence corresponds to the order of occurrence of the events themselves, comprehension is facilitated. In accordance with this hypothesis, studies of complex adverbial sentences have shown that on a sentence recall task normal adults made significantly fewer errors remembering the sense of OOM than NOOM sentences (Clark and Clark 1968; Smith and McMahon 1970). The hypothesis was also confirmed in the comprehension experiments with normal and educable mentally retarded Greek children (Natsopoulos and Xeromeritou 1988). However, others studies of 5-year-olds children (Amidon and Carey 1972) and aphasics with relatively preserved auditory comprehension (Ansell and Flowers 1982) demonstrated that participants used the OOM strategy only when they did not understand the terms *before* and *after*.

Note that although no general explanation of this phenomenon was found, the latest paper on this topic, to our best knowledge, is (Natsopoulos and Xeromeritou 1988). The main goal of the current experiment is to consider the problem on Russian material.

2 The Experiment

2.1 Hypotheses

The present study was undertaken to investigate Russian speaking adults' comprehension of complex adverbial sentences. Based on the studies reviewed above, the following three hypotheses were tested, see (2).

- (2) Hypotheses
- (i) Russian adults produced significantly fewer errors on 'Main-Sub' sentences than 'Sub-Main' sentences;
 - (ii) Russian adults produced significantly fewer errors on *before*-sentences than *after*-sentences;
 - (iii) Russian adults produced significantly fewer errors on OOM-sentences than NOOM-sentences.

The features of experimental sentences tested in our study are summing up in Table 1.

Table 1: Experimental sentences feature bundles.

Example	Sentence type	Clause order	Conjunction type	Order of mention
1a.	Before1	Sub-Main	+Prior	NOOM
1b.	After2	Main-Sub	–Prior	NOOM
1c.	After1	Sub-Main	–Prior	OOM
1d.	Before2	Main-Sub	+Prior	OOM

Note that each of the three hypotheses predicts (1d) to be the easiest sentence type: (i) in (1d) the main clause comes first, while in (1a, c) it does not; (ii) before in (1d) is less complex than after in (1b, c); (iii) the order of mention of the two events in (1d) corresponds to the order of occurrence, while in (1a, b) it does not.

2.2 The Method

Participants. Thirty four undergraduate students from the St.-Petersburg State University took part in this experiment. All were native Russian speakers who had lived in Russia all their lives, and had normal or corrected-to-normal vision and hearing; they were paid to participate in the experiment.

Sentence Stimuli and Design. Twenty complex adverbial sentences were presented to each participant. Each set contained five sentences of each of the four sentence types: 'Before1', 'Before2', 'After1' and 'After2'. A sample of each sentence type (in Russian) with English translations is shown in (3).

In Russian, as in English, *pered tem kak* 'before' and *posle togo kak* 'after' relate a dependent clause event to a main clause event when either preposed (examples (3a, c)) or embedded (examples (3b, d)) in the construction. The dependent clause with *pered tem kak* always come next in time to the main clause event whereas the dependent clause event with *posle togo kak* always precedes in time the main clause event.

- (3) Examples from the experiment

- a. Teper' **pered tem kak** perelozhete oranzheviju svechu v paket, goluboj gvozd' polozhite v banku. 'Now **before** moving orange candle in the paper bag, blue nail put in the jar.'
- b. A teper' koričneviju nožku položite v korobku, **posle togo kak** peredvinete sinij korablik pod samolet. 'And now put the brown foot into the box **after** moving the blue ship under the plane.'
- c. Teper' **posle togo kak** peredvinete krasnuju korovu na skovorodku, zelenyj jakor' polozhite v korobku. 'Now **after** moving red cow on the skillet, green anchor put in the box.'
- d. A teper' rozovyj samoletik polozhite poverx krovati, **pered tem kak** perelozhete krasnuju tetrad' v chemodan. 'And now put the pink plane on top of the bed **before** moving red notebook into the suitcase.'

Procedure. Participants were tested individually in a single session of approximately 30 minutes duration. They were seated in front of a vertical plastic board comprising a three-by-three grid, in the center of which was a fixation cross. 'Object' pictures were colorized versions of black/white line drawings of common objects presented in (Cycowicz et al. 1997), scaled to fit a 2.5"x 2.5" square, cut out and laminated. At the start of each trial, four object pictures were placed in cells of the grid. As the 'objects' were positioned, the experimenter named each of them (see example of experimental trial in (4)). Then the computer provided a recorded spoken instruction for the participant to move an object to a designated container. Participants were asked to listen to each of 20 trials and perform the required actions as quickly as possible. Each trial consisted of a preamble and three instructions.

(4) Example of experimental trial

preamble	Èto krovatka. 'This is a bed.' Èto nožka. 'This is a foot.' Èto samoletik. 'This is a plane.' Èto korablik. 'This is a ship.'
Instruction 1.	Sinjuju položite krovat' v bočku. 'Put the blue bed in the barrel.'
Instruction 2.	Teper' rozovyj samoletik položite poverx krovatki. 'Now put the pink plane on top of the bed.'
Instruction 3.	A teper' koričneviju nožku položite v korobku, posle togo kak peredvinete sinij korablik pod samolet. 'And now put the brown foot in the box after moving the blue ship under the plane.'

The second or the third instruction of each trial was experimental, the other instructions of the trial were fillers.

2.3 The Results

The results (see Table 2 below) showed that participants made a total of 133 errors (19,6%) out of 680 responses; participants did not make any 'item error' (moving one or two incorrect items) or 'number error' (moving only one item); all of errors were 'order errors' - participants moved the correct items but in the incorrect, i.e. reversal, order.

Surprisingly, despite of expected errors distribution, 116 out of 133 errors (87%) occurred on the type (1d) – the easiest sentence type according to each of the three verified hypotheses. The English easiest type became the hardest in Russian!

Table 2: Results of the experiment.

Example	Sentence type	Errors, number (out of 170)	Errors, percent
1a	Before1	6	3,8
1b	After2	7	4,4
1c	After1	4	2,5
1d	Before2	116	72
total		133	19,6

3 Discussion

Of the three factors presumed to affect Russian adults' comprehension of complex adverbial sentences none was significant. This finding seriously contrasts with previous studies the authors of which reported significantly more order errors on (i) 'Sub-Main' sentences, (ii) *after*-sentences, and (iii) NOOM-sentences. Therefore we need to find a new explanation.

First, consider again the question about the canonical clause order in complex adverbial sentences cross-linguistically. As was mentioned above, the 'Main-Sub' ('Before2' and 'After2') sentences in English are considered transformationally simpler than 'Sub-Main' ('Before1' and 'After1') sentences. Hence, they are less difficult for understanding than sentences with 'Sub-Main' order. In contrast, in Japanese complex sentences the adverbial clause must precede the main clause. Consequently, in Japanese only 'Before1' and 'After1' sentences are permitted (Sasanuma & Kamio 1976). As Sasanuma and Kamio pointed out, an explanation for the discrepancy between English and Japanese results (significantly more order errors occurred on *before*- than *after*-sentences in Japanese) might be related to this syntactic constraint of Japanese: Because *after*-sentence is OOM sentence and *before*-sentence is NOOM sentence, the first could be understood better.

We suggest that Russian complex adverbial sentences lie between English and Japanese complex adverbial sentences (see Table 3): While Russian permits all the four adverbial constructions ('Before1', 'Before2', 'After1' and 'After2'), the canonical clause order in Russian complex adverbial sentences is 'Sub-Main'; the analysis of Russian National Corpus (www.ruscorpora.ru) confirmed the hypothesis. Hence, sentences with 'Main-Sub' order are more difficult for understanding than sentences with 'Sub-Main' order. Thus, we predict Russian counterparts of (1a, c) sentences to elicit less errors than those of (1b,d).

Table 3: Clause Order Cross-linguistically.

Language	Constructions permitted	Clause order permitted	Canonical clause order
English	Before2 After2 Before1 After1	Main-Sub Sub-Main	Main-Sub
Japanese	Before1 After1	Sub-Main	Sub-Main
Russian	Before2 After2 Before1 After1	Main-Sub Sub-Main	Sub-Main

Secondly, we argue that when a participant (e.g., due to limitations of the working memory) does not fully understand a task demand she follows the specific strategy: Because a participant knows that she must fulfill both commands, she act out first the command of the clause that is kept in the working memory in the least stable and the least accessible form.

Now, the question is: Which clause is kept in the working memory in the least stable and the least accessible form? According to the study of (Townsend and Ravelo 1980), there are three different clausal processing strategies. First, **the clause-by-clause approach** (Caplan 1972) implies that immediately after one hears a sentence, the semantic form of the initial clause is more accessible than that of the final clause. Secondly, **the structural-presuppositional approach** (Townsend and Bever 1977) states that the semantic form of an asserted main clause is more accessible than that of a presupposed subordinate clause just after the sentence has been heard. According to the third, **the causal-temporal approach**, the semantic form of an initial clause which is more likely to be interpreted as the causal event for the other event mentioned is more accessible just after the sentence has been heard (Townsend and Bever 1978).

The three predictions mentioned above are summing up in Table 4 below.

Table 4: Predictions on clause accessibility.

approach, by	the least accessible clause
clause-by-clause (Caplan, 1972)	final
structural-presuppositional (Townsend and Bever, 1977)	subordinate
causal-temporal (Townsend and Bever, 1978)	final

It is evident that any of the three approaches predicts that a participant acts out first the command of ‘Before2’ or ‘After2’ clauses (i.e. ‘Main-Sub’ sentence). It is important that for sentences with ‘After2’, like ‘And now put the brown foot into the box after moving the blue ship under the plane’, this strategy leads to correct results, but for sentences with ‘Before2’, like ‘And now put the pink plane on top of the bed before moving red notebook into the suitcase’, results become incorrect.

In sum, the two hypotheses – (i) the canonical (hence, the simplest) clause order in Russian complex adverbial sentences is ‘Sub-Main’ (i.e. ‘Before1’ and ‘After1’ sentences are simpler than ‘Before2’ and ‘After2’ sentences), and (ii) due to limitations of the working memory a participant acts out first the hardest command (i.e. the command of ‘Before2’ or ‘After2’ clauses) - allow us to correctly predict the pattern of the results of our experiment. However, both of them need further empirical justification in new studies on Russian materials.

4 Current Experiments

Here we consider two new paradigms of our complex adverbial sentences comprehension studies, namely working memory (WM) and developmental pilot experiments.

4.1 Working Memory and Complex Adverbial Sentence Comprehension

A number of experimental results have provided evidence that syntactic processing in comprehension requires the allocation of WM resources. Many research has found the fact that sentences that have more complex syntactic structures are more difficult and time consuming to understand (e.g., see (MacDonald 1997)). The results experiments in which such on-line methodologies as eye-tracking, self-paced word-by-word reading, and lexical decision task are used provided evidence that eye fixation durations, self-paced reading and lexical decision times increase at the points in a sentence where models of sentence processing predict an increased processing load.

The purpose of our new experiment was to test the WM effect, so twenty four High Span participants with $WM \geq 4$ and twenty four Low Span participants with $WM < 4$ on a Russian adaptation of Daneman and Carpenter (1980) took part in the experiment. The experiment was more complicate – a participant was forced to save information about four items out of nine disposed on the table, while in the first experiment she dealt with only four items. The results

showed (1) that the second experiment really involved more resource-consuming computation (29% versus 19,6%); (2) strong WM effect: 20% for High-Spans and 37,5% for Low-Spans. Our two-factor hypothesis confirmed as well: ‘Before2’ was the hardest type and ‘After2’ was the easiest one. However, we need further empirical justification of the fact on the experimental materials of our main experiment.

4.2 Age and Complex Adverbial Sentence Comprehension

Several different experiments examined the developmental changes of the comprehension of complex adverbial sentences with *before* and *after* cross-linguistically. In our pilot developmental study on Russian material, twenty children (from 4 to 7 year-olds), twenty teenagers (from 12 to 15 year-olds), twenty students (from 19 to 25 year-olds), and twenty adults (from 40 to 50 year-olds) acted out the events of four complex adverbial sentence types that were less complicate than sentences for our main experiment described above, e.g. *Pered tem kak ty peredvinesh’ poezd, peredvin’ samolet* ‘Before you move a train, move a plane’.

The results (see the histogram on the Figure 1 below) show that the number of errors decreases from children (54 errors out of 160 sentences) to students (13 errors out of 160 sentences) and slightly increases from students to adults (23 errors out of 160 sentences). Note that the type ‘Before2’ was the hardest type in this experiment again, but the difference between ‘Before2’ type and the other types was not so huge as for our main experiment (because, in our opinion, sentences for the experiment were less complicate).

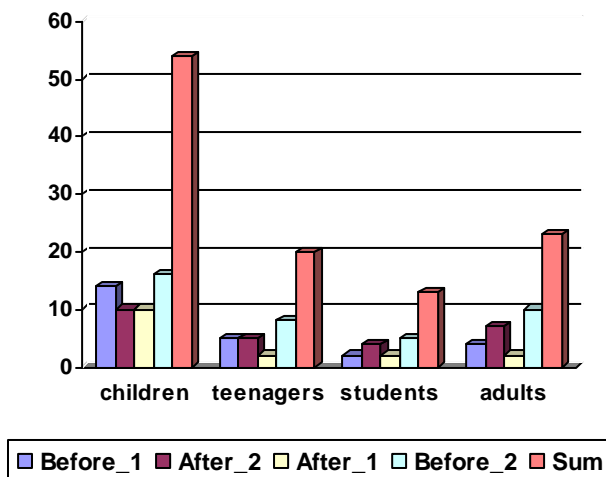


Figure 1: Number of errors in pilot Russian experiment.

Our current experiment with three- and five-year-olds Russian children tests the following continuity hypothesis that children processing mechanisms work just like adults: Children as adults make significantly more errors in Before2 sentences than in other adverbial sentences.

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