

Charles University

Faculty of Arts

Institute of Czech Language and Theory of Communication

Study Programme: Empirical and Comparative Linguistics

DIPLOMA THESIS

Bc. et Bc. Ondřej Drobil

Effects of Adjective Position on Information Recall in Czech

Vliv pozice adjektiva na vybavování informací v češtině

Thesis Supervisor: doc. Mgr. Jan Chromý, Ph.D.

2025

Prohlašuji, že jsem diplomovou práci vypracoval samostatně, že jsem řádně citoval všechny použité prameny a literaturu a že práce nebyla využita v rámci jiného vysokoškolského studia či k získání jiného nebo stejného titulu. Pro jazykovou korekturu byly použity nástroje generativní umělé inteligence.

I hereby declare that I have written this diploma thesis independently, using only the mentioned and duly cited sources and literature, and that the work has not been used in another university study programme or to obtain the same or another academic title. Generative artificial intelligence tools were used for proofreading.

V Praze dne / In Prague on: 6. 5. 2025

Ondřej Drobil

At this point, I would like to express my gratitude especially to my supervisor doc. Mgr. Jan Chromý, Ph.D., for his invaluable support and advice during the writing of this thesis. I would also like to thank the members of the ERCEL Lab and my fellow students for their valuable feedback. My thanks also go to all participants and the two external annotators. Last but not least, I would like to thank my family and close ones for their support throughout my studies and during the writing of this thesis.

Abstract – EN

This diploma thesis investigates how the position of adjectives in Czech affects their immediate recall, building on previous research on recall and comprehension. The introductory chapters summarise findings on adjective position in Czech and existing research on memory and recall. The thesis further presents relevant approaches from the field of language processing. Based on the Feature-Label-Order principle (Ramskar et al., 2010), which assumes that nouns define and narrow the set of relevant features to which adjectives may subsequently refer, a hypothesis was formulated that adjectives will be better recalled in the postnominal than in the prenominal position. The research is based on seven experiments – six with written stimuli using various presentation modes (whole-sentence-at-once, word-by-word, phrase-by-phrase) and one with spoken stimuli. In four experiments, only the position of adjectives modifying a direct object or locative adjunct was manipulated. In the subsequent three experiments, in addition to position, modifier type was also manipulated – apart from adjectives, genitive modifiers, which, unlike adjectives, typically appear in postnominal position, were also included in the sentences. Recall was tested using open-ended comprehension questions. Both recall accuracy and recorded reaction times were subsequently analysed using mixed-effects regression models. Results showed that in six out of seven experiments, postnominal adjectives were recalled significantly better than prenominal adjectives. Genitives were also better recalled in the postnominal position in two experiments, suggesting that syntactic unusualness is likely not the cause of better recall of postnominal adjectives. Genitives were recalled slightly better than adjectives in two written experiments, while in the spoken experiment, no difference between adjectives and genitives was observed. Whereas in the word-by-word experiments, there was a significant effect of adjective position on reaction times, in experiments with the whole-sentence-at-once presentation, no significant effect of adjective position on reaction times was observed. The results thus correspond to the prediction based on the Feature-Label-Order principle.

Key words: recall, psycholinguistics, adjective position, comprehension, memory, Czech

Abstrakt – CZ

Diplomová práce zkoumá vliv pozice adjektiv v češtině na jejich okamžité vybavování (recall) a navazuje na předchozí výzkum vybavování a porozumění. Úvodní kapitoly shrnují poznatky o pozici adjektiv v češtině a dosavadní zjištění výzkumu paměti a vybavování. Práce dále představuje relevantní přístupy z oblasti zpracování jazyka. Na základě principu Feature-Label-Order (Ramscar et al., 2010), který předpokládá, že substantiva vymezují a zužují množinu relevantních rysů, k nimž mohou následně referovat adjektiva, byla formulována hypotéza, že adjektiva budou lépe vybavována v postnominální než v prenominální pozici. Výzkum je založen na sedmi experimentech – šesti s psanými stimuly a s využitím různých způsobů jejich prezentace (celé věty jako celek, slovo po slově, fráze po frázi) a jednom s mluvenými stimuly. Ve čtyřech experimentech byla manipulována pouze pozice adjektiva rozvíjejícího přímý předmět, respektive příslovečné určení místa. V následujících třech experimentech byl kromě pozice manipulován i typ přívlastku – kromě adjektiv byly do vět zahrnuty i genitivní přívlastky, které se na rozdíl od adjektiv typicky vyskytují v postnominální pozici. Vybavování bylo testováno pomocí otevřených otázek. Přesnost vybavení i zaznamenané reakční časy byly následně analyzovány pomocí smíšených regresních modelů. Výsledky ukázaly, že v šesti ze sedmi experimentů byla postnominální adjektiva vybavována významně lépe než prenominální adjektiva. I genitivy byly ve dvou experimentech vybavovány lépe v postnominální pozici, což naznačuje, že syntaktická neobvyklost zřejmě není příčinou lepšího vybavování postnominálních adjektiv. Genitivní přívlastky byly ve dvou psaných experimentech vybavovány nepatrně lépe než adjektiva, v mluveném experimentu se rozdíl mezi adjektivy a genitivy neprojevil. Zatímco v experimentech s prezentací slovo po slově byl významný vliv pozice adjektiva na reakční časy, v experimentech s prezentací stimulů po celých větách nebyl signifikantní vliv pozice adjektiva na reakční časy zaznamenán. Výsledky tak odpovídají predikci na základě principu Feature-Label-Order.

Klíčová slova: vybavování, psycholingvistika, pozice adjektiva, porozumění, paměť, čeština

Obsah

1	Introduction	8
2	Background of the Current Study	9
2.1	<i>Position of adjectives in Czech: Previous findings</i>	<i>10</i>
2.2	<i>Czech adjectives from the perspective of communicative efficiency</i>	<i>14</i>
2.3	<i>Expectation-based accounts and possible effects of predictability</i>	<i>16</i>
2.4	<i>Feature-Label-Order principle and possible advantage for postnominal adjectives</i>	<i>18</i>
2.5	<i>Research on recall from word lists and sentences</i>	<i>19</i>
2.6	<i>Memory-based approaches to language processing and the effect of representational complexity ..</i>	<i>21</i>
2.7	<i>Good-enough approach, ambiguity and information structure</i>	<i>22</i>
2.8	<i>Summary</i>	<i>24</i>
3	Current Study	26
3.1	<i>Round 1 (Experiments 1 and 2)</i>	<i>26</i>
3.1.1	Participants	27
3.1.2	Materials	27
3.1.3	Procedure	28
3.1.4	Data coding	29
3.1.5	Data analysis	29
3.1.6	Results	31
3.1.7	Discussion	33
3.2	<i>Round 2 (Experiments 3 and 4)</i>	<i>35</i>
3.2.1	Participants	35
3.2.2	Materials	35
3.2.3	Procedure	36
3.2.4	Data coding	36
3.2.5	Data analysis	37
3.2.6	Results	38
3.2.7	Discussion	40
3.3	<i>Round 3 (Experiment 5 and 6)</i>	<i>42</i>
3.3.1	Participants	42
3.3.2	Materials	42
3.3.3	Procedure	43
3.3.4	Data coding	43
3.3.5	Data analysis	44
3.3.6	Results	45
3.3.7	Discussion	48
3.4	<i>Round 4 (Experiment 7)</i>	<i>50</i>
3.4.1	Participants	50
3.4.2	Materials	50
3.4.3	Procedure	52
3.4.4	Data coding	53
3.4.5	Data analysis	53
3.4.6	Results	53
3.4.7	Discussion	54
3.5	<i>General Discussion</i>	<i>56</i>
4	Conclusion	63
	Bibliography	64

Appendix 1	73
<i>Experiments 1 and 2 – epxerimental items</i>	<i>73</i>
<i>Experiments 3 and 4 – experimental items</i>	<i>74</i>
<i>Experiments 5 and 6 – experimental items</i>	<i>75</i>
<i>Experiment 7 – experimental items</i>	<i>76</i>
Appendix 2	77
<i>Consent form.....</i>	<i>77</i>

1 Introduction

The following thesis addresses a novel research question: How does the position of bare adjectives affect their immediate post-sentential recall in Czech? Building on the *Feature-Label-Order* principle, we hypothesised that postnominal adjectives would be recalled more accurately than prenominal ones. We tested this hypothesis across seven experiments varying in syntactic structure, presentation mode or modality. Together, these experiments offer an initial and exploratory investigation of how adjective position shapes memory representations and how it may affect sentence comprehension in Czech. The thesis follows a standard structure. The first part reviews previous conceptual literature and empirical research relevant to our topic. We begin by the background of our study and continue by explaining how adjectives vary in terms of their position in written and spoken Czech. Then, we introduce *communicative efficiency* as a potential explanation for the positional variability of Czech adjectives and further elaborate our predictions concerning the effects on recall based on the Feature-Label-Order principle. Next, we highlight some relevant findings from research on recall and memory. Additionally, we discuss implications from other approaches to language processing, including *memory-based accounts* and the *good-enough approach*. Finally, the research question, hypothesis and key predictions are summarised. The next part of the thesis provides descriptions of methods, results and discussions of seven experiments. Finally, the main findings and their broader implications are summarised in the General Discussion section.

2 Background of the Current Study

We begin by defining what we mean by *immediate post-sentential recall*. Following Chromý and Tomaschek (2024) or Chromý and Vojvodić (2024), immediate post-sentential recall can be defined as the ability to access specific information from memory immediately after reading a written sentence or listening to a spoken utterance. Methodologically, immediate post-sentential recall can be considered an offline task that involves a comprehension question as a cue to test consciously accessible memory representations of information presented in the sentence.

Immediate post-sentential recall should also be distinguished from *memory retrieval*. Memory retrieval – in its broader sense – is an umbrella term for accessing stored information in memory (see Traxler, 2012). However, in a narrower sense, particularly in research on sentence processing (e.g., Kluender & Kutas, 1993; Troyer et al., 2016), the term often refers to online mechanisms through which memory representations are accessed and which are typically unconscious. For example, retrieval occurs when listeners or readers process personal pronouns referring to a previously encountered noun phrase – at that moment, the original representation needs to be *retrieved* and integrated into the ongoing discourse (Karimi et al., 2018). When distinguishing between the two concepts, Nobel and Shiffrin (2001) argue that retrieving information from memory is, in fact, an inherent part of recall. Therefore, we consider previous research on (online) retrieval also relevant for our study.

Recall has established itself as an alternative to other psycholinguistic tasks (such as yes/no comprehension questions) that test the accessibility of information conveyed by words in a sentence (Patson et al., 2009). To the best of our knowledge, the experimental design based on open-ended comprehension questions targeting specific pieces of information, as employed in this study, was pioneered by Chromý and Vojvodić (2024), who examined how information conveyed by different syntactic categories was recalled. Their results showed, for example, that adjuncts were recalled significantly less accurately than direct objects. The authors attributed this effect to the degree of selective attention participants directed to different types of information. They also argued that differences in recall may originate at the stage of online processing – an assumption we adopt in this thesis as well.

Previous research has demonstrated that noun modification by adjectives enhances memory representations of noun phrases (Hofmeister, 2011). However, it remains less well understood

how memory representations are affected by the position of modifiers (Karimi et al., 2019). To the best of our knowledge, no psycholinguistic study to date has directly examined how adjective position affects recall of the adjective itself. Specifically, we restrict our focus to bare adjectives used attributively and address the research question of how their position – either prenominal or postnominal – affects their immediate post-sentential recall. We explicitly exclude pre- or postmodified adjectives and adjectives used predicatively. Thus, throughout this thesis, unless stated otherwise, references to prenominal or postnominal adjectives concern bare adjectives functioning as attributes of nouns.

2.1 Position of adjectives in Czech: Previous findings

Although Czech is generally considered a language with flexible word order, the positional variability of adjectives is relatively limited – at least according to descriptions in traditional grammars. Uhlířová (2017) notes that the unmarked position of bare adjectives is prenominal. Postnominal adjectives may occur under specific conditions: when the adjective is emphasized or placed in contrast (*Lesy kolem Křivoklátku jsou **lesy hluboké a mlčenlivé***. = *The forests around Křivoklát are **forests deep and silent****.¹), when it serves a differentiating or enumerative function (*dodáváme dřevo smrkové, modřínové a jasanové* = *we supply **wood spruce, larch and ash****), when it expresses emotion (*zloděj zlodějská* = *thief **thievish****), in poetic language (*měsíčku na nebi hlubokém* = *moon in the **sky deep****) or in terminological usage (*kyselina solná* = *acid **hydrochloric****). Similar classifications appear in Czech grammars (e.g., Karlík et al., 2012; Štícha, 2013).

The assumption that the postnominal position is marked and functionally restricted is presumably derived from analyses of written language. Our intuition as a native speaker, as well as anecdotal observations (*svetr modrej bych si mohla do toho divadla vzít* = *I could wear a **sweater blue*** to the theater*.) suggest that in informal spoken communication, postnominal adjectives may occur even in the absence of the conditions or functions listed above. In their work on the syntax of spoken Czech, Hoffmannová et al. (2019) discuss this pattern and propose that it could be classified as a *turn construction unit continuation* or *addition*. They suggest that in terms of information structure, a postnominal adjective could be marked and interpreted as

¹ Czech examples provided by Uhlířová (2017). English translations intentionally preserve the adjective position.

the rheme of an utterance. However, they remain rather inconclusive as to whether this is always the case and whether information structure is the actual or sole driving principle behind the positional variability of Czech adjectives.

Navrátilová and Zikánová (2017) point out that in earlier developmental periods of the Czech language, both prenominal and postnominal adjectives could be found even in written form, often without any clear functional differentiation. This observation also casts doubt on the assumption that the postnominal position always fulfils specific functions in discourse and opens the possibility that positional variation may be more neutral than previously assumed.

A formal analysis of the positional variability would likely provide further insights into the usage and function of postnominal adjectives. However, to our knowledge, no such analysis considering postnominal bare adjectives has been conducted for Czech (see Karlík & Caha, 2017). Existing formal accounts of adjective position in Polish – a typologically close language – do not provide clear explanations (Wągiel, 2014). Similarly, in his analyses of Italian adjectives, Cinque (2010) states that it remains unclear why certain types of adjectives – such as those denoting colours or shapes – can appear both prenominally and postnominally.

The most reliable sources for capturing the investigated phenomenon are corpora of spontaneous informal spoken Czech, such as ORTOFON (Lukeš et al., 2024). Therefore, we conducted a small-scale corpus probe as part of this thesis. The findings are presented in this section. We used data from the newest version of the ORTOFON corpus (version 3), which comprises approximately 3 million tokens and is balanced in terms of variables such as age, gender, level of education and dialectal region of the speakers (Lukeš et al., 2024).

Both prenominal and postnominal adjectives were retrieved using analogous queries in CQL. Due to their length, the full queries are provided on OSF (<https://osf.io/7e2qa/>). Since spoken corpora are not syntactically annotated, the construction of the queries could rely only on morphological tags. The morphological annotation of spoken corpora is also more complicated due to specific aspects of spoken language – such as false starts, hesitations, substandard word forms or interruptions – and may, therefore, contain more errors (Kopřivová et al., 2017).

Although we ensured that the retrieved adjectives and nouns agreed in case, number and gender, the queries inevitably returned some instances where the adjective did not modify the adjacent noun (*že těm lidem co se líbí ta .. naše **služba Chlapská** zásilka tak nám to takzvaně můžou lajknout* = *that the people who like the ... our **service Manly** Delivery they can like it.*). The

query for postnominal adjectives also returned postmodified adjectives, adjectives used predicatively or as complements. Nevertheless, since our goal was to obtain an exploratory overview of the phenomenon of postnominal adjectives in spoken Czech, the limited precision did not pose a significant problem. Restricting the query would have significantly reduced the number of retrieved examples and risked overlooking relevant usage patterns. Therefore, we deliberately prioritised recall over precision.

While we identified 2,912 instances of postnominal adjectives in the ORTOFON corpus, prenominal adjectives with 27,660 instances were still substantially more frequent. This corresponds to a 9.5% to 90.5% ratio between postnominal and prenominal instances. However, even the 9.5% cannot be considered marginal or anomalous. The examples below demonstrate that bare adjectives can indeed occur postnominally in spoken Czech and that postposition does not appear to alter the meaning of the adjectives – unlike, for example, in French. Furthermore, based on listening to the relevant corpus segments – available alongside the recordings – it seems that postnominal adjectives do not have to be additionally marked as rheme or focus by pitch accent (given that the whole noun phrase is not already marked as such).

*měla to mi to mi hrozně chutnalo .. právě my bysme chtěli s Ondrou jít někdy .. při nějaké .. **příležitosti slavnostní** (= occasion festive*) protože ono je to dražší záležitost .. celkem .. tak bysme si chtěli zajít na steaky .. to by bylo*

nějakou krabičku která už tak jako měla ty léta za sebou ..] + [(nadechnutí)] + [že že ty hodi dohodil mi tam **baterku novou** (= battery new*) šlup šlup a jako p* prostě hodinky že jo .]+ [(pousmání)] + [k obleku maj mít ručičky já mám prostě digitální*

*ještě bydleli v Brně .. jako že jsem šla .. @@ jak se jezdí na lopatě na takový tý .. **placce plastový** (= plate plastic*) jo jo jo (hluk v pozadí) tak jako že .. (smích) (pousmání) (nadechnutí) takovej kopeček v parku byl úplně malinkej jo kolik+*

*a najednou slyším sedíme tam nějaký pán já nevím tak po po čtyřicítce a von .. najednou slyším takovou **ránu divnou** (= bang strange*) říkám si kruci což tohle mohlo bejt rána do dveří dveře to nebyly nic .. a pak* (Lukeš et al., 2024)

In the transcripts, pauses between words are marked by one or two dots and are annotated based on the transcriber's perception, not acoustic analysis (Benešová et al., 2012). With regard to the presence of pauses between nouns and postnominal adjectives, no pause was indicated in 82.4%

of cases. To our knowledge, no literature suggests what the pause or its duration in this specific case of postnominal adjectives in Czech might indicate. In her work on utterance completion, Vorreiter (2003) distinguishes between *add-ons* and *non-add-ons*, the latter being defined as units added to an utterance that “do not come off audibly as additions” (p. 5), since there is no (audible) break between them. Such a classification could perhaps apply to postnominal adjectives in Czech if we inherently treated them as additions. However, the problem is that the instances without a pause mentioned above do not seem to function in this way. Rather, they appear to form an integral part of the noun phrase.

To better understand the usage of these constructions, we created a sample of 100 cases (only from those instances of postnominal adjectives without a preceding pause) and annotated them manually. First, we assessed whether the instance indeed represented our case – that is, whether the adjective was a bare attribute of the preceding noun. We further annotated whether the head noun was preceded by a pronoun, a numeral or another adjective. We also aimed to determine whether these instances corresponded to some previously listed functions (e.g., contrast, biological terms or idiomatic use). The annotated sample is available on OSF (<https://osf.io/7e2qa/>).

As expected, the precision of the CQL query was not particularly high. A true postnominal bare attribute was identified in 58% of the sample. In the remaining cases, the adjective was either not syntactically related to the noun or incorrectly tagged (19%), formed a complement in constructions with the verb *mít* (= *to have*) (10%), was part of a copula predicate (7%) or was postmodified (6%). Among the valid 58 cases, 3 cases represented a fixed expression (e.g., *anděla strážnýho* = *angel guardian**) or a terminological phrase (e.g., *metrů čtverečních* = *metres square**). 7 cases could be classified as instances of additional specification or emphasis, based on the preceding context (*a já jsem vymyslela teďka strategii jsem navrhla na **Instagram** že pojedeme i **Instagram firemní*** = *and I have come up with a strategy now I have suggested on Instagram that we use **Instagram corporate**** as well). For the remaining 48 cases, we examined the preceding context from a syntactic perspective. In the majority of cases (34), the head noun was preceded by another modifier – most frequently the demonstrative *ten* (= *this*), but also by other pronouns such as *takový* (= *such*), *nějaký* (= *some*) or by numerals. In several instances, it was preceded by an additional adjective (*dušený maso domácí* = *stewed meat homemade**).

Given the small sample size and the relatively low precision of the query, it is not possible to generalise our findings regarding the distribution of individual variants. However, that was not the aim of our corpus probe. Our objective was to demonstrate that the phenomenon can be attested in spoken Czech, that postnominal adjectives are clearly not marginal or anomalous and that existing theoretical accounts fail to adequately describe their usage. At this stage, we do not attempt to formulate any implications for our study of how adjective position impacts recall. We now turn to the last pattern identified in our sample – that postmodified head nouns are frequently preceded by a pronoun, adjective or both. As we will argue in the following section, the pattern is consistent with the principle of *communicative efficiency*. The next section introduces this concept and discusses the role of adjectives from this perspective, supported by additional corpus findings.

2.2 Czech adjectives from the perspective of communicative efficiency

Communicative efficiency is a principle that presumes that “an efficient language should enable a speaker to transmit many different messages successfully with minimal effort” (Gibson et al., 2019, p. 392; see also Levshina, 2022). Another goal of the speaker should be to smooth the amount of information across a whole sentence (Dye et al., 2018). Within this framework, Dye et al. (2018) conducted a corpus analysis showing that the smoothing of information – achieving more equal distribution of the information amount – can be accomplished by using adjectives, which make the following nouns more predictable and thus reduce the uncertainty about the upcoming input.

They illustrate this tendency by comparing data from German and English. German has an extensive system of articles marking case, number and gender (with a certain degree of syncretism). Encountering a definite article thus limits the set of potential candidate nouns that may follow, effectively reducing or redistributing nominal entropy, as shown in Dye et al. (2017). In contrast, English articles do not provide such specific morphological information. Based on a comparison of the two languages, Dye et al. (2018) found that English speakers use adjectives more frequently than German speakers and concluded that English adjectives – although seemingly redundant – provide an alternative means to narrow the number of potential nouns in a similar way to the system of German articles.

Could Czech adjectives serve a similar function in that they smooth the amount of information over discourse and make nouns more predictable? We used the following formulas provided by

Dye et al. (2017), which we adapted to our phenomenon. The calculations were again based on data from ORTOFON (version 3) (Lukeš et al., 2024). We compared the overall entropy of nouns, the conditional entropy of nouns following adjectives and the conditional entropy of nouns following pronouns. The data and scripts are available on OSF (<https://osf.io/7e2qa/>).

$$Entropy(Nouns) = - \sum_i P(Noun_i) \log_2 P(Noun_i) \approx - \sum_i \frac{Count(Noun_i)}{Total(Noun)} \log_2 \frac{Count(Noun_i)}{Total(Noun)}$$

Formula 1 $Entropy(Nouns)$ is calculated by summing the products of the relative frequency of each lemma (relative to all occurrences of nouns) and their $\log_2$ value. The resulting sum is then converted into a positive number.

$$\begin{aligned} Entropy(Nouns|Adj) &= - \sum_i P(Noun_i|Adj) \log_2 P(Noun_i|Adj) \\ &\approx - \sum_i \frac{Count(Noun_i|Adj)}{Total(Noun|Adj)} \log_2 \frac{Count(Noun_i|Adj)}{Total(Noun|Adj)} \end{aligned}$$

Formula 2 $Entropy(Nouns|Adj)$ is calculated by summing the products of the relative frequency of each lemma following adjectives (relative to all occurrences of nouns following adjectives) and their $\log_2$ value. The resulting sum is then converted into a positive number. The calculation for entropy of nouns following pronouns is analogous.

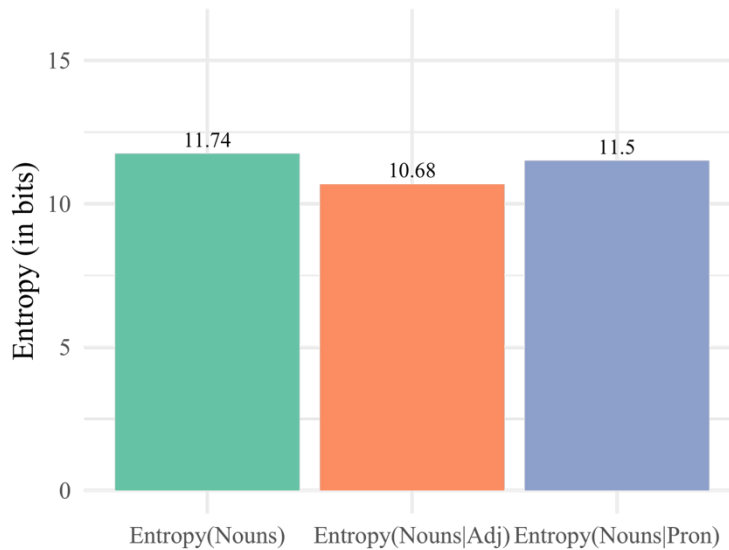


Figure 1 Comparison of nominal entropy (in bits) based on the data from ORTOFON. $Entropy(Nouns)$ is calculated based on the relative frequencies of all noun lemmas in ORTOFON, $Entropy(Nouns|Adj)$ concerns noun lemmas following adjectives, $Entropy(Nouns|Pron)$ lemmas following pronouns.

Figure 1 shows that prenominal adjectives reduce lexical entropy of nouns ($11.74 > 10.68$ bits). This difference indicates that nouns following adjectives are less diverse and more predictable or specified. The difference of 1 bit can be interpreted so that the uncertainty about the upcoming input becomes twice lower. Adjectives also reduce entropy more than pronouns ($11.5 > 10.68$ bits). Such a result was expected – while pronouns determine only the morphosyntactic

properties of the upcoming noun, adjectives also cue the semantic properties of the upcoming noun.

The analysis suggests that Czech adjectives could indeed smooth information over discourse, potentially explaining why they mostly precede nouns – even in spoken Czech. From the perspective of communicative efficiency, we suggest that the prenominal position of adjectives tends to dominate because shifting to the postnominal position likely occurs only when the pressure to reduce uncertainty is weaker – for example when the context is already constraining enough or when the head noun is already preceded by a pronoun or another adjective specifying its properties, as we saw in the previous section. Additionally, we can speculate that in the cases without a pause between the noun and the postnominal adjective, the speaker does not need to specify the noun, allowing the adjective to be placed postnominally. By contrast, the cases with a significant pause before the adjective may indicate a deliberate act of additional specification prompted by communicative partner’s reaction. However, such claims would require more rigorous research, which is not the focus of this thesis.

What does this mean for our research? Communicative efficiency may be considered one of the principles underlying the positional variability of Czech bare adjectives. But can it provide implications for their recall or processing? One might assume that when an adjective appears prenominally, both its morphosyntactic and semantic properties need to be processed, whereas postnominal placement may benefit from the preactivation of morphosyntactic properties via the head noun (and via any preceding modifiers). This could perhaps facilitate processing of postnominal adjectives. However, even if it were true, implications for memory encoding and representation cannot be directly inferred. Moreover, studies have questioned whether what is efficient for the speaker is also efficient for the recipient of the message (Trott & Bergen, 2022). This further complicates the possibility of formulating clear implications for our research focused on the side of comprehension. A stronger prediction can be formulated only in combination with *expectation-based accounts* and the *Feature-Label-Order* principle (Ramscar et al., 2010), and eventually with the good-enough approach in language processing.

2.3 Expectation-based accounts and possible effects of predictability

Expectation-based accounts of language processing are based on the concept of prediction – a domain-general cognitive mechanism which posits that the human brain continuously anticipates sensory input (Clark, 2013). This principle underlies several models of language

comprehension, which assume that when humans read or hear language input, they rely on internalised statistical distributions of lexical items and syntactic structures to anticipate what comes next (Linzen & Jaeger, 2016). As a result, word processing is already initiated at the moment the preceding context is processed (Kuperberg & Jaeger, 2016). Sometimes, a single word may be predicted with high certainty, but only in highly constraining contexts, which are quite rare in naturalistic discourse – more often, multiple dimensions of the upcoming input are preactivated to varying degrees (Luke & Christianson, 2016). Language comprehension is thus conceptualised “as an incremental process of belief updating”, in which predictions are not “all-or-nothing” but rather probabilistic and graded in parallel, drawing on multiple dimensions of the input (Kuperberg & Jaeger, 2016, pp. 33, 36).

Empirical research within this framework primarily concerns online processing difficulty, suggesting that the processing difficulty of a word in a sentence is related to how predictable it is based on the previous context (Futrell et al., 2020). The predictability of a word is usually approximated using its surprisal value – a metric based on Shannon's (1948) information theory, which is calculated as the logarithm of its conditional probability (Hale, 2001; Levy, 2008). The conditional probabilities can be derived from corpora (Smith & Levy, 2013) or cloze probability tasks (Lowder et al., 2018). An alternative metric of predictability (or uncertainty) is the already demonstrated entropy, which also originates from the information theory (Linzen & Jaeger, 2016). Experimental findings suggest that both surprisal and entropy have mutually distinct effects on lexical (Lowder et al., 2018) and syntactic (Linzen & Jaeger, 2016) processing.

Despite this evidence, Huettig and Mani (2016) argue that prediction is often unnecessary for language comprehension and may be often hindered by working memory capacity. The role of working memory as a mediating factor explaining interindividual differences in prediction is also often underexplored (Huettig, 2015). Furthermore, expectation-based approaches have another significant issue – they provide limited insight into how prediction affects the memory representations formed during sentence comprehension (Häuser & Kray, 2023).

While the study of Häuser and Kray (2023) suggests that predictable words are better encoded into memory, these findings cannot be directly applied to investigate the impact of adjective position on recall because the authors of that study focused on semantic predictability. In the previous section, we observed that prenominal adjectives may reduce uncertainty about the

following noun. Could the reverse also be true? Could nouns, by smoothing information over discourse, make postnominal adjectives more predictable?

Due to the limited number of postnominal adjectives in the ORTOFON corpus, it was not possible to conduct an analogous analysis of entropy among adjectives. However, even the theoretical premise that nouns would predict (in a strict sense) postnominal adjectives is somewhat flawed, because postnominal adjectives as a structure are rather rare. Still, can we find a theoretical model related to the expectation-based accounts that provides an implication for how the position of adjectives will affect their recall? We can answer this question with the already mentioned *Feature-Label-Order* principle (Hoppe et al., 2020; Ramscar, 2013; Ramscar et al., 2010).

2.4 Feature-Label-Order principle and possible advantage for postnominal adjectives

Ramscar et al. (2010) argue that when features of an object are presented first, they serve as cues that predict the upcoming label, making the label easier to learn compared to a setting in which the label is presented before the features. According to the authors, this hypothesised effect can be well demonstrated in children learning adjectives denoting colours. They suggest that learning is more efficient if colour words are preceded by nouns denoting objects bearing that colour. In such cases, the nouns direct children’s attention to the object and narrow the set of possible features that the upcoming adjective may refer to. For example, telling a child “the ball is blue” instead of “the blue ball” facilitates the association between the actual colour and the corresponding adjective.

Critically, the learning effect proposed by Ramscar et al. (2010) is based on repeated exposure and building of cue structures during which the associations between the features and their labels increase. Nevertheless, consistent with some principles of statistical learning (Romberg & Saffran, 2010), we assume that such cue structures are formed over a lifetime of exposure to language during which speakers acquire statistical regularities between adjectives and nouns (not necessarily in a particular order). This perspective aligns with Karimi et al. (2019), who similarly argue that language users might be sensitive to patterns of language production they were regularly exposed to.

We therefore suggest that the general Feature-Label-Order principle can be applied to our topic. In linguistic terms, a noun preactivates its features and narrows the set of potential adjectives

that may plausibly refer to them. If the encountered adjective matches one of the activated features, it will be better encoded. Therefore, we predict that postnominal adjectives should be recalled more accurately than prenominal ones. Even though the Feature-Label-Order principle likely provides the strongest implications for our study, one could still reasonably argue that the principle rather concerns learning and long-term memory representations, while our experiments test short-term memory. Are there any alternative frameworks that could further support our prediction about the effects on recall?

2.5 Research on recall from word lists and sentences

Recall has a long tradition in psychological research, dating back to the first half of the 20th century (e.g., Brener, 1940). In contrast to the approach adopted in this thesis, earlier recall studies (e.g., Cohen, 1963) primarily focused on the ability to remember and recall words from lists. These studies investigated both free recall (without a precise order) and serial recall (with an accurate order) (Waugh, 1961). While certain principles investigated in research on recall from word lists – such as the effects of recency (Greene, 1986) or imageability (Tse & Altarriba, 2007) – can be directly applied to our psycholinguistic research on immediate post-sentential recall, in most earlier studies, the language material served primarily an instrumental purpose.

Despite this limitation, research on recall from lists of words can still offer additional insights, particularly in examining the impact of adjective-noun ordering on the recall of noun phrases. Lambert and Paivio (1956) demonstrated that English noun phrases consisting of an adjective and a noun in the non-canonical order (i.e., noun-adjective) were recalled more accurately. Kusyszyn and Paivio (1966) replicated this finding, while controlling for potential intervening variables, such as concreteness and transitional probability. In contrast, Perham et al. (2009) reported superior recall accuracy for the canonical word order in English.

Schweppe et al. (2022) identified a more nuanced pattern in German – a language with morphologically richer adjective flexion, which is more comparable to Czech. The study focused on the recall of semantically unrelated pairs of nouns and adjectives. They observed that when the adjective had a suffix corresponding to the grammatical gender of the noun (*frecher Lachs* = *cheeky salmon*), the recall accuracy was higher in the canonical (adjective-noun) order. In contrast, in lists with uninflected adjectives (*frech Lachs*), the effect of word order on recall was not significant. This implies that long-term memory knowledge of both word order and morphological constraints – or their interaction – may enhance verbal short-

term memory. The results are also consistent with *language-based theories of verbal short-term memory* (Schweppe et al., 2022). Unlike theories that emphasise only the influence of pre-learned phonological chunks (Baddeley, 2000), language-based theories propose that short-term memory mechanisms also rely on long-term memory knowledge of semantic and morphosyntactic constraints that speakers internalise through exposure to natural language production (Schwering & MacDonald, 2020).

We cannot draw firm conclusions for our study, as Schweppe et al. (2022) did not examine the recall of adjectives separately, focusing instead on the recall accuracy of the whole word pairs. Additionally, their hypothesis favouring premodified noun phrases was based on the assumption that the prenominal position is the only grammatical option – which is valid for German but not for Czech, where both positions may occur, as we showed earlier. We could still perhaps expect that prenominal adjectives would be recalled better even in Czech, since the adjective-noun order is much more frequent in usage. However, it remains a question what role semantics will play. According to Schwering and MacDonald (2020), semantic regularities may influence the impact of word-order constraints. Contrary to Schweppe et al. (2022), who intentionally focused on unrelated pairs of adjectives and nouns, our experiments will test recall from sentences with semantically related pairs.

Apart from recall from word lists, studies have also focused on recall from whole sentences and investigated how different syntactic categories are recalled. Clark (1966) found that adjective modifiers of subjects were recalled worse than objects but better than verbs in simple English sentences. Mehler et al. (1978) conducted a study on French using the *rapid sequential visual presentation* of sentences containing adjectives in prenominal attributive, postnominal attributive and predicative positions. They found that attributive adjectives were recalled worse than predicative ones. Since predicative adjectives occurred after the noun (even if not immediately), this pattern suggests that postnominal adjectives could be recalled more accurately. However, the authors found no significant difference in recall between prenominal and postnominal attributive adjectives.

Taken together, psychological research on recall from word lists and sentences provides rather inconclusive implications for the impact of adjective position on immediate post-sentential recall. Nevertheless, since Schweppe et al. (2022) and Schwering and MacDonald (2020) emphasised that language comprehension mechanisms play an important role in forming memory representations, we searched for implications in these areas. We have already

discussed the expectation-based approaches to sentence processing. The following sections are dedicated to memory-based accounts and the good-enough approach to language processing.

2.6 Memory-based approaches to language processing and the effect of representational complexity

Memory-based approaches propose that humans rely on linguistic and non-linguistic knowledge stored in long-term or short-term memory to process language input (McKoon & Ratcliff, 1998). Word processing involves using cues to retrieve or approximate previously encoded representations (van den Bosch & Daelemans, 2013). It is assumed that processing difficulties are related to limits of attentional focus, similarity-based interference and memory decay over time (Lewis et al., 2006). Experimental research has shown that memory retrieval can be impeded by introducing multiple competing candidates for retrieval (Van Dyke & Johns, 2012), but it can also be facilitated by directing attention to the encoded concept that needs to be later retrieved (Fedorenko et al., 2013), by increasing the representational complexity of the concept that needs to be later retrieved (Hofmeister, 2011) or by including a pause before the word is encoded (Karimi et al., 2024). These findings provide evidence that memory constraints may play a crucial role in sentence processing, at least in controlled experimental settings (Futrell et al., 2020).

Earlier, we noted that retrieval can be considered an inherent part of recall. What are the implications for our study? Hofmeister (2011) demonstrated that memory representations of nouns become more robust when the encoded nouns are modified, which leads to easier retrieval, as evidenced by shorter reading times at retrieval sites in relative clauses. However, in our study, we manipulate the position of the modifier that contributes to the representational complexity, not the complexity itself. It is also noteworthy that Karimi et al. (2024) questioned the effect of modification and showed that the same facilitation can be achieved by delaying the onset of the encoded noun instead of modifying it. Furthermore, Hofmeister (2011) also noted that the effects of representational complexity may not extend beyond the scope of online processing. In contrast, we test offline recall, which may measure different aspects of language processing such as memory encoding and storage. Therefore, while findings from the previously mentioned studies are important for our research question, they must be interpreted carefully.

A more relevant study was conducted by Karimi et al. (2019), who replicated the modification effect but also investigated the impact of modifier position. In addition to measuring online retrieval difficulty, they had participants read sentences containing pre- or postmodified nouns and produce their continuations. The authors then measured how frequently participants used pronouns to refer back to the noun phrases. They found that the postmodified noun phrases were more likely to be referred to with a pronoun in production experiments. They also observed shorter reading times at retrieval sites in a comprehension experiment, suggesting a more robust representation for the postmodified noun phrases. Do their findings imply that even the postmodifiers themselves would be encoded more robustly? Not necessarily.

Karimi et al. (2019) investigated English material, where the premodified noun phrases were modified by a bare adjective, while the postmodified ones by a relative clause. So, even if we assumed that the memory robustness extended to the relative clause as well, it remains unclear whether similar effects would apply to bare postnominal adjectives. The authors somewhat acknowledge this issue, noting that it would be critical to replicate the effect on a language allowing nouns to be modified by bare adjectives in both positions interchangeably.

Additionally, we must address the specific task that was employed in the production study to measure successful retrieval and whether it is comparable to how we measure recall in our study. According to Karimi et al. (2019), the instances where participants referred to a noun phrase with a pronoun instead of repeating it verbatim implied a more robust memory encoding. In contrast, our study considers recall accurate only when participants reproduce the word as it was presented in the sentence. It is therefore possible that, apart from employing a different task, we are also measuring different cognitive processes related to memory or comprehension. Thus, although – to our knowledge – the study is the only one examining the effect of modifier position, it unfortunately does not offer conclusive implications for our specific research question.

2.7 Good-enough approach, ambiguity and information structure

The final framework we will discuss is the good-enough approach to language processing. The approach was intended as a critique of language comprehension models that relied on compositionality and also aimed to explain why some linguistic structures – such as garden-path sentences or implausible passive sentences – are consistently misinterpreted (Ferreira et al., 2002). The good-enough approach suggests that language comprehension does not

necessarily involve complete, detailed parsing and interpretation of the input (Frances, 2024). Instead, humans tend to interpret language input only as thoroughly or accurately as they need for successful communication, often adapting their comprehension strategies to specific tasks, contexts or situations (Ferreira & Yang, 2019).

Earlier, in accordance with the Feature-Label-Order principle, we asserted that nouns may narrow the set of features that following postnominal adjectives may refer to. We predicted that postnominal adjectives would be recalled better. However, this prediction may be challenged by the good-enough approach. As we already stated, Chromý and Vojvodić (2024) suggested that the optional information conveyed by adjectives would be less accessible from memory. At the same time, there are studies suggesting that adjectives (or specifically colour adjectives) tend to be used redundantly – they are used in contexts where such specification is not necessary (Koolen et al., 2013). Another study also showed that such redundant adjectives are used more often in a language with prenominal adjectives (English), compared to a language with postnominal adjectives (Spanish) (Rubio-Fernández, 2016). Although we cannot assume that the patterns observed in production studies will be reflected in a comprehension study, we could still expect that postnominal adjectives, which no longer reduce the uncertainty about the upcoming head noun, could be considered even more optional than prenominal ones and that could, in turn, impede their recall.

Another critical point involves the potential ambiguity of postnominal adjectives in sentences. In the first section, which discussed the positional variability of adjectives in spoken Czech, we showed that although postnominal adjectives are less frequent, they can still be attested in the corpora of informal spoken Czech. Therefore, Czech language users should have been exposed to them and be able to parse the sentences that contain them. However, we also acknowledge that in isolated written sentences presented word-by-word in a self-paced-reading paradigm, postnominal adjectives might be interpreted as modifying some upcoming noun – one that has not yet been encountered but is anticipated – rather than the preceding one. Therefore, we will measure both recall accuracy and online reaction times to better understand how sentences containing postnominal adjectives are actually read and processed.

Nevertheless, research from the good-enough tradition suggests that ambiguity and the strategies humans employ to cope with it do not necessarily impact comprehension measured by offline task performance. Qian et al. (2018) investigated garden-path sentences, triangulating self-paced-reading and ERP data with response accuracy to comprehension questions. They

found no consistent patterns in reading times and ERP data related to comprehension accuracy, indicating that misinterpretation must be caused by other factors than readers failing to reanalyse the sentence during processing. Christianson et al. (2024) further investigated garden-path sentences and concluded that rereading a sentence or its parts does not necessarily imply that response accuracy would increase. Therefore, beyond its implications concerning shallow processing, the good-enough approach also provides a framework for interpreting the results of experiments in our study, in case some form of reanalysis due to ambiguity should occur.

The final implication for our study concerns the role of information structure. Ferreira and Lowder (2016) suggest that information structure is a fundamental principle underlying sentence processing. They claim that while given information is processed in a good-enough, superficial manner, new or focused information processing is driven by predictive mechanisms. The effect of focus on offline language processing was already explored in a study by Birch and Garnsey (1995), who demonstrated – using word recognition and word naming tasks – that when a word is focused, its memory representation becomes more robust. This assumption was also investigated by Chromý and Vojvodić (2024), who tested recall and showed that when adjuncts in a sentence were focused, the recall accuracy was higher. If we assumed that by shifting adjectives to the postnominal position, their status in terms of information structure changes – a tendency proposed by Hoffmannová et al. (2019) – this would constitute another argument for why postnominal adjectives could be recalled better. However, our study will primarily assume that postnominal adjectives are not automatically focused and do not function as the rheme of a sentence. We will, at least, try to minimise the potential impact of information structure as an additional intervening factor through careful design of the stimuli.

2.8 Summary

To summarise the previous sections, the aim of this thesis is to investigate the following research question and to test the following hypothesis H1:

RQ: What is the effect of adjective position on its recall?

H1: Postnominal adjectives will have higher recall accuracy than prenominal adjectives.

This prediction is primarily based on the Feature-Label-Order (FLO) principle (Ramscar et al., 2010). The principle suggests that when nouns precede adjectives, they activate the set of features that may be referred to by adjectives that follow them, thereby facilitating their

encoding and recall. Furthermore, in line with the communication efficiency principles observed in language production (Dye et al., 2017, 2018) and with support from our corpus probe, we expect that recall accuracy may benefit from the fact that processing prenominal adjectives involves both semantic and morphosyntactic properties, while postnominal adjectives only need to confirm the properties and features preactivated by the head noun. Some support for the superiority of postnominal adjectives can also be found in earlier studies on recall, which demonstrated a higher recall accuracy for postmodified noun phrases. It is important to note that while we assume that differences in recall may originate in earlier stages of processing, we do not provide specific predictions concerning online processing.

Apart from the empirical studies on recall and the literature on the Feature-Label-Order principle, we also considered alternative psycholinguistic frameworks such as memory-based accounts and the good-enough approach. Memory-based accounts suggest that increasing representational complexity through modification may enhance memory robustness but the findings about the impact of adjective position manipulation remain inconclusive, according to Karimi et al. (2019). Conversely, the good-enough approach (Ferreira et al., 2002) offers the alternative possibility that the postnominal adjectives might be processed in a relatively shallow manner, indicating that humans might not necessarily benefit from the different extent of semantic or morphosyntactic cues, or that they might consider postnominal adjectives to be even more optional. Finally, the influence of information structure, particularly focus or rheme, is documented by several studies (Birch & Garnsey, 1995; Chromý & Vojvodić, 2024), but in our study, we do not address it directly and will try to minimise its potential impact methodologically.

3 Current Study

Our study is based on four rounds of online experiments. Participants in all experiments were native speakers of Czech without any reported reading problems. They were undergraduate students at Charles University and received course credit for their contribution. We also ensured that the same participants did not participate in multiple experiments. Each of the first three rounds consisted of two experiments, differing in the presentation mode (whole-sentence-at-once and word-by-word in Rounds 1 and 2; phrase-by-phrase and word-by-word in Round 3). The structure of the stimuli was substantially changed after Round 1 and remained approximately the same for the subsequent experiments. The final Round 4, consisted of one experiment with spoken stimuli generated by artificial intelligence. In each experiment, we manipulated the adjective position and examined its effect on recall accuracy. In Rounds 3 and 4, we introduced a second variable – modifier type. Apart from responses to comprehension questions, we also recorded reaction times (RTs) in the written experiments. Each round of experiments has separate sections dedicated to methods, results and discussion. The main findings are then summarised in the General Discussion section. All datasets and scripts containing details about modelling are available on OSF (<https://osf.io/7e2qa/>).

3.1 Round 1 (Experiments 1 and 2)

The first two experiments aimed to gain preliminary insights into how prenominal and postnominal adjectives are recalled and how participants process them in terms of reaction times. Both experiments involved written sentences in which we manipulated the position of adjectives modifying a direct object. Each sentence was immediately followed by an open-ended comprehension question targeting the adjective. In Experiment 1, a whole-sentence-at-once presentation mode was employed, while in Experiment 2, the sentences were presented word-by-word. Although postnominal bare adjectives are specific to spoken Czech, we decided to present the stimuli in written form at this first stage, as we were also interested in measuring how they are processed online – reflected by reaction times on the target noun phrase and the following spillover region (Experiment 2), as well as by the reaction times for the whole sentences (Experiment 1).

3.1.1 Participants

The presented analyses are based on data from 184 students (138 women, 46 men; mean age = 21.62 years) in Experiment 1 and 172 students (136 women, 35 men, 1 not disclosed; mean age = 22.23 years) in Experiment 2.

3.1.2 Materials

Experiments 1 and 2 contained 30 experimental items and 90 filler items (see Appendix 1 for the list of experimental items). Each stimulus consisted of two clauses. The first clause had the form of direct speech enclosed in quotation marks, which was intended to simulate spoken language. It comprised a subject (feminine or masculine proper name), a verb, a direct object (target noun phrase – either premodified or postmodified) and a locative adjunct. The second part was a reporting clause consisting of a verb, a subject (masculine or feminine proper name) and an indirect object in the dative case (proper name or common noun denoting a person). The proper names were chosen so that any effects of semantic interference could be minimised.

Ramscar et al. (2010) demonstrated the Feature-Label-Order principle primarily on features such as colour or shape. For this reason, we decided to test adjectives denoting visual qualities. We designed the experimental items by starting from the target noun phrases. First, we created a list of appropriate adjectives and chose corresponding nouns that denoted concrete objects and could be plausibly modified by those adjectives. We checked their plausibility in corpora. However, due to the lack of data from spoken corpora, we used written corpora, though even there we could only verify the adjective-noun order. For the postmodified noun phrases, we had to rely on our own judgements. In the resulting pairs of adjectives and nouns, all combinations of number and gender were represented. The resulting noun phrases were then completed to fit the previously described scheme. To further simulate the intentional spokenness of the stimuli or at least of the part containing the target noun phrase, we used Common Czech endings for the adjectives.

In both experiments, we manipulated only the position of the adjective in the target noun phrase. There were, therefore, only two conditions for each experimental item, and we used a within-subjects design. The sentences were followed by an open-ended comprehension question targeting the adjective in the first clause. The question had the same form, regardless of the condition. An example of an experimental item with a corresponding comprehension question can be found in Table 1:

Adjective position	Stimulus	Comprehension question
Prenominal	„Vojta vylil špinavou vodu do květináče,“ žaloval Viktor uklízečce.	Jakou vodu vylil Vojta?
	<i>“Vojta poured dirty water into the pot,” Viktor complained to the cleaning lady.</i>	
Postnominal	„Vojta vylil vodu špinavou do květináče,“ žaloval Viktor uklízečce.	<i>What water did Vojta pour?</i>
	<i>“Vojta poured water dirty* into the pot,” Viktor complained to the cleaning lady.</i>	

Table 1 Examples of an experimental item and a corresponding comprehension question from Experiments 1 and 2, with non-literal translations preserving the adjective position. The target noun phrase is marked in bold.

In addition to the 30 experimental items, 90 filler items were created. Some fillers contained the direct speech with a reporting clause preceding it (instead of following it), some consisted of a reported speech, and some had the form of a simple clause. Comprehension questions for the filler items also targeted information conveyed by words of different syntactic categories.

3.1.3 Procedure

Both experiments were intended to take approximately 20–25 minutes to complete. They were conducted online, using the PCIBex platform (Zehr & Schwarz, 2018). First, participants were informed about the duration and principle of the experiment and received instructions on how to control the experiment interface. They were asked to read the sentences at a natural reading pace, similar to how they would read an email or a news article, and to answer the comprehension questions as quickly as possible. They were presented with an informed consent form (see Appendix 2), which they had to confirm to proceed. Then, they were asked to fill in information concerning their gender, age, mother tongue, and to report any serious difficulties with reading or comprehension. Participants could also fill in their e-mail address so that their contribution could be credited. The addresses were removed prior to the analysis and the data were anonymised.

Participants then again received the set of instructions on how to use the interface. This was followed by three practice items so that participants could familiarise themselves with the format of the experiment. In Experiment 1, the sentences were first displayed as a series of underscores. When participants pressed the spacebar key, an entire sentence appeared. Pressing spacebar again revealed a comprehension question. Reaction times (i.e., the time between pressing the spacebar key for the first and second time), as well as participants’ answers, were recorded. Pressing Enter presented the next trial. In Experiment 2, a series of underscores was shown again at first. Participants were required to press spacebar for the next word to appear.

Reaction times for each word were recorded, as were the responses to comprehension questions. In both experiments, the experimental and filler items were presented in a fully randomised order.

3.1.4 Data coding

To calculate recall accuracy based on the responses to the comprehension questions, the answers needed to be manually annotated. The annotation followed several criteria: We rated as correct an exact repetition of the given adjective (regardless of case, number or gender), including answers with obvious typos that did not alter the meaning of the word. Adjectives that were morphologically related, such as *šedý* instead of *šedivý* (both meaning *grey*), were also accepted as correct answers. On the other hand, we did not mark answers as correct if a change in a letter or a part of the word altered its meaning completely, as it could not be determined whether this stemmed from an interference, a typo or a misreading of the original word (*moudrý* instead of *modrý*). Answers containing more words from the sentences were accepted as correct as long as the target adjective was included.

During the annotation, we identified a problem related to the structure of some stimuli: some participants interpreted the locative adjunct as a modifier of the noun in the target noun phrase (*kluzký chodníky před školou* = *slippery pavements in front of the school*). Such responses (0.36% in Experiment 1 and 0.45% in Experiment 2) were excluded from the analysis. The problem concerned multiple items and both conditions, although it was more frequent in the prenominal condition, which is logical, since in that case, the adjunct appeared immediately after the noun. All other responses – such as an incorrect adjective or answers like *XXX* or *nevím* (= *I don't know*) – were coded as incorrect. We did not further categorise the incorrect responses, so all responses were, therefore, coded as either correct, incorrect or NA.

3.1.5 Data analysis

In Experiment 1 (whole-sentence-at-once), we analysed recall accuracy – reported as the proportion of incorrect answers to open-ended questions, and reaction times (RTs) – the time required to read and process the whole sentence. First, we removed trials with RTs shorter than 1 s and longer than 100 s. Then, we calculated log(RTs) and used an upper-bound criterion of 2.5 SDs to further exclude outlier RTs. Altogether, 1.92% of RT values were removed. As for recall accuracy, due to the earlier mentioned problems with some stimuli, 0.36% of responses were coded as NA and excluded from the analysis as well. We also checked participants' overall

records. No participant was excluded based on low recall accuracy (<50%) or high proportion of missing RT values (>10%).

In Experiment 2 (word-by-word), we analysed recall accuracy and also reaction times on each word separately. The data cleaning procedure was similar to that of Experiment 1. First, we excluded all RTs below 100 ms and over 10 s, then calculated their log-transformed values and applied the same upper bound (2.5 SDs). A total of 2.43% of RTs were removed from the dataset. Again, no participant was excluded based on low recall accuracy (<50%) or high proportion of extreme values in RTs (>10%).

We assumed that there would be general variability between participants in terms of their cognitive abilities, strategies employed in the experiments or sensitivity to the postnominal position. At the same time, we expected variability between items in terms of processing demands and memory storage, and that the manipulation of adjective position might not have the same effects across all items. Therefore, it was justified to include random intercepts for participant and item, and adjective position as a random slope for both participant and item. In all analyses, we adopted an approach consistent with Matuschek et al. (2017), in which we tried multiple models, starting from the most complex ones (in terms of random effects and slopes structure) and moving towards simpler ones. We used ANOVA to assess whether a more complex model provided a significantly better fit to the data than a simpler model. The simpler model was also selected if the more complex model failed to converge or exhibited singularity issues. Adjective position contrasts were set as -0.5 for the prenominal position and 0.5 for the postnominal position in both experiments.

Recall accuracy as a dependent variable was modelled the same way in both experiments, using a logit mixed-effects regression model (Jaeger, 2008), with adjective position as a fixed effect, and participant and item as random effects, including adjective position as a random slope for item and participant. However, in Experiment 1, due to singularity issues, a random slope for participant was omitted and a random slope for item did not provide a significantly better fit. In Experiment 2, the models with random slopes for participant and item did not significantly improve the fit. Therefore, the slopes were excluded in both cases.

RTs were analysed using a linear mixed-effects regression model (Bates et al., 2015). In Experiment 1, we modelled log(RTs) for the whole sentences as a dependent variable, with adjective position as a fixed effect and participant and item as random effects (with adjective

position as a random slope for item). The full model failed to converge and a reduced model with a slope for item did not improve the fit compared to the one without any slopes. Therefore, we used a model without the slopes. In Experiment 2 (word-by-word), we first summed the RT values on positions 3 and 4, which corresponded to the target noun phrase, and then modelled log(RTs) as a dependent variable, with adjective position as a fixed effect and participant and item as random effects (with adjective position as a random slope for both participant and item). The full model significantly improved the fit over the reduced one. The spillover region (positions 5 and 6) was modelled separately. The full model improved the fit only marginally for position 5 and did not converge for position 6, so we chose reduced models with adjective position as a random slope for item.

3.1.6 Results

3.1.6.1 Recall accuracy

Adjective position	Exp. 1 (whole-sentence-at-once)	Exp. 2 (word-by-word)
Prenominal	124/2747 (4.51%) [3.74, 5.29]	156/2569 (6.07%) [5.15; 7.00]
Postnominal	76/2753 (2.76%) [2.15, 3.37]	91/2568 (3.54%) [2.83; 4.26]

Table 2 Recall accuracy (% incorrect) based on the adjective position in Experiments 1 and 2. Accuracy has the following format: incorrect answers/all answers, % incorrect in bold and brackets, 95% confidence interval in square brackets.

In Experiment 1, participants' mean accuracy was 96.36% (median 96.67%), with individual accuracy ranging from 73.33% to 100%. Item-level accuracy ranged from 86.96% to 99.46% (median 97.54%). The overall recall accuracy (% incorrect) is reported in Table 2 and Figure 2. Postnominal adjectives were recalled better than prenominal ones. The effect of adjective position was significant ($\beta = 0.571$, $SE = 0.154$, $z = 3.703$, $p < .001$).

In Experiment 2, participants' mean accuracy was 95.17% (median 96.67), with individual accuracy ranging from 67.86% to 100%. Item-level accuracy ranged from 81.76% to 99.42% (median 96.21%). The overall recall accuracy (% incorrect) is reported in Table 2 and Figure 2. The effect of adjective position was significant ($\beta = 0.548$, $SE = 0.141$, $z = 3.874$, $p < .001$). Postnominal adjectives were recalled better than prenominal ones.

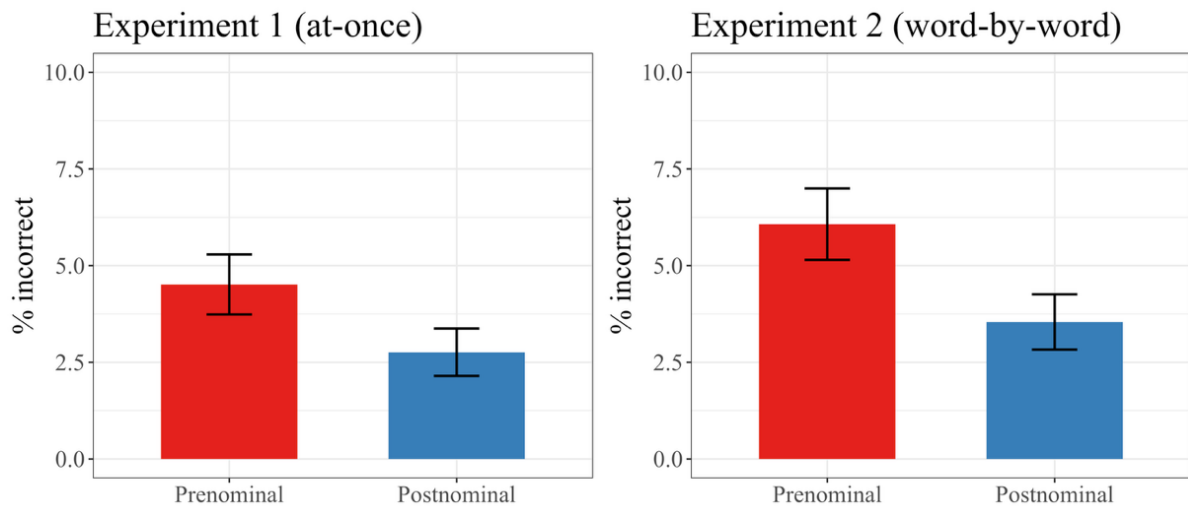


Figure 2 Recall accuracy (% incorrect) based on the adjective position in Experiments 1 and 2. Error bars denote 95% confidence intervals.

3.1.6.2 Reaction times

In Experiment 1, sentences with postnominal adjectives were processed slightly more slowly (6096 ms [5962, 6230]) than sentences with prenominal adjectives (5939 ms [5814, 6063]). However, the effect of adjective position was not statistically significant.

In Experiment 2, we focused on reaction times on the target noun phrase and the spillover region. There was no significant effect of adjective position on reaction times on the target noun phrase. The effect was significant on the preposition following the noun phrase ($\beta = 0.067$, $SE = 0.012$, $t = 5.418$, $p < .001$) and not significant on the noun that followed. That means that the prepositions following postnominal adjectives were read more slowly, but reaction times converged again on the following nouns. The reaction times on individual words in the sentences are visualised in Figure 3.

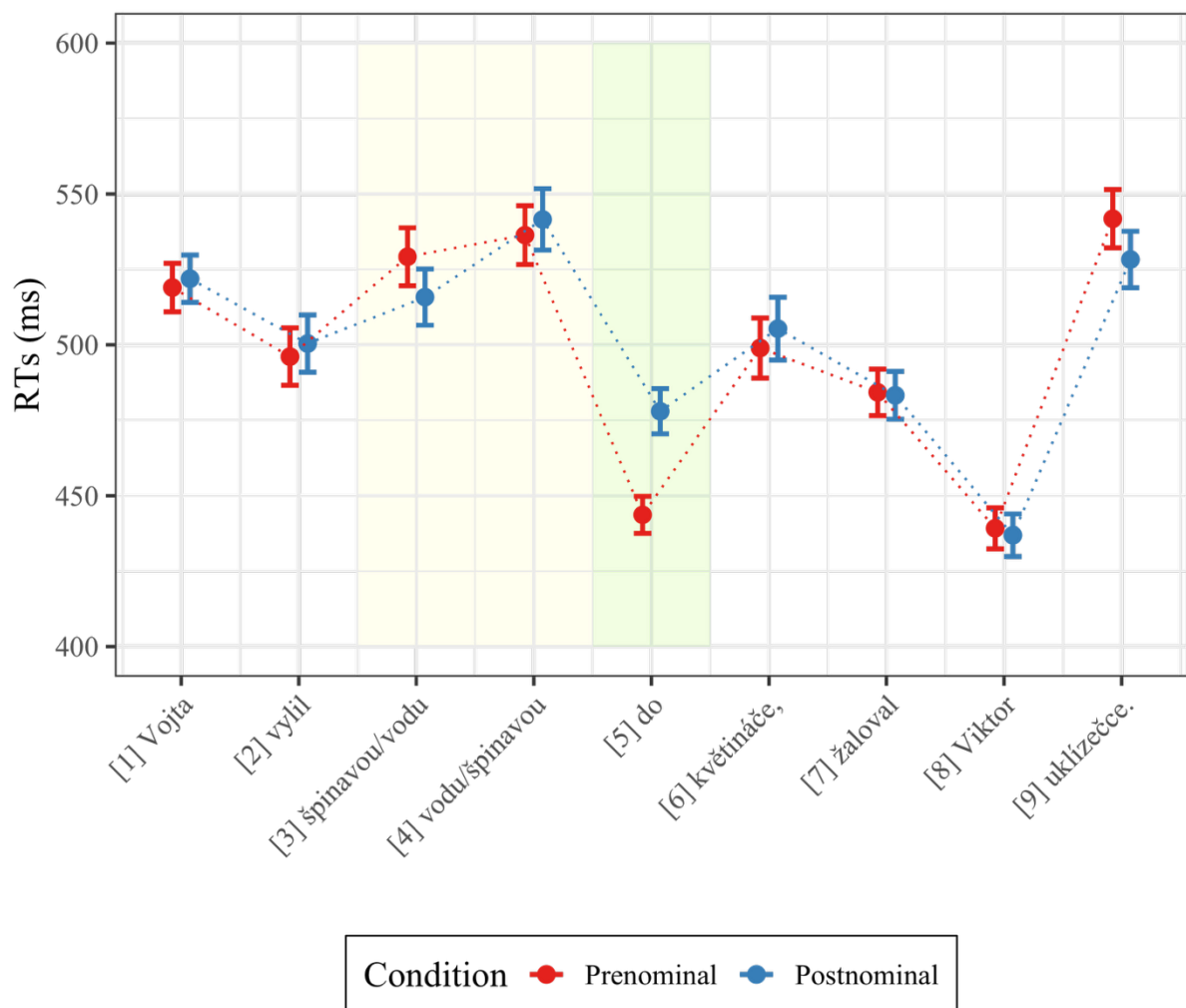


Figure 3 Reaction times in ms on individual words based on the adjective position in Experiment 2 (word-by-word). The target noun phrase and the spillover region are marked yellow and green respectively. Error bars denote 95% confidence intervals.

3.1.7 Discussion

The results from Experiments 1 and 2 support our hypothesis that postnominal adjectives are recalled more accurately than prenominal adjectives. The effect of adjective position was significant, regardless of the mode of presentation. What is somewhat surprising, however, is the overall low error rate observed in both experiments. This contrasts with earlier studies that highlighted the generally lower accessibility of adjectives (Chromý & Tomaschek, 2024; Mehler et al., 1978). Nevertheless, the recall accuracy aligns with the almost perfect accuracy of information conveyed by direct objects observed by the authors. It can be also attributed to the fact that, due to the structure of the sentence and its division, the clause containing the target noun phrase was quite short. Therefore, it was perhaps not so difficult to encode and store the information conveyed by the sentence.

The analysis of reaction times provided more ambiguous findings. In Experiment 1, which involved presenting whole sentences at once, no significant difference in reaction times was observed (although numerically, sentences with postnominal adjectives were read slightly more slowly). In the introductory sections, we noted that although there might be some principles explaining why postnominal adjectives occur at the level of production, it was difficult to predict their specific reading, therefore we did not formulate any hypothesis for online processing. To explain the pattern, we may only speculate. One possible explanation would be that the two structures are equivalent in terms of online processing. An alternative possibility would be that each adjective position is associated with similar overall processing difficulty, arising from different underlying mechanisms. A further possibility would be that reading and processing do differ, but the whole-sentence-at-once presentation allows for more flexible strategies, compensating for momentary processing differences.

In Experiment 2, we did not observe any significant differences in processing the target noun phrase, but postmodified noun phrases caused a slowdown in processing which emerged on the following preposition but was resolved right afterwards. The results thus indicate that the processing of postnominal adjectives involved some degree of processing difficulty or unexpectedness. At the same time, however, the spillover effect might have been caused or influenced by the presentation mode.

Taken together, the first round of experiments revealed that regardless of the presentation mode, postnominal adjectives were recalled more accurately than prenominal ones. Overall recall accuracy was higher in the experiment involving the whole-sentence-at-once presentation mode. The analysis of reaction times provided rather inconclusive findings. While we observed a significant effect of adjective position on the spillover region in the word-by-word experiment, no significant differences were attested when the sentences were presented at once. This pattern suggests that the observed differences in recall may stem from mechanisms or principles that might not be captured by reaction times.

3.2 Round 2 (Experiments 3 and 4)

Since we observed nearly perfect recall accuracy in Experiments 1 and 2 and noted differing patterns in online reaction times between different presentation modes, we decided to conduct another round of experiments in written form, again using the whole-sentence-at-once (Experiment 3) and the word-by-word (Experiment 4) presentation mode. The structure of the stimuli was significantly revised.

3.2.1 Participants

The analyses are based on data from 181 students (143 women, 36 men, 2 not disclosed, mean age = 22.36 years) in Experiment 3 and 179 students (140 women, 39 men, mean age = 23.1 years) in Experiment 4.

3.2.2 Materials

Experiments 3 and 4 comprised 20 experimental items and 75 filler items (see Appendix 1 for the list of experimental items). Each stimulus consisted of two clauses, however, this time, the direct speech format was not used. Instead, we adopted a format involving indirect speech containing the target noun phrase. This was motivated by our aim to use a form that more closely resembled spoken language, so that we could transfer the stimuli into spoken form in a subsequent experiment.

Instead of direct object, we chose a locative adjunct (with a genitive preposition) for the target noun phrase, as we expected that adjectives modifying adjuncts would be recalled less reliably, allowing more nuanced effects to emerge. To minimise the impact of morphosyntactic differences, we used only masculine singular nouns. Additionally, a demonstrative pronoun *ten* (= *the/this*) was inserted before the noun phrase so that the morphosyntactic properties were available before the adjective–noun pair was processed. As shown by our corpus probe, postmodified nouns were often preceded by demonstrative pronouns.

The first clause consisted of a proper name and a verb. The second included a conjunction, a locative adjunct (a genitive preposition, a demonstrative pronoun, an adjective and a noun), followed by a particle, a temporal adjunct (an adverb), a verb and a direct object modified by an attribute consisting of two coordinated nouns. This ensured that the target noun phrase would still be located far from the end of the sentence. Positioning the target noun phrase at the beginning of the clause also made it more likely to be interpreted as the theme and background.

Compared to the first round of experiments, the sentences became longer (9 words in Round 1 compared to 15 words in Round 2). Apart from the restriction to masculine singular nouns, the adjective-noun pairs were selected based on the same criteria as in the previous round. We changed the comprehension questions format. The questions included only the head noun, providing no additional contextual information that could have served as a cue for recalling the adjective. Examples of an item and a comprehension question can be found in Table 3.

Adjective position	Stimulus	Comprehension question
Prenominal	Ondra nepochopil, že do toho bílýho kostela opravdu loni nainstalovali oltář bez barvy a ornamentů.	O jaký kostel se jednalo?
	<i>Ondra didn't understand that they really installed an altar without paint and ornaments in the white church last year.</i>	
Postnominal	Ondra nepochopil, že do toho kostela bílýho opravdu loni nainstalovali oltář bez barvy a ornamentů.	What kind of church was it?
	<i>Ondra didn't understand that they really installed an altar without paint and ornaments in the church white* last year.</i>	

Table 3 Example of an experimental item and a corresponding comprehension question from Experiments 3 and 4, with non-literal translations preserving the adjective position. The target noun phrase is marked in bold.

In both experiments, we manipulated only the position of the adjective in the target noun phrase, so there were only two conditions for each experimental item, and we used a within-subjects design. A new set of 75 filler items was created. Some had a similar structure to the experimental items, with questions targeting different types of information conveyed by subjects, objects or temporal adjuncts. Others had completely different structures. We also used unconventional word orders in some sentence to reduce the salience of the adjective position manipulation.

3.2.3 Procedure

The procedure followed the same steps as in the previous experiments. Only the instructions were slightly modified. Participants were informed that the sentences, which they would read, were transcripts of conversations among family members.

3.2.4 Data coding

The criteria for coding responses in Experiments 3 and 4 were similar to those used in the previous experiments. In this round, we again encountered an issue that was not anticipated when we designed the stimuli. In certain items (e.g. *Radka uhodla, že do toho **slanýho koláče** zřejmě minule dali sýr s paprikou a rajčaty.* = *Radka guessed that they had probably put cheese with peppers and tomatoes in the **savoury pie** the last time.*), some participants provided

information conveyed by the direct object. For instance, when asked *O jaký koláč se jednalo?* (= *What pie was it?*), they answered *sýrový* (= *cheese*). Such responses (0.83% in Experiment 3 and 1.07% in Experiment 4) were again excluded from the analysis. Although the answers were factually correct, we could not determine whether they reflected an instance of interference, a failure to process the target adjective or simply greater accessibility of information from the end of the sentence. This finding highlights a methodological challenge: targeting information conveyed by adjectives may be complicated, as other words from the sentence may provide a plausible – and perhaps even correct – answer.

3.2.5 Data analysis

The data analysis followed the same steps and approaches as in Round 1. In Experiment 3, 2.85% of outlier RTs were excluded from the analysis, 4 participants were removed due to low recall accuracy (<50%). In Experiment 4, 2.36% of RTs were removed as outliers and 8 participants were removed due to low recall accuracy (<50%).

Adjective position contrasts were set as -0.5 for the prenominal position and 0.5 for the postnominal in both experiments. Recall accuracy was modelled as a dependent variable with adjective position as a fixed effect, and participant and item as random effects (with adjective position as a random slope for item and participant). Due to singularity issues, random slopes were omitted in Experiment 3. In Experiment 4, the full model including random slopes did not significantly improve the model's fit, so the slopes were also omitted.

As for RTs, in Experiment 3 (whole-sentence-at-once), we modelled log(RTs) for the whole sentence as a dependent variable, with adjective position as the only fixed effect and participant and item as random effects. Models with random slopes did not improve the fit. In Experiment 4 (word-by-word), we first summed the RTs on positions 5 and 6, corresponding to the target adjective and noun. We then modelled log(RTs) on the noun phrase as a dependent variable, with adjective position as a fixed effect and participant and item as random effects (with adjective position as a random slope for both participant and item). Due to convergence issues, the slopes were omitted. The RTs on the spillover region (positions 7, 8, 9) were modelled analogously.

3.2.6 Results

3.2.6.1 Recall accuracy

Adjective position	Exp. 3 (whole-sentence-at-once)	Exp. 4 (word-by-word)
Prenominal	248/1790 (13.85%) [12.23; 15.46]	366/1769 (20.69%) [18.80; 22.58]
Postnominal	161/1800 (8.94%) [7.63; 10.26]	285/1780 (16.01%) [14.31; 17.71]

Table 4 Recall accuracy (% incorrect) based on the adjective position in Experiments 3 and 4. Accuracy has the following format: incorrect answers/all answers, % incorrect in bold and brackets, 95% confidence interval in square brackets.

In Experiment 3, participants' mean accuracy was 88.56% (median 90%), with individual accuracy ranging from 52.63% to 100.00%. Item-level accuracy ranged from 72.93% to 97.06% (median = 90.09%). Postnominal adjectives were recalled better than prenominal ones. The effect of adjective position was significant ($\beta = 0.542$, $SE = 0.110$, $z = 4.947$, $p < .001$). The overall recall accuracy (% incorrect) is reported in Table 4 and Figure 4.

In Experiment 4, participants' mean accuracy was 81.59% (median 85.00%), with individual accuracy ranging from 50.00% to 100.00%. Item-level accuracy ranged from 58.10% to 96.09% (median = 83.32%). Again, we observed higher recall accuracy for postnominal adjectives. The effect of adjective position was statistically significant ($\beta = 0.361$, $SE = 0.093$, $z = 3.888$, $p < .001$). The overall recall accuracy (% incorrect) is reported in Table 4 and Figure 4.

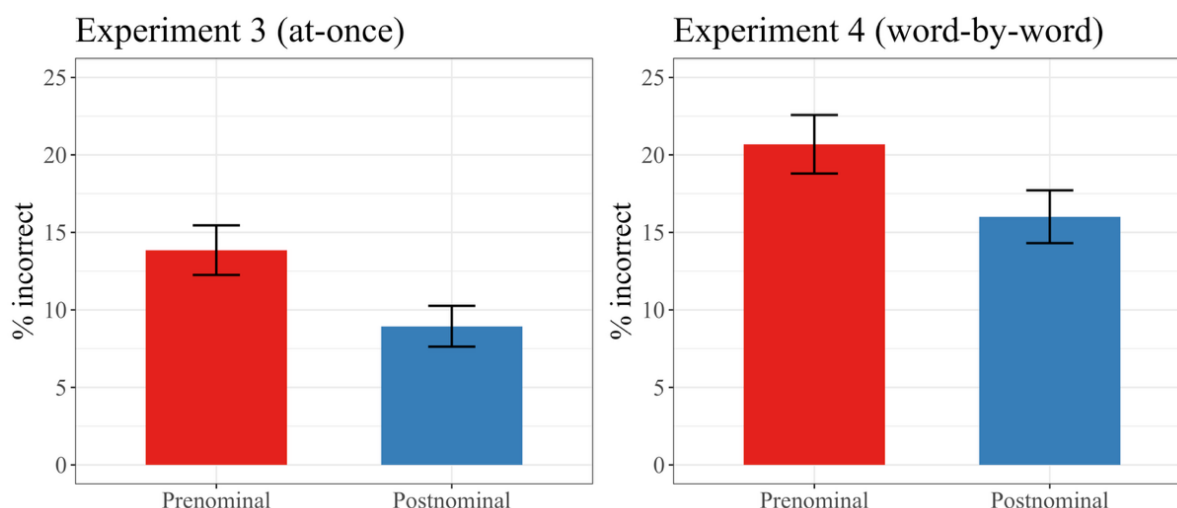


Figure 4 Recall accuracy (% incorrect) based on the adjective position in Experiments 3 and 4. Error bars denote 95% confidence intervals.

3.2.6.2 Reaction times

In Experiment 3, sentences with postnominal adjectives were read and processed slightly more slowly (7996 ms [7797; 8195]) than those with prenominal adjectives (7857 ms [7658; 8057]). However, the effect of adjective position was not significant.

In Experiment 4, there was no significant effect of adjective position on reaction times on the noun phrase itself. However, the effect was significant on the following particle ($\beta = 0.061$, $SE = 0.017$, $t = 3.503$, $p < .01$), temporal adverb ($\beta = 0.044$, $SE = 0.015$, $t = 2.986$, $p < .01$) and verb ($\beta = 0.045$, $SE = 0.010$, $t = 4.385$, $p < .001$). Reaction times converged again on the direct object (position 11). The reaction times on individual words are visualised in Figure 5.

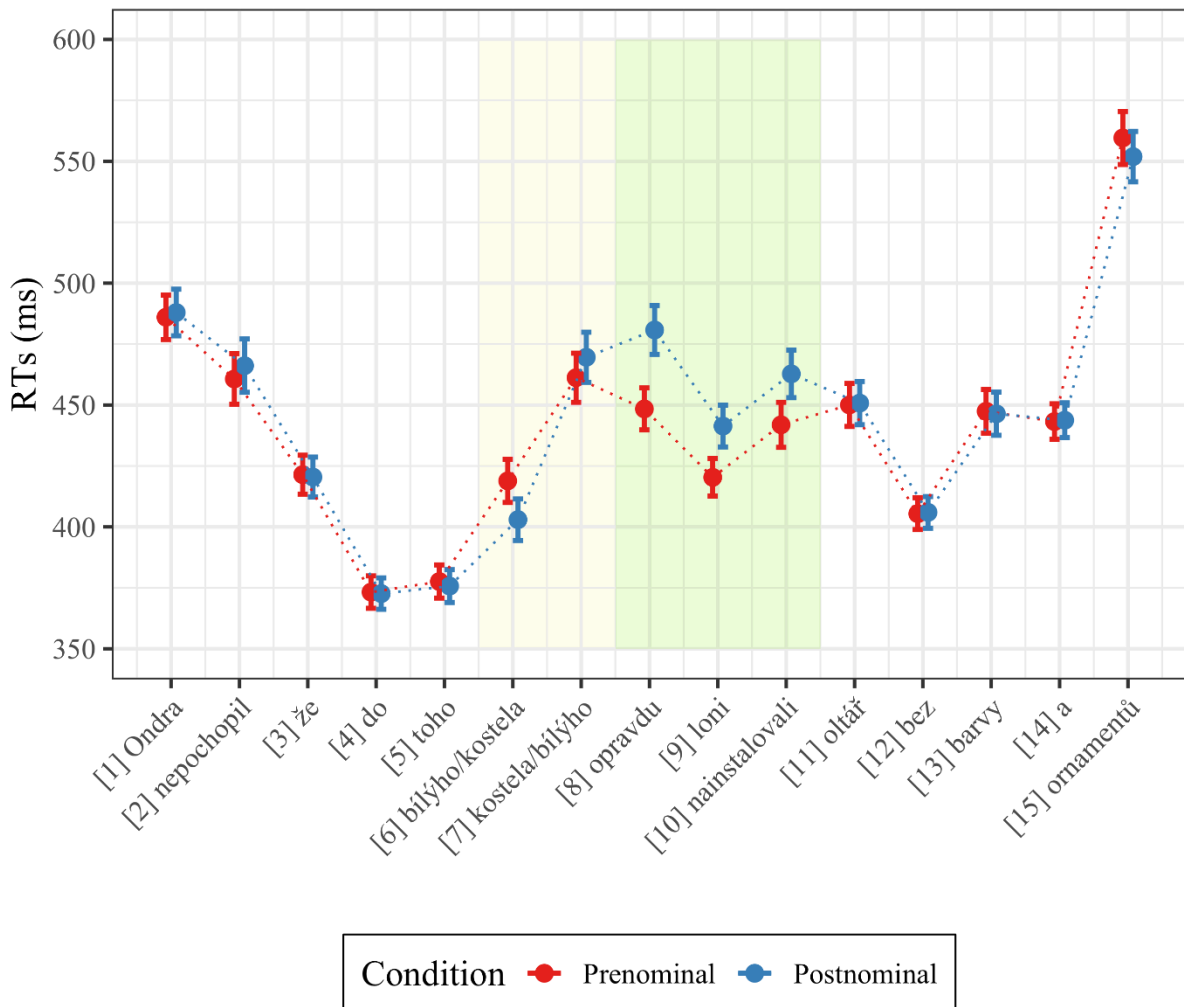


Figure 5 Reaction times in ms on individual words in Experiment 4 (word-by-word). The target noun phrase and the spillover region are marked yellow and green respectively. Error bars denote 95% confidence intervals.

3.2.7 Discussion

In terms of recall accuracy, Experiments 3 and 4 were consistent with the results of Experiments 1 and 2. Postnominal adjectives were generally recalled more accurately than prenominal ones. This time, however, the proportion of incorrect responses was higher, reflecting the fact that the adjective modified locative adjuncts, which convey optional information that readers might pay less attention to (Chromý & Vojvodić, 2024). The overall lower recall accuracy may also be attributed to the increased sentence length compared to the first round of experiments. Furthermore, we again found that recall accuracy was lower when sentences were presented in the whole-sentence-at-once mode compared to the word-by-word presentation.

The analysis of reaction times in Round 2 had similar outcomes to those in Round 1. In Experiment 3, adjective position did not significantly affect the duration of sentence reading and processing. We provided possible explanations in the previous round of experiments, and they apply here as well. In Experiment 4, there was again no significant effect of adjective position on reaction times on the target noun phrase. Notable differences, however, were observed on the spillover region. The particle, temporal adverb and verb following postnominal adjectives were read significantly more slowly. After that, reaction times converged again. We observed a similar pattern in Experiment 2, although the slowdown in reaction times was restricted only to the preposition immediately following the target noun phrase.

This raises a question of how to interpret the spillover effects. Could they indicate a garden-path effect? A postnominal adjective in the genitive case could initially be interpreted as modifying another noun that is yet to appear, rather than the preceding one. Consistent with Ceháková and Chromý (2023), a garden-path effect would predict a difference in reaction times at the point where readers revise their initial interpretation – in our case, on the particle in Experiment 4 and on the preposition in Experiment 2. While the differences were significant in both experiments, a garden-path effect would likely produce spillover effects as well. This can be observed in Experiment 4, where the difference in reaction times persisted even on the adverb and verb. However, in Experiment 2, reaction times converged by the second word following the postnominal adjective. This suggests that the prolonged reaction times might rather reflect some other form of processing difficulty.

Could the reason be that postnominal adjectives are syntactically unusual or unexpected? Although previous studies have indicated that people rather tend to remember typical and

predictable information (e.g., Häuser & Kray, 2023), we decided to investigate this potential explanation in the third round of experiments.

Taken together, we can argue that the superior recall of postnominal adjectives across four experiments is consistent with the Feature-Label-Order principle (Ramscar et al., 2010). Furthermore, the comparison across different presentation modes in both rounds suggests that differences in recall accuracy may not necessarily be related to prolonged reaction times. Likewise, the comparison of reaction time patterns on words following the target noun phrase between Experiments 2 and 4 indicates that reanalysis or ambiguity do not necessarily account for the observed patterns.

3.3 Round 3 (Experiment 5 and 6)

In the next round of two experiments, we aimed to address the possibility that the differences in adjective recall may stem from the syntactic unusualness of postnominal adjectives. We introduced a second independent variable by replacing adjectives with noun modifiers in the genitive case (further referred to as genitive modifiers or simply genitives), which canonically occur in the postnominal position. If the recall advantage were driven by syntactic unusualness, an opposite pattern would be expected for genitive modifiers: prenominal genitive modifiers would be recalled better.

We used slightly modified stimuli from the previous round of experiments and altered the mode of presentation in Experiment 5. Since our previous experiments involving the whole-sentence-at-once presentation mode revealed no significant differences in reaction times, we decided to present stimuli phrase-by-phrase. We assumed that if the target noun phrase was presented as a whole, the likelihood of encountering and resolving ambiguity might be reduced compared to the word-by-word presentation. At the same time, the phrase-by-phrase presentation allowed for more fine-grained observation of RT patterns than whole-sentence-at-once presentation.

3.3.1 Participants

The analyses are based on data from 135 students (104 women, 30 men, 1 not disclosed, mean age = 22.60 years) in Experiment 5 and 153 students (116 women, 36 men, 1 not disclosed, mean age = 23.05 years) in Experiment 6.

3.3.2 Materials

In both experiments, we used 20 experimental items from Round 2, which were slightly modified, plus 75 filler items. We used a 2×2 within-subjects design. Each participant received one of the four conditions per item. For the genitive modifiers, we selected feminine proper names. Proper names were suitable for this manipulation because they lack systematic population-level associations with the nouns they modify, in contrast to adjective–noun pairs. Only feminine proper names could be chosen because masculine genitives following a genitive preposition and a masculine demonstrative pronoun might be misinterpreted as the head noun of the entire phrase. Such ambiguity is avoided when using feminine names.

In Round 2, we used proper names as the subject of the first clause. Since these would likely cause interference, we omitted the subject and changed the verb form to the first person. We

also modified the stimuli, which were earlier identified as problematic, by negating the verbs in the second clause, so that it was not possible to answer the comprehension question based on the information conveyed by the direct object of the clause. This can be demonstrated by the example in Table 5, where answering *zázvorový* (= *ginger*) to *O jaký mošt se jednalo?* (= *Which cider was it?*) would have clearly indicated a misunderstanding or a failure to recall the target adjective. We completely changed three stimuli because the genitive modification was not appropriate for the original noun phrase. We also revised the form of the comprehension questions, since an analogous question targeting the genitive in the previously employed format (*O čí mošt se jednalo?*) sounded rather unnatural.

Modifier position X Modifier type	Stimulus	Comprehension question
Prenominal adjective	Zjistila jsem, že do toho horkýho moštu taky potom nepřidali zázvor s rakytníkem a hřebíčkem. <i>I found out they also didn't add ginger with sea buckthorn and cloves to the hot cider afterwards.</i>	Jaký mošt to byl?
	Zjistila jsem, že do toho moštu horkýho taky potom nepřidali zázvor s rakytníkem a hřebíčkem. <i>I found out they also didn't add ginger with sea buckthorn and cloves to the cider hot* afterwards.</i>	What cider was it?
Prenominal genitive	Zjistila jsem, že do toho Renaty moštu taky potom nepřidali zázvor s rakytníkem a hřebíčkem. <i>I found out they also didn't add ginger with sea buckthorn and cloves to Renata's cider* afterwards.</i>	Čí mošt to byl?
Postnominal genitive	Zjistila jsem, že do toho moštu Renaty taky potom nepřidali zázvor s rakytníkem a hřebíčkem. <i>I found out they also didn't add ginger with sea buckthorn and cloves to cider Renata's* afterwards.</i>	Whose cider was it?

Table 5 Example of an experimental item, its segmentation into phrases (only in Experiment 5) and corresponding comprehension questions from Experiments 5 and 6, with non-literal translations preserving the modifier position. The target noun phrase is marked in bold. The phrases are divided by vertical bars.

3.3.3 Procedure

The procedure for Experiment 6 (word-by-word) was the same as in Experiments 2 and 4. For Experiment 5 (phrase-by-phrase), participants received specific instructions concerning this presentation mode. In this experiment, stimuli were segmented into multi-word phrases containing no more than three words, with respect to presumed reading strategies. The filler items were segmented using the same criteria. An example of the segmentation is provided in Table 5, with phrases divided by vertical bars (|).

3.3.4 Data coding

The criteria for coding responses were the same as in Round 2.

3.3.5 Data analysis

The data analysis followed the same steps and approaches as in the previous rounds. In Experiment 5, 1.73% of outlier RT values were removed. Two participants had over 10% of their RT values missing. However, manual inspection revealed that the missing values systematically concerned the final word of each sentence which indicated some technical issue. They were both included in the analysis. Five participants had a recall accuracy lower than 50%, they were excluded. In Experiment 6, 1.38% of outlier RT values were removed. Two participants had a recall accuracy below 50% and were thus excluded.

Concerning modelling, it was again theoretically justified to suppose that both the modifier type and position could impact recall accuracy and reaction times and that these variables might interact. We also assumed that participants might be sensitive towards both the modifier type and position variability and that both variables could account for variability across different experimental items. Modifier type contrasts were set as 0 for adjective and 1 for genitive, while modifier position contrasts as 0 for prenominal and 1 for postnominal.

In both experiments, recall accuracy was modelled as a dependent variable, with modifier position, modifier type and their interaction as fixed effects. Participant and item served as random effects. Modifier position and modifier type were initially included as random slopes for both participant and item. In Experiment 5, the best-fitting model excluded modifier position as a random slope for both random effects. More complex models had either problems with singularity issues or did not improve the model's fit significantly. In Experiment 6, the best-fitting model included only modifier type as a random slope for item.

In Experiment 5, we modelled RTs for position 3 (target noun phrase) and 4 (spillover region, consisting of a particle and a temporal adverb). In both models, the dependent variable was $\log(\text{RT})$, with modifier type, modifier position and their interaction as fixed effects, and participant and item as random effects. Random slopes were omitted (due to singularity issues). In Experiment 6, we modelled RTs on the target noun phrase (summed up RTs on positions 6 and 7) and on the following spillover region (positions 8, 9 and 10 separately). In these models, $\log(\text{RTs})$ was the dependent variable. Modifier type, modifier position and their interaction were included as fixed effects, with participant and item as random effects. Modifier position was included as a random slope only when modelling the RTs on the target noun phrase, where it significantly improved the model's fit. More complex models exhibited singularity issues.

3.3.6 Results

3.3.6.1 Recall accuracy

Modifier position X type	Exp. 5 (phrases)	Exp. 6 (word-by-word)
Prenominal adjective	132/675 (19.56%) [16.56; 22.55]	135/765 (17.65%) [14.95; 20.35]
Postnominal adjective	127/675 (18.81%) [15.87; 21.76]	96/765 (12.55%) [10.20; 14.90]
Prenominal genitive	106/675 (15.70%) [12.96; 18.45]	92/765 (12.03%) [9.72; 14.30]
Postnominal genitive	92/675 (13.63%) [11.04; 16.22]	83/765 (10.85%) [8.65; 13.05]

Table 6 Recall accuracy based on position and type in Experiments 5 and 6. Accuracy has the following format: incorrect answers/all answers, % incorrect in bold and brackets, 95% confidence interval in square brackets.

In Experiment 5, participants' mean recall accuracy was 83.07% (median 85%), with individual accuracy ranging from 50% to 100%. Item-level accuracy ranged from 62.22% to 96.30% (median = 81.66%). Only modifier type had a borderline significant effect on recall accuracy ($\beta = 0.463$, $SE = 0.250$, $z = 1.851$ $p = 0.064$) Genitive modifiers might be recalled slightly better. The effect of modifier position and the interaction between type and position were not significant. The results are reported in Table 6 and Figure 6.

In Experiment 6, participants' mean recall accuracy was 86.73% (median 90%), with individual accuracy ranging from 55% to 100%. Item-level accuracy ranged from 75.82% to 96.73% (median = 86.60%). The model reported a significant effect of modifier position ($\beta = 0.434$, $SE = 0.151$, $z = 2.873$, $p < .01$). Recall was better for postnominal modifiers compared to prenominal ones. Additionally, the data suggest that genitives might be recalled slightly better than adjectives, however, this effect was again borderline significant ($\beta = 0.466$, $SE = 0.259$, $z = 1.802$, $p = 0.072$). The effect of the interaction between the two variables was not significant.

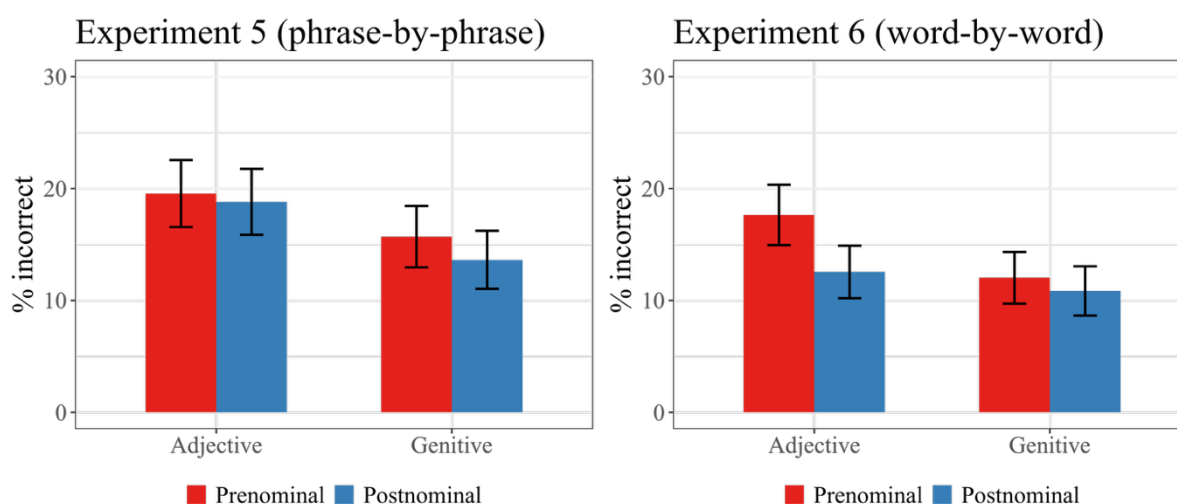


Figure 6 Recall accuracy (% incorrect) based on the modifier position and type in Experiments 5 and 6. Error bars denote 95% confidence intervals.

3.3.6.2 Reaction times

In Experiment 5, the analysis of reaction times on the target noun phrase revealed that both the effect of modifier type ($\beta = 0.079$, $SE = 0.020$, $t = 3.941$, $p < .001$) and modifier position ($\beta = 0.074$, $SE = 0.020$, $t = 3.682$, $p < .001$) were significant. The effect of their interaction was not significant. This suggests that postmodified noun phrases were read more slowly than premodified ones and phrases with genitives were read more slowly than phrases with adjectives. On the spillover region, the effect of modifier position remained significant ($\beta = 0.090$, $SE = 0.019$, $t = 4.825$, $p < .001$), while the effect of modifier type did not. The interaction between the two variables was significant ($\beta = -0.070$, $SE = 0.026$, $t = -2.691$, $p < .01$). This suggests that words following postnominal modifiers were read more slowly but the differences after adjectives were far more pronounced, as illustrated in Figure 7. Reaction times then converged on the verb.

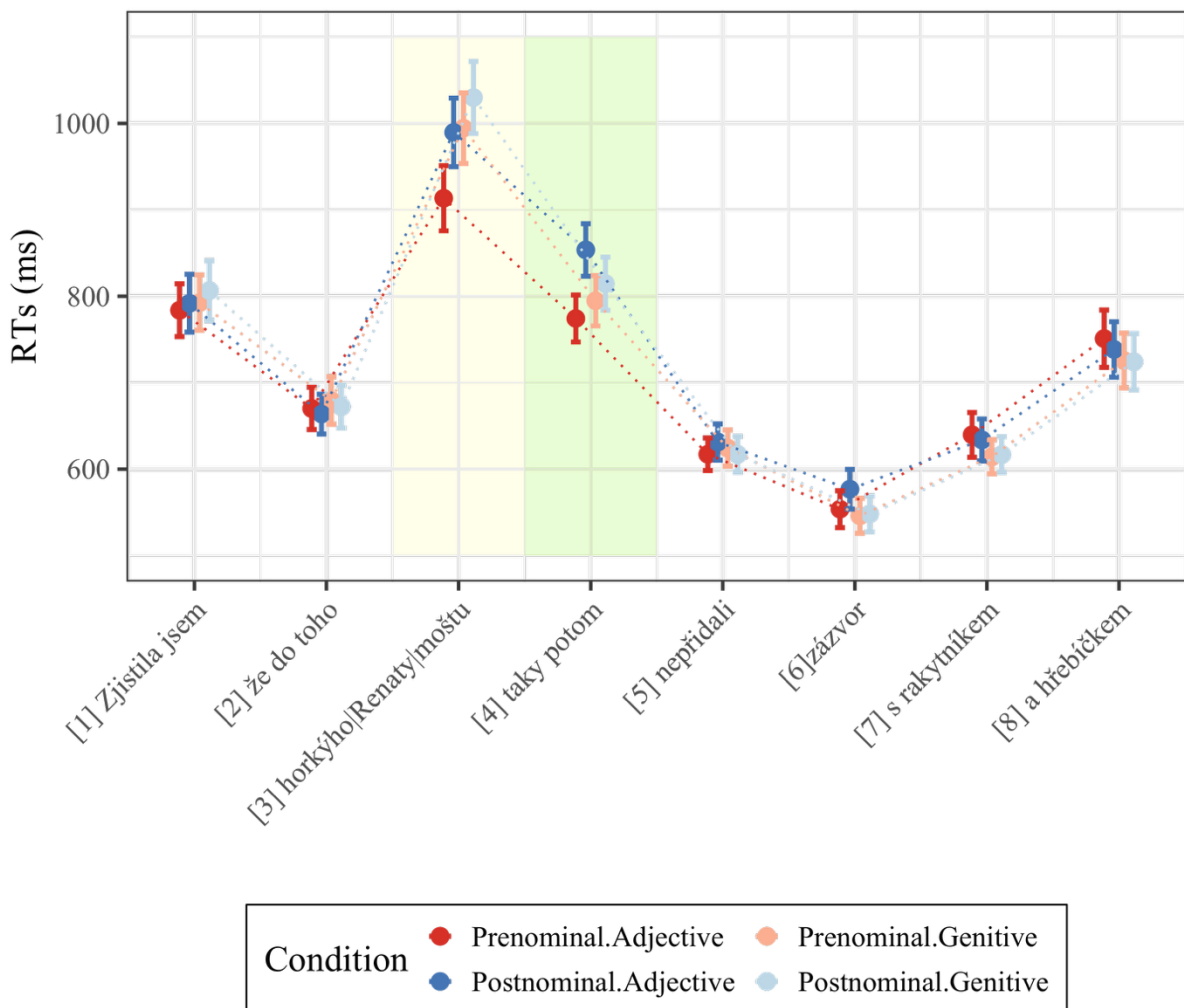


Figure 7 Reaction times in ms on phrases in Experiment 5 (phrase-by-phrase). The target noun phrase and its spillover region are marked yellow and green respectively. Error bars denote 95% confidence intervals.

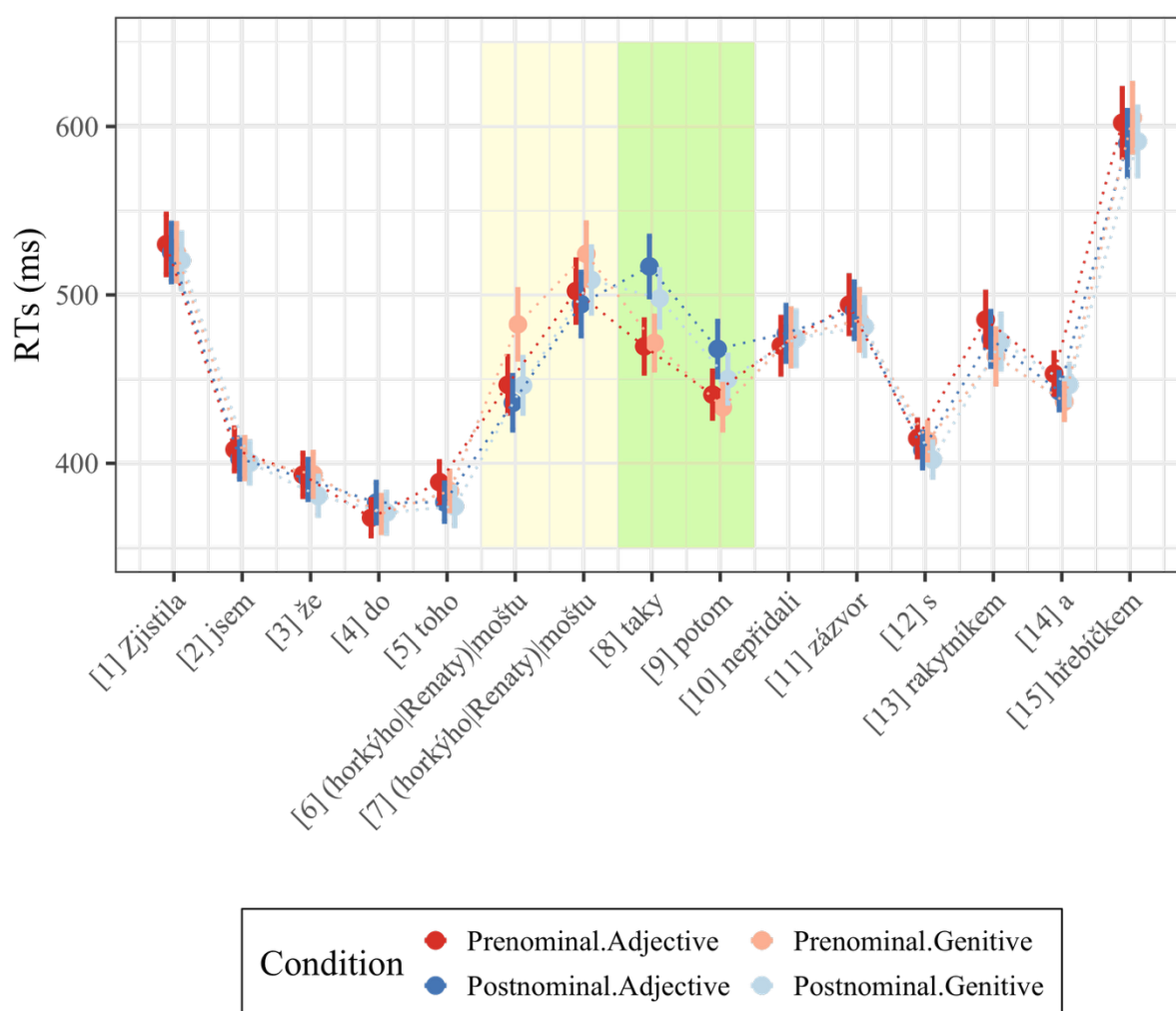


Figure 8 Reaction times in ms on individual words in Experiment 6 (word-by-word). The target noun phrase and its spillover region are marked by yellow and green. Error bars denote 95% confidence intervals.

The reaction times on individual words in Experiment 6 are visualised in Figure 8. There was no significant effect of modifier position on the summed reaction times on the noun phrase but the effect of modifier type was significant ($\beta = 0.063$, $SE = 0.014$, $t = 4.387$, $p < .001$) and the interaction of the two variables as well ($\beta = -0.044$, $SE = 0.020$, $t = -2.184$, $p < .05$). This suggests that noun phrases with genitives were read more slowly and the difference was more pronounced on premodified noun phrases. On the subsequent words, we observed a significant effect of modifier position on the particle ($\beta = 0.088$, $SE = 0.017$, $t = 5.027$, $p < .001$) and the temporal adverb ($\beta = 0.046$, $SE = 0.016$, $t = 2.990$, $p < .01$). The effect was not significant on the verb, where the reaction times converged. The effect of modifier type and the interaction were not significant on any of the three words. This would suggest that the two words following postnominal modifiers were read more slowly and the reaction times converged again on the verb.

3.3.7 Discussion

Experiment 5 (phrase-by-phrase) was the first experiment in which no effect of modifier position on recall accuracy was observed. A possible explanation is that the phrase-by-phrase mode of presentation – not used in the previous experiments – may have disrupted the incremental processing usually associated with reading sentences presented word-by-word. Paradoxically, at the level of reaction times, we observed an effect of modifier position in Experiment 5 – both the postmodified target noun phrase and the spillover region were read more slowly. Moreover, the spillover effect seems to be more pronounced after postnominal adjectives compared to postnominal genitives.

Experiment 6 (word-by-word) replicated the pattern in recall accuracy from the previous rounds of experiments, with postnominal modifiers being recalled better than prenominal ones. A similar pattern in reaction times was also observed. Modifier position did not have a significant effect on the target noun itself but affected reaction times on the spillover region. Contrary to Experiment 5, the interaction of position and type did not significantly affect reaction times on the spillover region. But from Figure 8, it is apparent that – at least numerically – words following postnominal genitives might have been read slightly faster than words following postnominal adjectives, which was a pattern observed in Experiment 5. Compared to the previous round – to Experiment 4, where approximately the same stimuli were used, the convergence of reaction times occurred one word earlier (on the verb rather than on the direct object), suggesting a slightly faster resolution of potential processing difficulty in Experiment 6.

The primary aim of this round of experiments was to compare the recall accuracy of adjectives and genitives in terms of their position. We assumed that if participants were more likely to recall syntactically odd or unusual structures, recall accuracy would be higher for prenominal genitives than for postnominal ones. However, this prediction was not supported by our data in either experiment. In Experiment 5, no significant effect of modifier position was observed at all, whereas in Experiment 6, modifier position significantly affected recall accuracy, with postnominal modifiers being recalled better. Given that the interaction between modifier position and type was not significant in any of the two experiments, we may conclude that with respect to their position, genitives were recalled either to the same degree (Experiment 5) or to a similarly different degree (Experiment 6) as adjectives. Therefore, syntactic unusualness probably does not account for the higher recall accuracy among postnominal adjectives.

Nevertheless, it might account for differences in online processing. We observed slower reaction times on phrases with more unusual prenominal genitives compared to phrases with prenominal adjectives in Experiment 6 – see Figure 8. Such a difference was indicated by the significant interaction of modifier type and position. And results from Experiment 5 suggest that postnominal adjectives, which are more unusual, yielded a more pronounced spillover effect compared to postnominal genitives. Thus, it can be concluded that there are clearly some differences associated with both structures in terms of their position at the level of online processing, but these may not necessarily explain the patterns in recall. It seems that among genitives, the effect of position on reaction times manifests itself on the actual word, while differences in processing adjectives based on their position might be rather observed on their spillover region.

Both experiments also revealed a borderline significant advantage for genitives over adjectives in terms of recall accuracy. No specific prediction was made concerning this comparison, as it primarily served as a control in our study. Although the p-values were in both cases slightly higher than the conventional 0.05, we report these effects, because one might have expected genitives to be recalled even less accurately than adjectives, given that the semantic association between an object and its possessor is arguably weaker than the association between an object and its feature. Moreover, proper names are generally considered less imageable than adjectives. Higher imageability has also been shown to facilitate recall in previous research (Tse & Altarriba, 2007). On the other hand, prior studies on post-sentential immediate recall might indicate that nouns could be generally recalled better than adjectives (Chromý & Tomaschek, 2024). It is therefore possible that this explains the slight recall advantage for genitives.

3.4 Round 4 (Experiment 7)

So far, we have demonstrated that postnominal adjectives were recalled better in most of our written experiments. Another experiment was designed to provide an initial insight into how adjective position affects recall in spoken language – a mode in which postnominal adjectives are well attested in corpora. In Experiment 7, both the modifier position and type were again manipulated. We used slightly modified stimuli from the previous experiments. Their recordings were generated using artificial intelligence.

3.4.1 Participants

The analyses are based on data from 220 students (157 women, 59 men, 1 non-binary, 3 not disclosed, mean age = 22.59) in Experiment 7.

3.4.2 Materials

In Experiment 7, 20 experimental items plus 75 filler items from the previous round were used – with slight modifications. See Appendix 1 for the list of experimental items, recordings are available on OSF (<https://osf.io/7e2qa/>). To avoid potential effects of voice variation, we chose a single voice – a female one. Therefore, the grammatical gender of the participles in the first clause had to be feminine in all items. The filler items were modified accordingly. Spoken stimuli were generated using the ElevenLabs Multilingual V2 model (ElevenLabs, 2025). The model offers a wide range of Czech-trained voices intended for various purposes (audiobooks, announcements or podcasts). Our primary criterion for selecting the voice was its suitability for informal conversation, since the stimuli were designed to resemble fragments of spontaneous informal communication. We selected *Anet*, a female voice, described as “[a] young Czech woman in her 20s, quiet intensity, naturally low pitch, fast pace, great for conversations and informative videos” (ElevenLabs, 2025).

The ElevenLabs interface allowed for the manipulation of two parameters – similarity and stability – on a scale from 0 to 100. Similarity refers to variability within one recording (where higher values make speech sound more artificial or monotonous), while stability concerns variability across regenerations (where higher values make regeneration more similar) (ElevenLabs, 2025). Although it could be interesting to manipulate both parameters and investigate their impact on perception or acoustic properties of the resulting stimuli, this was beyond the scope of this thesis. Based on several test recordings, both parameters were set to

50, consistent with the exploratory nature of the experiment and its focus on the potential use of AI in future research.

The resulting recordings were evaluated solely based on perception. The general requirement was that all words be pronounced clearly and accurately, with no missing parts of words, no missing whole words and no additional sounds. In this respect, the model performed adequately, most errors were not systematic and were resolved by regeneration.

However, one recurring issue concerned the Common Czech ending of adjectives within the target noun phrase. For example, in the noun phrase *modrýho slovníku* (= *blue dictionary*), the model constantly produced the standard form *modrého*. A successful workaround was found by replacing *y* with *í*, which prompted the model to generate the non-standard variant. Another issue occurred with the words *overall* (= *jumpsuit*) and *e-shop* (= *online shop*). These were repeatedly generated with pseudo-English pronunciation. As we did not find a solution for *overall*, we had to replace it with *kufř* (= *suitcase*), which fit the context appropriately. In contrast, the issue with *e-shop* was resolved by entering a pseudo-phonetic transcription *ešop*.

Karimi et al. (2024) showed that pauses are a significant intervening factor in processing and memory encoding. Therefore, we wanted to avoid significant pauses in the sentences, especially between the noun and adjective within the target noun phrase. Conversely, a natural pause was expected to occur between the two clauses and before vowel-initial words. The model occasionally failed to insert a glottal stop, linking the vowel to the preceding word instead. However, this error was not systematic.

As mentioned earlier, we also wanted to minimise the impact of information structure. In the written experiment, we wanted to achieve this by positioning the target noun phrase at the beginning of the clause, thereby increasing the likelihood that its components would be interpreted as the theme and background. In the spoken experiment, we sought to ensure that prosody would not mark the whole noun phrase or its constituents as the focus or rheme.

We generated a total of four recordings for each condition (2 x 2) of each item, all conforming to the general criteria. While some stimuli (or their specific conditions) had to be regenerated up to twenty times, in other cases the model produced four suitable outputs on the first attempt. The recordings were subsequently evaluated by two external and independent annotators. Their task was to select two variants for each condition of each item. The annotators were provided

with six evaluation criteria (Table 7) and were also instructed to select variants that would be similar to other conditions within the item.

1. There should be no noticeable pause immediately following the target noun phrase (although a minimal, perceptual pause may naturally occur if the following word begins with a vowel).
2. The intonation at the end of the sentence should fall naturally, giving the utterance the contour of a declarative sentence, not a question.
3. The target noun phrase should function as the theme of the utterance and should not carry prosodic focus.
4. Overall, there should be no significant pauses (natural pauses are acceptable between clauses or, for instance, before the conjunction <i>and</i> in the final coordinated structure).
5. In the postnominal modifier condition, there should be no emphasis placed specifically on the modifier.
6. Temporal adverbials should also not be marked by pitch accent.

Table 7 Evaluation criteria for annotators of spoken stimuli generated by artificial intelligence.

Across the full set of recordings, at least some degree of agreement between the two annotators was reached in 65 conditions, meaning that at least one variant was selected by both of them. 8 conditions resulted in a tie, requiring a final decision based on our own judgment. Additionally, after re-reviewing all recordings, in 5 of the 65 cases with agreement, we ultimately selected a variant that was preferred by only one of the annotators, rather than the one selected by both. For additional 5 recordings, the annotators noted specific issues that made us regenerate the corresponding recordings. As for the remaining 15 conditions with no overlap in the annotators' choices, in 10 cases, the lack of agreement occurred likely due to the fact that all variants were of comparable quality. We, therefore, chose the variant that we considered the most appropriate. In the remaining 5 cases, it was necessary to generate entirely new recordings. In total, this resulted in the regeneration of 10 conditions across 4 different items.

The criteria for generating the filler and practice items were less complex. The only requirements were that the sentences be articulated clearly, without any omissions and produced with natural intonation and pacing.

3.4.3 Procedure

The online experiment was conducted on the JATOS platform (Lange et al., 2015). In addition to the questions from the previous rounds, participants were also asked to report any difficulties with hearing. Otherwise, the procedure was similar to the previous rounds of experiments. The comprehension question appeared immediately after the recording was played. Participants could not pause or replay the recorded stimuli.

3.4.4 Data coding

The criteria for coding responses to the comprehension questions were the same as those used in the previous rounds of experiments.

3.4.5 Data analysis

The analysis followed the same steps and approaches as in the previous rounds. One participant was excluded based on low recall accuracy (<50%). In this experiment, only recall accuracy was modelled. Modifier type contrasts were again set as 0 for adjectives and 1 for genitives, while modifier position contrasts as 0 for prenominal and 1 for postnominal. The best-fitting model included recall accuracy as a dependent variable, with modifier position, modifier type and their interaction as fixed effects. Participant and item were included as random effects. Including modifier type as a random slope for item significantly improved the model's fit.

3.4.6 Results

Modifier position X type	Exp. 7 (spoken)
Prenominal adjective	148/1100 (13.40%) [11.40; 15.50]
Postnominal adjective	103/1100 (9.36%) [7.64; 11.10]
Prenominal genitive	121/1085 (11.20%) [9.28; 13.00]
Postnominal genitive	102/1115 (9.15%) [7.46; 10.80]

Table 8 Recall accuracy based on modifier position and type in Experiment 7. Accuracy has the following format: incorrect answers/all answers, % incorrect in bold and brackets, 95% confidence interval in square brackets.

The overall recall accuracy (% incorrect) is reported in Table 8 and Figure 9. Participants' mean recall accuracy was 89.23% (median 90.00%), the lowest scoring-participant achieved an accuracy of 50%, while the highest-scoring participant reached 100%. Across items, recall accuracy ranged from 76.36% to 96.82% (median = 89.32%). Only modifier position yielded a significant effect on recall accuracy ($\beta = 0.502$, $SE = 0.142$, $z = 3.535$, $p < .001$). Postnominal modifiers were recalled better than prenominal ones. The effects of modifier type and the interaction of type and position were not significant.

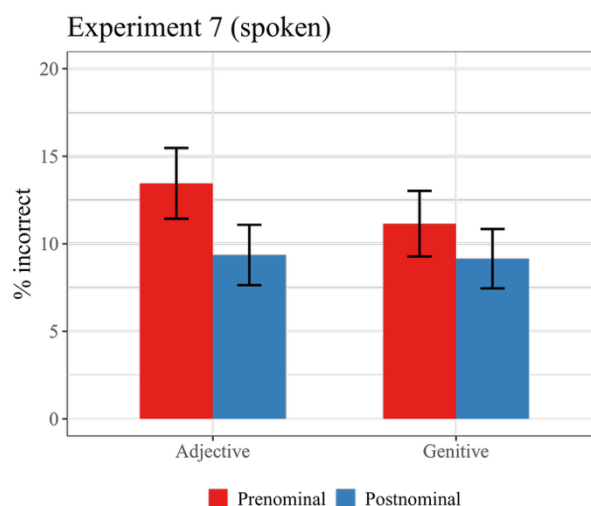


Figure 9 Recall accuracy (% incorrect) based on the modifier position and type in Experiment 7. Error bars denote 95% confidence intervals.

3.4.7 Discussion

The results of the spoken experiment confirmed the effects of position on recall, observed in five out of six previous experiments. Postnominal modifiers were better recalled than prenominal ones. Unlike in the previous round, no effect of modifier type was observed. We suggested that the marginally higher recall accuracy of genitives might be due to participants reading them longer which was somewhat reflected in the reaction times data. Such a mechanism, however, is not possible in the spoken modality, where listeners cannot control how long they are exposed to individual parts of the utterance. Importantly, the fact that a difference in adjective recall by position was observed under more naturalistic conditions where participants could neither consciously nor unconsciously influence stimulus exposure is crucial. This finding suggests that the recall advantage for postnominal modifiers is systematic and likely driven by more general principles of language processing and organisation.

It is nevertheless possible that some effect of processing postnominal adjectives occurred even in this experiment. However, within the current research design – in experiments distributed online – we lacked the means to measure it. Unlike in the written experiments, where reaction times on individual words or for the whole sentence can be recorded. For future research, it would be worthwhile to introduce an additional variable – such as a comprehension question targeting participants' recall of information conveyed by words that occur later in sentences (e.g., information conveyed by the temporal adjunct or the direct object in this case). This could perhaps help determine whether processing postnominal adjectives yields some effects even in

the spoken modality and impairs the processing and encoding of words following the target noun phrase.

This experiment again indicated that the effect of adjective position is unlikely to be attributed to syntactic unusualness, as such an explanation would predict the opposite pattern for genitive modifiers. We argue that the spoken experiment offers the highest ecological validity, given that postnominal adjectives are, as previously noted, predominantly characteristic of spoken Czech. At the same time, we acknowledge the limitations of using AI-generated stimuli. Although the recordings were carefully prepared and perceptually evaluated, they were not validated through acoustic analysis. Therefore, the potential influence of prosodic variation remains an open question. Future research employing recordings produced by human voice actors would be also valuable for validating our current findings.

3.5 General Discussion

The primary aim of this thesis was to investigate how the position of bare adjectives in Czech affects their immediate recall. Since the thesis addressed a rather novel research question without a direct precedent in the existing literature, we had to rely on predictions from more general literature on learning, sentence processing and memory. Based on the Feature-Label-Order principle (Ramscar et al., 2010), we predicted that postnominal adjectives would be recalled more accurately than prenominal ones. The underlying mechanism was that when nouns referring to objects are presented first, they narrow and preactivate the set of potential features denoted by adjectives that follow. We tested the hypothesis (H1) in seven experiments. We varied the modality of the stimuli (written in Exp. 1–6; spoken in Exp. 7), the structure of the stimuli (direct speech in Exp. 1, 2; speech-like-sentences in Exp. 3–6), the syntactic category of the modified noun phrases (direct objects in Exp. 1, 2; locative adjuncts in Exp. 3–7) and the presentation mode (whole-sentence-at-once in Exp. 1, 3; word-by-word in Exp. 2, 4, 6; phrase-by-phrase in Exp. 5). In all experiments, we manipulated the adjective position (prenominal vs. postnominal). We also introduced the modifier type (adjectives vs. genitives) as a second independent variable in Rounds 3 and 4.

In all but one of the seven experiments, participants tended to remember postnominal adjectives (or modifiers in general) more accurately. The exception was Experiment 5, which employed the phrase-by-phrase presentation mode – an approach that might have disrupted the incremental nature of sentence reading and processing. In the final Experiment 7, which employed spoken stimuli generated by AI tools, the postnominal advantage for recall was also observed. Given that postnominal adjectives (as used in our experiments) are primarily a feature of spoken Czech, the experiment involving spoken stimuli – although AI-generated – can be considered the most ecologically valid. Nevertheless, it is important to consider that patterns observed in an experimental setting often do not replicate in more naturalistic research designs (Futrell et al., 2020).

Different experimental designs and structures of the stimuli were associated with varying levels of recall accuracy (regardless of adjective position). The highest accuracy (over 95%) was observed in Experiments 1 and 2, which can likely be attributed to the fact that the adjectives modified a direct object. Later, we opted for a locative adjunct and the recall accuracy decreased. This aligns with previous findings that core information expressed by objects is generally recalled almost perfectly, while locative adjuncts, conveying optional information,

tend to be recalled less reliably (Chromý & Vojvodić, 2024). We suggest that this tendency may extend to information conveyed by modifiers within the noun phrases of the respective syntactic categories. Additionally, the sentences used in the first round of experiments were shorter than those in the subsequent experiments, which could be another factor facilitating higher recall accuracy. This effect is again supported by previous research (Chromý & Tomaschek, 2024). The variability in recall can also presumably be affected by the modality of the stimuli, the presentation mode, or even the form of comprehension questions. In the first round of experiments, the questions were more informative compared to those in later experiments, where it contained only the head noun. The summary of recall accuracy across all experiments is visualised in Figure 10. The effects of modifier position, modifier type and their interaction on recall are summarised in Table 8:

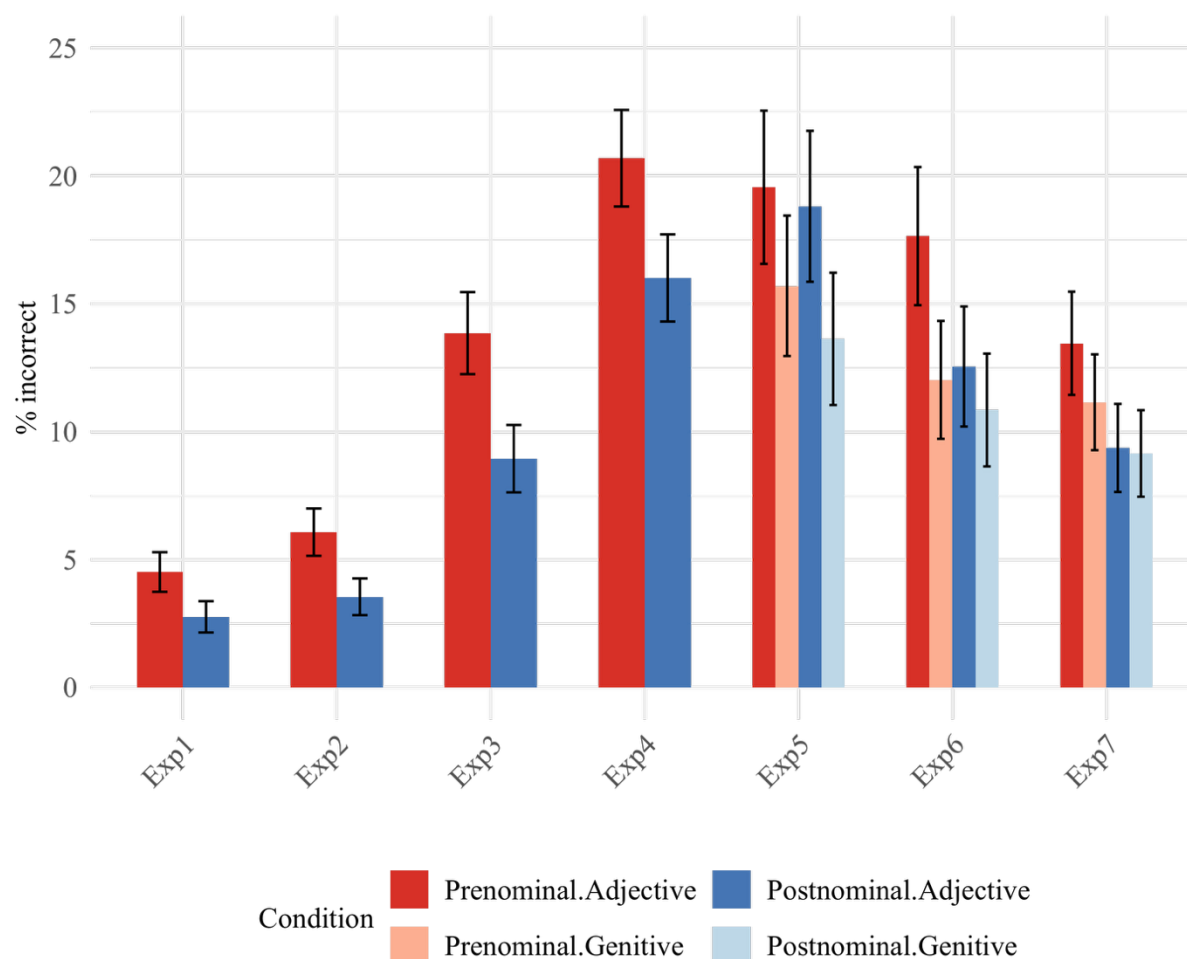


Figure 10 Summary of recall accuracy (% incorrect) based on the modifier position and modifier type in Experiments 1–7. Error bars denote 95% confidence intervals.

Experiment	Modifier position significant?	Modifier type significant?	Interaction significant?
Exp. 1 (at-once)	YES <i>Postnominal better</i>	–	–
Exp. 2 (word-word)	YES <i>Postnominal better</i>	–	–
Exp. 3 (at-once)	YES <i>Postnominal better</i>	–	–
Exp. 4 (word-by-word)	YES <i>Postnominal better</i>	–	–
Exp. 5 (phrases)	NO	Borderline YES <i>Genitives better</i>	NO
Exp. 6 (word-by-word)	YES <i>Postnominal better</i>	Borderline YES <i>Genitives better</i>	NO
Exp. 7 (spoken)	YES <i>Postnominal better</i>	NO	NO

Table 8 Summary of the effects of modifier position and modifier type on recall accuracy in Experiments 1–7.

The introduction of modifier type as a second variable in Rounds 3 and 4 was intended to check whether the recall advantage of postnominal adjectives could be explained by their relative syntactic unusualness. If it were the case, we could expect the opposite pattern for genitives – better recall for prenominal genitives, since genitives are usually used in the postnominal position. However, we did not find any support for this assumption in any of our experiments. In both Experiments 6 and 7, postnominal modifiers were recalled better regardless of their type, and in Experiment 5, the effect of modifier position was not significant, which means that genitive modifiers “behaved” approximately the same as adjectives in terms of position and recall accuracy.

Concerning reaction times, the results of our analyses are summarised in Table 9. In Experiments 2, 4 and 6 (word-by-word), a significant effect did not appear on the actual noun phrase. It emerged only later – on the spillover region. Words following postmodified noun phrases were read more slowly. Such patterns can be interpreted in various ways. They might, for example, indicate some form of processing difficulty. We also cannot rule out that some form of local ambiguity could arise during the processing of postnominal adjectives. However, the results of Experiment 2, where reaction times converged right on the second word after the target noun phrase, rather argue against the presence of ambiguity that needed to be resolved.

In Experiments 1 and 3 (whole-sentence-at-once), no significant differences in reaction times were observed based on the adjective position, even though recall accuracy did differ significantly. We, therefore, suggest that if some form of processing difficulty in the word-by-word experiments occurred, it did not have to be caused only by the postnominal adjectives, it

could also be influenced by the presentation mode itself. To gain a clearer understanding of how postnominal adjectives or generally modifiers are processed, we could combine the whole-sentence-at-once presentation mode with eye-tracking. Such an experimental setting would allow for detailed recording of regressions during reading, thereby offering more comprehensive insights into the effects of adjective position.

Experiment	Modifier position significant?	Modifier type significant?	Interaction significant?
Exp. 1 (at-once)	NO	–	–
Exp. 2 (word-by-word)	YES (spillover) <i>Slower RTs on 1 word after postmodified NPs</i>	–	–
Exp. 3 (at-once)	NO	–	–
Exp. 4 (word-by-word)	YES (spillover) <i>Slower RTs on 3 words after postmodified NPs</i>	–	–
Exp. 5 (phrase)	YES (NP + spillover) <i>Slower RTs on postmodified NPs + 2 words</i>	YES (NP) <i>Slower RTs on NPs with genitives</i>	YES (spillover) <i>Slower RTs after postnominal adjectives</i>
Exp. 6 (word-by-word)	YES (spillover) <i>Slower RTs following postmodified NPs</i>	YES (NP) <i>Slower RTs on NPs with genitives</i>	YES (NP) <i>Slower RTs on NPs with prenominal genitives</i>

Table 9 Summary of the effects of modifier position and modifier type on reaction times in Experiments 1–7.

Let us point out a general problem with the analysis of reaction times on the manipulated target noun phrase. In Experiments 2, 4 and 6, we proceeded by taking the reaction times on the adjectives and nouns and modelled the effect of modifier position and type on the sum of the two values. However, if we assume that differences in processing are often observable also (or only) on the spillover region, then the two “sums” might not be equivalent. The sum on the premodified noun phrase corresponds to the prenominal adjective, the noun plus the spillover of the adjective. In contrast, the sum of the postmodified phrase involves the noun, the postnominal adjective plus the spillover of the noun. So while the adjective spillover component is included in the sum of premodified noun phrase reaction times, it is not included in the sum of postmodified noun phrases.

That prenominal adjectives also seem to have some spillover effect was (visually) evident from the reaction times in Experiments 2 and 4 (see Figures 3 and 5), where the premodified nouns had slower reaction times than the postmodified ones. Such a pattern goes against expectation-based approaches, which would predict that the prenominal adjective would reduce uncertainty and thus make the reaction times on the following noun shorter. We emphasise that the analysis of reaction times in our study was exploratory in nature. We also note that we considered our

chosen solution to sum up the reaction times on the target noun phrase as the most appropriate, also with respect to comparability with Experiment 5, where the whole phrase was presented at once. We acknowledge that this methodological issue is critical and needs to be addressed in future research.

Although the reaction time patterns were ambiguous when compared across the written experiments, we could still speculate about the conditions under which patterns in reaction times might explain the differences in recall accuracy. But what about Experiment 7, where participants could not control (consciously or not) the exposure to the stimuli or their parts, and the differences in recall of adjectives based on their positions were still observed? It is possible that the sources of such differences may vary between the spoken and written modality. This question remains unanswered, since research on the effect of modality on language comprehension provides rather inconclusive findings about when or how modality matters (Rogowsky et al., 2016). Nevertheless, such an explanation would be consistent with the good-enough approach, which presumes that language processing strategies are adapted to the demands of specific tasks and situations (Karimi & Ferreira, 2016).

On the other hand, concerning modifier type, the explanation suggesting that the observed differences in recall accuracy may have a direct cause in the prolonged reaction times might actually be plausible – but also challenged by the above-mentioned methodological issue. In Experiments 5 and 6, participants processed noun phrases with genitives more slowly than those with adjectives. Genitives were also marginally better recalled. In contrast, Experiment 7, with approximately the same stimuli, revealed no significant effect of modification type. It should be noted, however, that this second type of modification was introduced primarily as a “control” and the stimuli involved a specific subset of genitive modifiers – feminine proper names. Therefore, the generalisability of our findings concerning the effects of modifier type is also limited. In future research, it would be interesting to test directly how online processing may influence recall and to adapt our research design accordingly for this purpose.

Taken together, postnominal adjectives appear to be encoded more robustly. However, it remains unclear whether the observed patterns in recall accuracy are driven by structural and functional aspects – that is, by the properties, variability and usage of adjectives – or rather by their processing – that is, by some cognitive mechanisms and adopted strategies. We argue that the more accurate recall of postnominal adjectives is consistent with the Feature-Label-Order

(FLO) principle (Ramscar et al., 2010), which, in the end, concerns all of the mentioned aspects to some extent.

However, there are certain limitations to our claim. In future research, it is crucial to manipulate not only the position of the adjective, but also the degree to which nouns and adjectives are semantically associated or the extent to which they are constraining. We could quantify it, for instance, via surprisal or entropy as measures of predictability. If the effects of adjective position on recall were even more pronounced among adjectives that are strongly associated with the preceding noun – denoting their most typical feature, for example – this would further support our hypothesis that the recall advantage can be attributed to the Feature-Label-Order principle. This aspect is critical, given that our experiments revealed a similar pattern for genitives as for adjectives – genitive modifiers were also better recalled in the postnominal position. However, such a result is not predicted by the Feature-Label-Order principle, since nouns referring to objects do not probably preactivate the specific names of their possessors – certainly not at the population level.

For the time being, our interpretation is that the position effect in genitives may be explained by the fact that the postnominal position is canonical, perhaps even more canonical than in the case of the prenominal position of adjectives (and for some language users, it may even be the only position that is grammatical). Therefore, it may correspond more to participants' long-term memory knowledge of word order constraints, which may boost its short-term memory encoding and storage, as discussed by Schweppe et al. (2022). For adjectives, however, we suggest that the semantic factor of the Feature-Label-Order principle overrides long-term knowledge of word order constraints (which would otherwise favour prenominal adjectives). In other words, we assume that the advantage of the postnominal position observed for both modifier types may arise from an interaction of multiple underlying mechanisms.

Nevertheless, an alternative explanation for the effect of modifier position, regardless of its type, remains plausible – one grounded in the memory-based approaches. According to this perspective, the recall advantage for postnominal adjectives (or modifiers) may stem from the fact that working memory capacity, which gradually decays over time, is one of the limiting factors (Lewis et al., 2006). Karimi et al. (2019) proposed that processing premodifiers is more difficult because they can only be encoded into memory once the head noun has been processed. In contrast, postmodification does not involve such demands. We could find support for this explanation in our data as well. In Experiment 5, where sentences were presented phrase-by-

phrase, and both the head noun and the modifier were, therefore, shown to participants at the same time, the effect of position was not significant. This aspect could be potentially investigated in future research. Since several studies reveal the impact of working memory capacity on recall (Unsworth, 2009; Unsworth et al., 2010), it would be worthwhile to further explore whether inter- and intraindividual differences in memory capacity among participants might influence the patterns observed in our study as well.

Prosodic manipulation may also offer an interesting perspective for future spoken language experiments. As previously noted, some instances in the corpus data demonstrated the presence of pauses and the role of information structure in relation to the adjective position. Previous studies have confirmed the impact of these factors on recall or on memory in general (Birch & Garnsey, 1995; Chromý & Vojvodić, 2024; Ferreira & Lowder, 2016; Karimi et al., 2024). Although we aimed to minimise their influence in our spoken experiment, they should be a central focus in future steps. This is particularly important, as manipulating these factors would also allow us to further explore the potential of using artificial intelligence to generate experimental stimuli and to achieve greater ecological validity.

Lastly, ecological validity and prosody are also closely related to another topic for future enquiry – the redundancy of adjectives. In the introductory sections, we suggested that postnominal adjectives might theoretically be perceived as more redundant, which could lead participants to pay them less attention and thus recall them less accurately. Although we did not observe lower recall rates for postnominal adjectives, we also did not manipulate their redundancy per se. Engelhardt and Ferreira (2014) showed that redundant adjectives tend to be articulated with shorter durations than context-necessary adjectives, suggesting a potential approach to manipulate redundancy. It would be interesting to investigate whether the effect could interact with the effect of adjective position.

4 Conclusion

The thesis aimed to investigate how the position of bare attributive adjectives in Czech affects their immediate post-sentential recall. Across seven experiments with different experimental designs, we found consistent evidence that postnominal adjectives were recalled more accurately than prenominal ones. This pattern supported our predictions based on the Feature-Label-Order principle, suggesting that presenting nouns before adjectives may facilitate feature activation and enhance memory encoding and storage of the adjectives. The pattern was observed in six out of seven experiments. The absence of interaction between modifier position and modifier type further indicated that the effect was likely not caused by the syntactic unusualness of postnominal adjectives. Although the analysis of reaction times did not reveal entirely consistent results across different presentation modes, it suggested potential directions for finding sources of the attested recall differences in online processing mechanisms, but also in language organisation. Future research should systematically manipulate factors such as the degree of semantic association between nouns and adjectives, modifier redundancy or prosodic features in spoken language to deepen our understanding of the observed effects. In sum, the thesis showed how even subtle variations in word order can systematically impact comprehension and memory representations. It provides new insights into our understanding of how Czech word order and adjective-noun semantics may interact in language processing and memory, offering new directions for future experimental research.

Bibliography

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, 4(11), 417–423. [https://doi.org/10.1016/S1364-6613\(00\)01538-2](https://doi.org/10.1016/S1364-6613(00)01538-2)

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67, 1–48. <https://doi.org/10.18637/jss.v067.i01>

Benešová, L., Komrsková, Z., Kopřivová, M., Lukeš, D., Poukarová, P., & Škarpová, M. (2012). *Pravidla transkripce pro korpus ORTOFON*. Ústav Českého národního korpusu FF UK.

Birch, S. L., & Garnsey, S. M. (1995). The Effect of Focus on Memory for Words in Sentences. *Journal of Memory and Language*, 34(2), 232–267. <https://doi.org/10.1006/jmla.1995.1011>

Brener, R. (1940). An experimental investigation of memory span. *Journal of Experimental Psychology*, 26(5), 467–482. <https://doi.org/10.1037/h0061096>

Ceháková, M., & Chromý, J. (2023). Garden-path sentences and the diversity of their (mis)representations. *PLOS ONE*, 18(7), e0288817. <https://doi.org/10.1371/journal.pone.0288817>

Christianson, K., Dempsey, J., Tsiola, A., Deshaies, S.-E. M., & Kim, N. (2024). Retracing the garden-path: Nonselective rereading and no reanalysis. *Journal of Memory and Language*, 137, 104515. <https://doi.org/10.1016/j.jml.2024.104515>

Chromý, J., & Tomaschek, F. (2024). Learning or Boredom? Task Adaptation Effects in Sentence Processing Experiments. *Open Mind*, 8, 1447–1468. https://doi.org/10.1162/opmi_a_00173

Chromý, J., & Vojvodić, S. (2024). When and where did it happen? Systematic differences in recall of core and optional sentence information. *Quarterly Journal of Experimental Psychology*, 77(1), 111–132. <https://doi.org/10.1177/17470218231159190>

Cinque, G. (2010). *The Syntax of Adjectives: A Comparative Study*. MIT Press.

Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, 36(3), 181–204.

<https://doi.org/10.1017/S0140525X12000477>

Clark, H. H. (1966). The prediction of recall patterns in simple active sentences. *Journal of Verbal Learning and Verbal Behavior*, 5(2), 99–106. [https://doi.org/10.1016/S0022-5371\(66\)80001-4](https://doi.org/10.1016/S0022-5371(66)80001-4)

Cohen, B. H. (1963). Recall of categorized words lists. *Journal of Experimental Psychology*, 66(3), 227–234. <https://doi.org/10.1037/h0048846>

Dye, M., Milin, P., Futrell, R., & Ramscar, M. (2017). A Functional Theory of Gender Paradigms. In F. Kiefer, J. Blevins, & H. Bartos (Eds.), *Perspectives on Morphological Organization* (Vol. 2017). Brill. https://doi.org/10.1163/9789004342934_011

Dye, M., Milin, P., Futrell, R., & Ramscar, M. (2018). Alternative Solutions to a Language Design Problem: The Role of Adjectives and Gender Marking in Efficient Communication. *Topics in Cognitive Science*, 10(1), 209–224. <https://doi.org/10.1111/tops.12316>

ElevenLabs docs | ElevenLabs Documentation. (n.d.). Retrieved 25 April 2025, from <https://elevenlabs.io/docs/overview>

Engelhardt, P. E., & Ferreira, F. (2014). Do speakers articulate over-described modifiers differently from modifiers that are required by context? Implications for models of reference production. *Language, Cognition and Neuroscience*, 29(8), 975–985. <https://doi.org/10.1080/01690965.2013.853816>

Fedorenko, E., Woodbury, R., & Gibson, E. (2013). Direct Evidence of Memory Retrieval as a Source of Difficulty in Non-Local Dependencies in Language. *Cognitive Science*, 37(2), 378–394. <https://doi.org/10.1111/cogs.12021>

Ferreira, F., Bailey, K. G. D., & Ferraro, V. (2002). Good-Enough Representations in Language Comprehension. *Current Directions in Psychological Science*, 11(1), 11–15. <https://doi.org/10.1111/1467-8721.00158>

Ferreira, F., & Lowder, M. W. (2016). Chapter Six—Prediction, Information Structure, and Good-Enough Language Processing. In B. H. Ross (Ed.), *Psychology of Learning and Motivation* (Vol. 65, pp. 217–247). Academic Press. <https://doi.org/10.1016/bs.plm.2016.04.002>

Ferreira, F., & Yang, Z. (2019). The Problem of Comprehension in Psycholinguistics. *Discourse Processes*, 56(7), 485–495. <https://doi.org/10.1080/0163853X.2019.1591885>

Frances, C. (2024). Good enough processing: What have we learned in the 20 years since Ferreira et al. (2002)? *Frontiers in Psychology*, 15. <https://doi.org/10.3389/fpsyg.2024.1323700>

Futrell, R., Gibson, E., & Levy, R. P. (2020). Lossy-Context Surprisal: An Information-Theoretic Model of Memory Effects in Sentence Processing. *Cognitive Science*, 44(3), e12814. <https://doi.org/10.1111/cogs.12814>

Gibson, E., Futrell, R., Piantadosi, S. P., Dautriche, I., Mahowald, K., Bergen, L., & Levy, R. (2019). How Efficiency Shapes Human Language. *Trends in Cognitive Sciences*, 23(5), 389–407. <https://doi.org/10.1016/j.tics.2019.02.003>

Greene, R. L. (1986). Sources of recency effects in free recall. *Psychological Bulletin*, 99(2), 221–228. <https://doi.org/10.1037/0033-2909.99.2.221>

Haeuser, K. I., & Kray, J. (2023). Effects of prediction error on episodic memory retrieval: Evidence from sentence reading and word recognition. *Language, Cognition and Neuroscience*, 38(4), 558–574. <https://doi.org/10.1080/23273798.2021.1924387>

Hale, J. (2001). A Probabilistic Earley Parser as a Psycholinguistic Model. *Second Meeting of the North American Chapter of the Association for Computational Linguistics*. NAACL 2001. <https://aclanthology.org/N01-1021/>

Hoffmannová, J., Homoláč, J., & Mrázková, K. (2019). *Syntax mluvené češtiny*. Academia.

Hofmeister, P. (2011). Representational complexity and memory retrieval in language comprehension. *Language and Cognitive Processes*, 26(3), 376–405. <https://doi.org/10.1080/01690965.2010.492642>

Hoppe, D. B., van Rij, J., Hendriks, P., & Ramscar, M. (2020). Order Matters! Influences of Linear Order on Linguistic Category Learning. *Cognitive Science*, 44(11), e12910. <https://doi.org/10.1111/cogs.12910>

Huetig, F. (2015). Four central questions about prediction in language processing. *Brain Research*, 1626, 118–135. <https://doi.org/10.1016/j.brainres.2015.02.014>

Huetig, F., & Mani, N. (2016). Is prediction necessary to understand language? Probably not. *Language, Cognition and Neuroscience*, 31(1), 19–31. <https://doi.org/10.1080/23273798.2015.1072223>

Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language*, 59(4), 434–446. <https://doi.org/10.1016/j.jml.2007.11.007>

Karimi, H., Diaz, M., & Ferreira, F. (2019). “A cruel king” is not the same as “a king who is cruel”: Modifier position affects how words are encoded and retrieved from memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 45(11), 2010–2035. <https://doi.org/10.1037/xlm0000694>

Karimi, H., Diaz, M., & Wittenberg, E. (2024). Delayed onset facilitates subsequent retrieval of words during language comprehension. *Memory & Cognition*, 52(3), 491–508. <https://doi.org/10.3758/s13421-023-01479-3>

Karimi, H., & Ferreira, F. (2016). Good-enough linguistic representations and online cognitive equilibrium in language processing. *Quarterly Journal of Experimental Psychology*, 69(5), 1013–1040. <https://doi.org/10.1080/17470218.2015.1053951>

Karimi, H., Swaab, T. Y., & Ferreira, F. (2018). Electrophysiological evidence for an independent effect of memory retrieval on referential processing. *Journal of Memory and Language*, 102, 68–82. <https://doi.org/10.1016/j.jml.2018.05.003>

Karlík, P., & Caha, P. (2017). *ADJEKTIVUM | Nový encyklopedický slovník češtiny*. <https://www.czechency.org/slovník/ADJEKTIVUM?bib=true>

Karlík, P., Nekula, M., Rusínová, Z., & Grepl, M. (2012). *Příruční mluvnice češtiny*. NLN, Nakladatelství Lidové noviny.

Kluender, R., & Kutas, M. (1993). Bridging the Gap: Evidence from ERPs on the Processing of Unbounded Dependencies. *Journal of Cognitive Neuroscience*, 5(2), 196–214. <https://doi.org/10.1162/jocn.1993.5.2.196>

Koolen, R., Goudbeek, M., & Krahmer, E. (2013). The Effect of Scene Variation on the Redundant Use of Color in Definite Reference. *Cognitive Science*, 37(2), 395–411.

<https://doi.org/10.1111/cogs.12019>

Kopřivová, M., Komrsková, Z., Lukeš, D., & Poukarová, P. (2017). Korpus ORAL: sestavení, lemmatizace a morfologické značkování. *Korpus–Gramatika–Axiologie*, 15, 47–67.

Kuperberg, G. R., & Jaeger, T. F. (2016). What do we mean by prediction in language comprehension? *Language, Cognition and Neuroscience*, 31(1), 32–59. <https://doi.org/10.1080/23273798.2015.1102299>

Kusyszyn, I., & Paivio, A. (1966). Transition probability, word order, and noun abstractness in the learning of adjective-noun paired associates. *Journal of Experimental Psychology*, 71(6), 800–805. <https://doi.org/10.1037/h0023221>

Lambert, W. E., & Paivio, A. (1956). The influence of noun-adjective order on learning. *Canadian Journal of Psychology / Revue Canadienne de Psychologie*, 10(1), 9–12. <https://doi.org/10.1037/h0083652>

Lange, K., Kühn, S., & Filevich, E. (2015). "Just Another Tool for Online Studies" (JATOS): An Easy Solution for Setup and Management of Web Servers Supporting Online Studies. *PLOS ONE*, 10(6), e0130834. <https://doi.org/10.1371/journal.pone.0130834>

Levshina, N. (2022). *Communicative Efficiency*. Cambridge University Press.

Levy, R. (2008). Expectation-based syntactic comprehension. *Cognition*, 106(3), 1126–1177. <https://doi.org/10.1016/j.cognition.2007.05.006>

Lewis, R. L., Vasishth, S., & Dyke, J. A. V. (2006). Computational principles of working memory in sentence comprehension. *Trends in Cognitive Sciences*, 10(10), 447–454. <https://doi.org/10.1016/j.tics.2006.08.007>

Linzen, T., & Jaeger, T. F. (2016). Uncertainty and Expectation in Sentence Processing: Evidence From Subcategorization Distributions. *Cognitive Science*, 40(6), 1382–1411. <https://doi.org/10.1111/cogs.12274>

Lowder, M. W., Choi, W., Ferreira, F., & Henderson, J. M. (2018). Lexical Predictability During Natural Reading: Effects of Surprisal and Entropy Reduction. *Cognitive Science*, 42(S4), 1166–1183. <https://doi.org/10.1111/cogs.12597>

- Luke, S. G., & Christianson, K. (2016). Limits on lexical prediction during reading. *Cognitive Psychology*, 88, 22–60. <https://doi.org/10.1016/j.cogpsych.2016.06.002>
- Lukeš, D., Kopřivová, M., Laubeová, Z., Poukarová, P., Horký, V., Jelinek, T., Křivan, J., Waclawičová, M., Benešová, L., & Škarpová, M. (2024). *ORTOFON v3: Korpus neformální mluvené češtiny s víceúrovňovým přepisem*. Ústav Českého národního korpusu FF UK.
- Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of Memory and Language*, 94, 305–315. <https://doi.org/10.1016/j.jml.2017.01.001>
- McKoon, G., & Ratcliff, R. (1998). MEMORY-BASED LANGUAGE PROCESSING: Psycholinguistic Research in the 1990s. *Annual Review of Psychology*, 49(Volume 49, 1998), 25–42. <https://doi.org/10.1146/annurev.psych.49.1.25>
- Mehler, J., Segui, J., Pittet, M., & Barrière, M. (1978). Strategies for sentence perception. *Journal of Psycholinguistic Research*, 7(1), 3–16. <https://doi.org/10.1007/BF01068041>
- Navrátilová, O., & Zikánová, Š. (2017). *VÝVOJ SLOVOSLEDU NOMINÁLNÍ SKUPINY* | Nový encyklopedický slovník češtiny. Retrieved 19 April 2025, from <https://www.czechency.org/slovník/V%C3%9DVOJ%20SLOVOSLEDU%20NOMIN%C3%81LN%C3%8D%20SKUPINY>
- Nobel, P. A., & Shiffrin, R. M. (2001). Retrieval processes in recognition and cued recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(2), 384–413. <https://doi.org/10.1037/0278-7393.27.2.384>
- Patson, N. D., Darowski, E. S., Moon, N., & Ferreira, F. (2009). Lingering misinterpretations in garden-path sentences: Evidence from a paraphrasing task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 35(1), 280–285. <https://doi.org/10.1037/a0014276>
- Perham, N., Marsh, J. E., & Jones, D. M. (2009). Short Article: Syntax and Serial Recall: How Language Supports Short-Term Memory for Order. *Quarterly Journal of Experimental Psychology*, 62(7), 1285–1293. <https://doi.org/10.1080/17470210802635599>
- Qian, Z., Garnsey, S., & Christianson, K. (2018). A comparison of online and offline measures

of good-enough processing in garden-path sentences. *Language, Cognition and Neuroscience*, 33(2), 227–254. <https://doi.org/10.1080/23273798.2017.1379606>

Ramscar, M. (2013). Suffixing, prefixing, and the functional order of regularities in meaningful strings. *Psihologija*, 46(4), 377–396. <https://doi.org/10.2298/PSI1304377R>

Ramscar, M., Yarlett, D., Dye, M., Denny, K., & Thorpe, K. (2010). The Effects of Feature-Label-Order and Their Implications for Symbolic Learning. *Cognitive Science*, 34(6), 909–957. <https://doi.org/10.1111/j.1551-6709.2009.01092.x>

Rogowsky, B. A., Calhoun, B. M., & Tallal, P. (2016). Does Modality Matter? The Effects of Reading, Listening, and Dual Modality on Comprehension. *SAGE Open*, 6(3), 2158244016669550. <https://doi.org/10.1177/2158244016669550>

Romberg, A. R., & Saffran, J. R. (2010). Statistical learning and language acquisition. *WIREs Cognitive Science*, 1(6), 906–914. <https://doi.org/10.1002/wcs.78>

Rubio-Fernández, P. (2016). How Redundant Are Redundant Color Adjectives? An Efficiency-Based Analysis of Color Overspecification. *Frontiers in Psychology*, 7. <https://doi.org/10.3389/fpsyg.2016.00153>

Schweppe, J., Schütte, F., Machleb, F., & Hellfrisch, M. (2022). Syntax, morphosyntax, and serial recall: How language supports short-term memory. *Memory & Cognition*, 50(1), 174–191. <https://doi.org/10.3758/s13421-021-01203-z>

Schwering, S. C., & MacDonald, M. C. (2020). Verbal Working Memory as Emergent from Language Comprehension and Production. *Frontiers in Human Neuroscience*, 14. <https://doi.org/10.3389/fnhum.2020.00068>

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, 27(3), 379–423. <https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>

Smith, N. J., & Levy, R. (2013). The effect of word predictability on reading time is logarithmic. *Cognition*, 128(3), 302–319. <https://doi.org/10.1016/j.cognition.2013.02.013>

Štícha, F. (2013). *Akademická gramatika spisovné češtiny*. Academia.

Traxler, M. J. (2012). Introduction to psycholinguistics: Understanding language science. In

Introduction to psycholinguistics: Understanding language science. Wiley-Blackwell.

Trott, S., & Bergen, B. (2022). Languages are efficient, but for whom? *Cognition*, 225, 105094. <https://doi.org/10.1016/j.cognition.2022.105094>

Troyer, M., Hofmeister, P., & Kutas, M. (2016). Elaboration over a Discourse Facilitates Retrieval in Sentence Processing. *Frontiers in Psychology*, 7. <https://doi.org/10.3389/fpsyg.2016.00374>

Tse, C.-S., & Altarriba, J. (2007). Testing the associative-link hypothesis in immediate serial recall: Evidence from word frequency and word imageability effects. *Memory*, 15(6), 675–690. <https://doi.org/10.1080/09658210701467186>

Uhlířová, L. (2017). *SLOVOSLED NOMINÁLNÍ SKUPINY | Nový encyklopedický slovník češtiny*. <https://www.czechency.org/slovník/SLOVOSLED%20NOMIN%C3%81LN%C3%8D%20SKUPINY>

Unsworth, N. (2009). Examining variation in working memory capacity and retrieval in cued recall. *Memory*, 17(4), 386–396. <https://doi.org/10.1080/09658210902802959>

Unsworth, N., Spillers, G. J., & Brewer, G. A. (2010). The contributions of primary and secondary memory to working memory capacity: An individual differences analysis of immediate free recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 36(1), 240–247. <https://doi.org/10.1037/a0017739>

van den Bosch, A., & Daelemans, W. (2013). Implicit Schemata and Categories in Memory-based Language Processing. *Language and Speech*, 56(3), 309–328. <https://doi.org/10.1177/0023830913484902>

Van Dyke, J. A., & Johns, C. L. (2012). Memory Interference as a Determinant of Language Comprehension. *Language and Linguistics Compass*, 6(4), 193–211. <https://doi.org/10.1002/lnc3.330>

Vorreiter, S. (2003). *Turn continuations: Towards a cross-linguistic classification*. <http://kops.uni-konstanz.de/handle/123456789/3682>

Wągiel, M. (2014). From Kinds to Objects Prenominal and Postnominal Adjectives in Polish.

In L. Veselovská & M. Janebová (Eds.), *Complex visibles out there: Proceedings of the Olomouc Linguistics Colloquium 2014: Language Use and Linguistic Structure* (pp. 457–477).

Waugh, N. C. (1961). Free versus serial recall. *Journal of Experimental Psychology*, 62(5), 496–502. <https://doi.org/10.1037/h0043891>

Zehr, J., & Schwarz, F. (2018). *PennController for Internet Based Experiments (IBEX)*. <https://www.pcibex.net/about-penncontroller/cite/>

Appendix 1

Experiments 1 and 2 – experimental items

ItemNo	Condition	Test Item	Question
1	adj-noun	„Dan koupil tlustej spacák v obchodě,“ připomněl Jindra vedoucím.	Jaký spacák koupil Dan?
1	noun-adj	„Dan koupil spacák tlustej v obchodě,“ připomněl Jindra vedoucím.	Jaký spacák koupil Dan?
2	adj-noun	„Stáňa posolila kluzký chodníky před školou,“ řekl Richard Kláře.	Jaké chodníky posolila Stáňa?
2	noun-adj	„Stáňa posolila chodníky kluzký před školou,“ řekl Richard Kláře.	Jaké chodníky posolila Stáňa?
3	adj-noun	„Martina zapálila vlhkou trávu na louce,“ sdělila Markéta policii.	Jakou trávu zapálila Martina?
3	noun-adj	„Martina zapálila trávu vlhkou na louce,“ sdělila Markéta policii.	Jakou trávu zapálila Martina?
4	adj-noun	„Jirka rozpustil růžový mejdlo v řece,“ odpověděl Libor Tadeášovi.	Jaké mýdlo rozpustil Jirka?
4	noun-adj	„Jirka rozpustil mejdlo růžový v řece,“ odpověděl Libor Tadeášovi.	Jaké mýdlo rozpustil Jirka?
5	adj-noun	„Olga vypracovala hutný těsto v lavoru,“ řekl Samuel prodavače.	Jaké těsto vypracovala Olga?
5	noun-adj	„Olga vypracovala těsto hutný v lavoru,“ řekl Samuel prodavače.	Jaké těsto vypracovala Olga?
6	adj-noun	„Šimon nepřinesl šedivý kraťasy z tréninku,“ prozradila Lida Anetě.	Jaké kraťasy nepřinesl Šimon?
6	noun-adj	„Šimon nepřinesl kraťasy šedivý z tréninku,“ prozradila Lida Anetě.	Jaké kraťasy nepřinesl Šimon?
7	adj-noun	„Lenka uklidila měkký tužky do pokoje,“ pošeptala Kamila bratrovi.	Jaké tužky uklidila Lenka?
7	noun-adj	„Lenka uklidila tužky měkký do pokoje,“ pošeptala Kamila bratrovi.	Jaké tužky uklidila Lenka?
8	adj-noun	„Štěpán vyzvedl běžový saka v čistírně,“ napsala Alena Jonášovi.	Jaká saka vyzvedl Štěpán?
8	noun-adj	„Štěpán vyzvedl saka běžový v čistírně,“ napsala Alena Jonášovi.	Jaká saka vyzvedl Štěpán?
9	adj-noun	„Agáta zahlédla rudej obličej za oknem,“ řekla Saša kadeřnici.	Jaký obličej zahlédla Agáta?
9	noun-adj	„Agáta zahlédla obličej rudej za oknem,“ řekla Saša kadeřnici.	Jaký obličej zahlédla Agáta?
10	adj-noun	„Matěj upustil duhový kulíčky do kanálu,“ vyčítal Jakub Danovi.	Jaké kulíčky upustil Matěj?
10	noun-adj	„Matěj upustil kulíčky duhový do kanálu,“ vyčítal Jakub Danovi.	Jaké kulíčky upustil Matěj?
11	adj-noun	„Jarmila zapomněla tyrkysovou sukni na chalupě,“ zavola Ondřej strejdovi.	Jakou sukni zapomněla Jarmila?
11	noun-adj	„Jarmila zapomněla sukni tyrkysovou na chalupě,“ zavola Ondřej strejdovi.	Jakou sukni zapomněla Jarmila?
12	adj-noun	„Albert přešel zrzavý kotě za kostelem,“ prozradila Petra Mileně.	Jaké kotě přešel Albert?
12	noun-adj	„Albert přešel kotě zrzavý za kostelem,“ prozradila Petra Mileně.	Jaké kotě přešel Albert?
13	adj-noun	„Ester nakrájela zelený rajčata na talířek,“ řekla Simona babičce.	Jaká rajčata nakrájela Ester?
13	noun-adj	„Ester nakrájela rajčata zelený na talířek,“ řekla Simona babičce.	Jaká rajčata nakrájela Ester?
14	adj-noun	„Miloš ukradl oranžový kartičky v klubovně,“ napsal Jaroslav Evelině.	Jaké kartičky ukradl Miloš?
14	noun-adj	„Miloš ukradl kartičky oranžový v klubovně,“ napsal Jaroslav Evelině.	Jaké kartičky ukradl Miloš?
15	adj-noun	„Klára vyhnala žlutý ptáčky z balkonu,“ žaloval Filip rodičům.	Jaké ptáčky vyhnala Klára?
15	noun-adj	„Klára vyhnala ptáčky žlutý z balkonu,“ žaloval Filip rodičům.	Jaké ptáčky vyhnala Klára?
16	adj-noun	„Josef přinesl dřavej kbelík ke studni,“ vyprávěl Čeněk Katce.	Jaký kbelík přinesl Josef?
16	noun-adj	„Josef přinesl kbelík dřavej ke studni,“ vyprávěl Čeněk Katce.	Jaký kbelík přinesl Josef?
17	adj-noun	„Nela zbourala šikmej sloup v zoo,“ sdělil Bruno správci.	Jaký sloup zbourala Nela?
17	noun-adj	„Nela zbourala sloup šikmej v zoo,“ sdělil Bruno správci.	Jaký sloup zbourala Nela?
18	adj-noun	„Mirek přerl silnou trubku ve sklepě,“ vyčítala Vendula Petrovi.	Jakou trubku přerl Mirek?
18	noun-adj	„Mirek přerl trubku silnou ve sklepě,“ vyčítala Vendula Petrovi.	Jakou trubku přerl Mirek?
19	adj-noun	„Pavel mrsknul bílý vajíčka za gauč,“ volala Marie manželovi.	Jaká vajíčka mrsknul Pavel?
19	noun-adj	„Pavel mrsknul vajíčka bílý za gauč,“ volala Marie manželovi.	Jaká vajíčka mrsknul Pavel?
20	adj-noun	„Ivan podlehl nízký zábradlí v divadle,“ prozradil Dominik učitel.	Jaké zábradlí podlehl Ivan?
20	noun-adj	„Ivan podlehl zábradlí nízký v divadle,“ prozradil Dominik učitel.	Jaké zábradlí podlehl Ivan?
21	adj-noun	„Iveta pomalovala kulatý okna na zámku,“ pošeptal Zdeněk Sylvě.	Jaká okna pomalovala Iveta?
21	noun-adj	„Iveta pomalovala okna kulatý na zámku,“ pošeptal Zdeněk Sylvě.	Jaká okna pomalovala Iveta?
22	adj-noun	„Vilém hodil ostrý nůžky na chodbu,“ přiznala Karolína řediteli.	Jaké nůžky hodil Vilém?
22	noun-adj	„Vilém hodil nůžky ostrý na chodbu,“ přiznala Karolína řediteli.	Jaké nůžky hodil Vilém?
23	adj-noun	„Soňa viděla křivý zuby v zrcadle,“ řekla Františka Mirkovi.	Jaké zuby viděla Soňa?
23	noun-adj	„Soňa viděla zuby křivý v zrcadle,“ řekla Františka Mirkovi.	Jaké zuby viděla Soňa?
24	adj-noun	„Adam schoval zrezlej hrnec pod židli,“ připomněla Gábina babičce.	Jaký hrnec schoval Adam?
24	noun-adj	„Adam schoval hrnec zrezlej pod židli,“ připomněla Gábina babičce.	Jaký hrnec schoval Adam?
25	adj-noun	„Emma našla rtěnkou lesklou pod lavicí,“ napsal Čeněk Lidě.	Jakou rtěnkou našla Emma?
25	noun-adj	„Emma našla rtěnkou lesklou pod lavicí,“ napsal Čeněk Lidě.	Jakou rtěnkou našla Emma?
26	adj-noun	„Vojta vytil špinavou vodu do květináče,“ žaloval Viktor uklízeče.	Jakou vodu vytil Vojta?
26	noun-adj	„Vojta vytil vylil špinavou do květináče,“ žaloval Viktor uklízeče.	Jakou vodu vytil Vojta?
27	adj-noun	„Patrik reklamoval prasklý sklo na internetu,“ řekla Veronika Adamovi.	Jaké sklo reklamoval Patrik?
27	noun-adj	„Patrik reklamoval sklo prasklý na internetu,“ řekla Veronika Adamovi.	Jaké sklo reklamoval Patrik?
28	adj-noun	„Šárka ušila kostkovaný pyžama na tábor,“ napsala Tereza organizátorům.	Jaká pyžama ušila Šárka?
28	noun-adj	„Šárka ušila pyžama kostkovaný na tábor,“ napsala Tereza organizátorům.	Jaká pyžama ušila Šárka?
29	adj-noun	„Linda přivezla zářivý diamanty ze zahraničí,“ prozradil Lukáš Valentýně.	Jaké diamanty přivezla Linda?
29	noun-adj	„Linda přivezla diamanty zářivý ze zahraničí,“ prozradil Lukáš Valentýně.	Jaké diamanty přivezla Linda?
30	adj-noun	„Michal položil průhledný desky na recepci,“ odpověděl Robert Sandře.	Jaké desky položil Michal?
30	noun-adj	„Michal položil desky průhledný na recepci,“ odpověděl Robert Sandře.	Jaké desky položil Michal?

Experiments 3 and 4 – experimental items

ItemNo	Condition	Test item	Question
1	adj-noun	Pavla podotkla, že do toho dolního bytu asi včera ubytovali partu s reprákem a štěnětem.	O jaký byt se jednalo?
1	noun-adj	Pavla podotkla, že do toho bytu dolního asi včera ubytovali partu s reprákem a štěnětem.	O jaký byt se jednalo?
2	adj-noun	Šárka zaslechla, že do toho hlasitýho klubu prej ráno zavolali policajty se psama a zásahovkou.	O jaký klub se jednalo?
2	noun-adj	Šárka zaslechla, že do toho klubu hlasitýho prej ráno zavolali policajty se psama a zásahovkou.	O jaký klub se jednalo?
3	adj-noun	Michal přítakal, že do toho oranžovýho koktejlu nejspíš potom zamíchali cukr s pepřem a smetanou.	O jaký koktejl se jednalo?
3	noun-adj	Michal přítakal, že do toho koktejlu oranžovýho nejspíš potom zamíchali cukr s pepřem a smetanou.	O jaký koktejl se jednalo?
4	adj-noun	Radka uhodla, že do toho slanýho koláče zřejmě minule dali sýr s paprikou a rajčaty.	O jaký koláč se jednalo?
4	noun-adj	Radka uhodla, že do toho koláče slanýho zřejmě minule dali sýr s paprikou a rajčaty.	O jaký koláč se jednalo?
5	adj-noun	Ondra nepochopil, že do toho bílýho kostela opravdu loni nainstalovali oltář bez barvy a ornamentů.	O jaký kostel se jednalo?
5	noun-adj	Ondra nepochopil, že do toho kostela bílýho opravdu loni nainstalovali oltář bez barvy a ornamentů.	O jaký kostel se jednalo?
6	adj-noun	Jarka prozradila, že do toho horkýho moštu taky potom přidali zázvor s rakyníkem a hřebíčkem.	O jaký mošt se jednalo?
6	noun-adj	Jarka prozradila, že do toho moštu horkýho taky potom přidali zázvor s rakyníkem a hřebíčkem.	O jaký mošt se jednalo?
7	adj-noun	Marek zjistil, že do toho drahýho obchodu snad hned zavedli pokladny bez obsluhy a hotovosti.	O jaký obchod se jednalo?
7	noun-adj	Marek zjistil, že do toho obchodu drahýho snad hned zavedli pokladny bez obsluhy a hotovosti.	O jaký obchod se jednalo?
8	adj-noun	Lucka zapoměla, že do toho fialovýho overalu asi včera zandali taštičku s jízdenkama a klíčem.	O jaký overal se jednalo?
8	noun-adj	Lucka zapoměla, že do toho overalu fialovýho asi včera zandali taštičku s jízdenkama a klíčem.	O jaký overal se jednalo?
9	adj-noun	Igor nepochopil, že do toho okrovýho paneláku prej loni postavili výtah bez okýnka a zrcadla.	O jaký panelák se jednalo?
9	noun-adj	Igor nepochopil, že do toho paneláku okrovýho prej loni postavili výtah bez okýnka a zrcadla.	O jaký panelák se jednalo?
10	adj-noun	Martin vysvětlil, že do toho tmavýho sklepa asi někdy uskladnili pytle s bramborama a cibulí.	O jaký sklep se jednalo?
10	noun-adj	Martin vysvětlil, že do toho sklepa tmavýho asi někdy uskladnili pytle s bramborama a cibulí.	O jaký sklep se jednalo?
11	adj-noun	Adriana přiznala, že do toho špinavýho batohu fakt potom zabalili notebook bez obalu a folie.	O jaký batoh se jednalo?
11	noun-adj	Adriana přiznala, že do toho batohu špinavýho fakt potom zabalili notebook bez obalu a folie.	O jaký batoh se jednalo?
12	adj-noun	Sofie zdůraznila, že do toho lesklýho hmečku prý kdysi schovali desetník s řetízem a náramkem.	O jaký hmeček se jednalo?
12	noun-adj	Sofie zdůraznila, že do toho hmečku lesklýho prý kdysi schovali desetník s řetízem a náramkem.	O jaký hmeček se jednalo?
13	adj-noun	Jára zkontroloval, že z toho mělkýho bazénku opravdu ráno vyndali vosy s broučkama a smetím.	O jaký bazének se jednalo?
13	noun-adj	Jára zkontroloval, že z toho bazénku mělkýho opravdu ráno vyndali vosy s broučkama a smetím.	O jaký bazének se jednalo?
14	adj-noun	Aneta potvrdila, že z toho rychlýho eshopu vopravdu minule objednali boiler bez příslušenství a záruky.	O jaký eshop se jednalo?
14	noun-adj	Aneta potvrdila, že z toho eshopu rychlýho vopravdu minule objednali boiler bez příslušenství a záruky.	O jaký eshop se jednalo?
15	adj-noun	Jirka zaslechl, že z toho hlubokýho kanálu fakt nakonec vylovili peněženku s výplatou a kartama.	O jaký kanál se jednalo?
15	noun-adj	Jirka zaslechl, že z toho kanálu hlubokýho fakt nakonec vylovili peněženku s výplatou a kartama.	O jaký kanál se jednalo?
16	adj-noun	Eliška vyhrkla, že z toho úzkýho parapetu fakt odpoledne ukradli pekáč s kachnou a kuřetem.	O jaký parapet se jednalo?
16	noun-adj	Eliška vyhrkla, že z toho parapetu úzkýho fakt odpoledne ukradli pekáč s kachnou a kuřetem.	O jaký parapet se jednalo?
17	adj-noun	Filip řekl, že z toho zelenýho rybníka ještě loni vytáhli sudy s vínem a medovinou.	O jaký rybník se jednalo?
17	noun-adj	Filip řekl, že z toho rybníka zelenýho ještě loni vytáhli sudy s vínem a medovinou.	O jaký rybník se jednalo?
18	adj-noun	Andrea objevila, že z toho modrýho slovníčku snad předtím vypustili stránku s kulturou a reáliemi.	O jaký slovníček se jednalo?
18	noun-adj	Andrea objevila, že z toho slovníčku modrýho snad předtím vypustili stránku s kulturou a reáliemi.	O jaký slovníček se jednalo?
19	adj-noun	Vašek potvrdil, že z toho žlutýho stanu opravdu nejdřív vynesli stoly bez lavic a nádobí.	O jaký stan se jednalo?
19	noun-adj	Vašek potvrdil, že z toho stanu žlutýho opravdu nejdřív vynesli stoly bez lavic a nádobí.	O jaký stan se jednalo?
20	adj-noun	Sára vyčetla, že z toho dlouhýho tunelu nejspíš loni odmontovali tabule bez podsvícení a barvy.	O jaký tunel se jednalo?
20	noun-adj	Sára vyčetla, že z toho tunelu dlouhýho nejspíš loni odmontovali tabule bez podsvícení a barvy.	O jaký tunel se jednalo?

Experiments 5 and 6 – experimental items

ItemNo	Position	Type	Item	question
1	adj-noun	adj	Zaslechl jsem, že do toho dolního bytu asi všichni ubytovali partu s reprákem a stěnětem.	Jaký byt to byl?
1	noun-adj	adj	Zaslechl jsem, že do toho bytu dolního asi všichni ubytovali partu s reprákem a stěnětem.	Jaký byt to byl?
1	adj-noun	gen	Zaslechl jsem, že do toho Terezy bytu asi všichni ubytovali partu s reprákem a stěnětem.	Či byt to byl?
1	noun-adj	gen	Zaslechl jsem, že do toho bytu Terezy asi všichni ubytovali partu s reprákem a stěnětem.	Či byt to byl?
2	adj-noun	adj	Zaslechla jsem, že do toho hlasitého klubu prej ráno zavolali policajty se psama a zásahovkou.	Jaký klub to byl?
2	noun-adj	adj	Zaslechla jsem, že do toho klubu hlasitého prej ráno zavolali policajty se psama a zásahovkou.	Jaký klub to byl?
2	adj-noun	gen	Zaslechla jsem, že do toho Martiny klubu prej ráno zavolali policajty se psama a zásahovkou.	Či klub to byl?
2	noun-adj	gen	Zaslechla jsem, že do toho klubu Martiny prej ráno zavolali policajty se psama a zásahovkou.	Či klub to byl?
3	adj-noun	adj	Poznamenal jsem, že do toho oranžového koktejlu nejspíš všichni nezamíchali cukr s pepřem a smetanou.	Jaký koktejl to byl?
3	noun-adj	adj	Poznamenal jsem, že do toho koktejlu oranžového nejspíš všichni nezamíchali cukr s pepřem a smetanou.	Jaký koktejl to byl?
3	adj-noun	gen	Poznamenal jsem, že do toho Andrey koktejlu nejspíš všichni nezamíchali cukr s pepřem a smetanou.	Či koktejl to byl?
3	noun-adj	gen	Poznamenal jsem, že do toho koktejlu Andrey nejspíš všichni nezamíchali cukr s pepřem a smetanou.	Či koktejl to byl?
4	adj-noun	adj	Zapomněla jsem, že do toho slaného koláče zřejmě minule nedali sýr s paprikou a rajčaty.	Jaký koláč to byl?
4	noun-adj	adj	Zapomněla jsem, že do toho koláče slaného zřejmě minule nedali sýr s paprikou a rajčaty.	Jaký koláč to byl?
4	adj-noun	gen	Zapomněla jsem, že do toho Elišky koláče zřejmě minule nedali sýr s paprikou a rajčaty.	Či koláč to byl?
4	noun-adj	gen	Zapomněla jsem, že do toho koláče Elišky zřejmě minule nedali sýr s paprikou a rajčaty.	Či koláč to byl?
5	adj-noun	adj	Řekl jsem, že do toho koženého penálu prostě hned schoval zapalovač s cigárama a trávou.	Jaký penál to byl?
5	noun-adj	adj	Řekl jsem, že do toho penálu koženého prostě hned schoval zapalovač s cigárama a trávou.	Jaký penál to byl?
5	adj-noun	gen	Řekl jsem, že do toho Heleny penálu prostě hned schoval zapalovač s cigárama a trávou.	Či penál to byl?
5	noun-adj	gen	Řekl jsem, že do toho penálu Heleny prostě hned schoval zapalovač s cigárama a trávou.	Či penál to byl?
6	adj-noun	adj	Zjistila jsem, že do toho horkého mostu taky potom nepřidali závor s rakytíkem a hřebíčkem.	Jaký most to byl?
6	noun-adj	adj	Zjistila jsem, že do toho mostu horkého taky potom nepřidali závor s rakytíkem a hřebíčkem.	Jaký most to byl?
6	adj-noun	gen	Zjistila jsem, že do toho Renaty mostu taky potom nepřidali závor s rakytíkem a hřebíčkem.	Či most to byl?
6	noun-adj	gen	Zjistila jsem, že do toho mostu Renaty taky potom nepřidali závor s rakytíkem a hřebíčkem.	Či most to byl?
7	adj-noun	adj	Zjistil jsem, že do toho drahého obchodu snad hned zavedli pokladny bez obsluhy a hotovosti.	Jaký obchod to byl?
7	noun-adj	adj	Zjistil jsem, že do toho obchodu drahého snad hned zavedli pokladny bez obsluhy a hotovosti.	Jaký obchod to byl?
7	adj-noun	gen	Zjistil jsem, že do toho Moniky obchodu snad hned zavedli pokladny bez obsluhy a hotovosti.	Či obchod to byl?
7	noun-adj	gen	Zjistil jsem, že do toho obchodu Moniky snad hned zavedli pokladny bez obsluhy a hotovosti.	Či obchod to byl?
8	adj-noun	adj	Zapomněla jsem, že do toho fialového overalu asi všichni zandali taštičku s jízenkama a klíčem.	Jaký overal to byl?
8	noun-adj	adj	Zapomněla jsem, že do toho overalu fialového asi všichni zandali taštičku s jízenkama a klíčem.	Jaký overal to byl?
8	adj-noun	gen	Zapomněla jsem, že do toho Denisy overalu asi všichni zandali taštičku s jízenkama a klíčem.	Či overal to byl?
8	noun-adj	gen	Zapomněla jsem, že do toho overalu Denisy asi všichni zandali taštičku s jízenkama a klíčem.	Či overal to byl?
9	adj-noun	adj	Řekla jsem, že do toho okrového paneláku prej loni postavili výťah bez okýnka a zrcadla.	Jaký panelák to byl?
9	noun-adj	adj	Řekla jsem, že do toho paneláku okrového prej loni postavili výťah bez okýnka a zrcadla.	Jaký panelák to byl?
9	adj-noun	gen	Řekla jsem, že do toho paneláku prej loni postavili výťah bez okýnka a zrcadla.	Či panelák to byl?
9	noun-adj	gen	Řekla jsem, že do toho paneláku Ivany prej loni postavili výťah bez okýnka a zrcadla.	Či panelák to byl?
10	adj-noun	adj	Zaslechl jsem, že do toho tmavého sklepa asi někdy uskladnili pytle s bramborama a cibulí.	Jaký sklep to byl?
10	noun-adj	adj	Zaslechl jsem, že do toho sklepa tmavého asi někdy uskladnili pytle s bramborama a cibulí.	Jaký sklep to byl?
10	adj-noun	gen	Zaslechl jsem, že do toho sklepa Nikolý asi někdy uskladnili pytle s bramborama a cibulí.	Či sklep to byl?
10	noun-adj	gen	Zaslechl jsem, že do toho sklepa Nikolý asi někdy uskladnili pytle s bramborama a cibulí.	Či sklep to byl?
11	adj-noun	adj	Řekla jsem, že do toho špinavého batohu fakt potom zabalili notebook bez obalu a folie.	Jaký batoh to byl?
11	noun-adj	adj	Řekla jsem, že do toho batohu špinavého fakt potom zabalili notebook bez obalu a folie.	Jaký batoh to byl?
11	adj-noun	gen	Řekla jsem, že do toho Zuzany batohu fakt potom zabalili notebook bez obalu a folie.	Či batoh to byl?
11	noun-adj	gen	Řekla jsem, že do toho batohu Zuzany fakt potom zabalili notebook bez obalu a folie.	Či batoh to byl?
12	adj-noun	adj	Zapomněl jsem, že do toho lesklého hmečku prý kdysi schovali desetič s fetizkem a náramkem.	Jaký hmeček to byl?
12	noun-adj	adj	Zapomněl jsem, že do toho hmečku lesklého prý kdysi schovali desetič s fetizkem a náramkem.	Jaký hmeček to byl?
12	adj-noun	gen	Zapomněl jsem, že do toho Markéty hmečku prý kdysi schovali desetič s fetizkem a náramkem.	Či hmeček to byl?
12	noun-adj	gen	Zapomněl jsem, že do toho hmečku Markéty prý kdysi schovali desetič s fetizkem a náramkem.	Či hmeček to byl?
13	adj-noun	adj	Poznamenala jsem, že z toho mělkého bazénku opravdu ráno vyndali vosy s broučkama a smetím.	Jaký bazének to byl?
13	noun-adj	adj	Poznamenala jsem, že z toho bazénku mělkého opravdu ráno vyndali vosy s broučkama a smetím.	Jaký bazének to byl?
13	adj-noun	gen	Poznamenala jsem, že z toho bazénku Simony opravdu ráno vyndali vosy s broučkama a smetím.	Či bazének to byl?
13	noun-adj	gen	Poznamenala jsem, že z toho bazénku Simony opravdu ráno vyndali vosy s broučkama a smetím.	Či bazének to byl?
14	adj-noun	adj	Zjistil jsem, že z toho rychlého eshopu opravdu minule objednali bojler bez příslušenství a záruky.	Jaký eshop to byl?
14	noun-adj	adj	Zjistil jsem, že z toho eshopu rychlého opravdu minule objednali bojler bez příslušenství a záruky.	Jaký eshop to byl?
14	adj-noun	gen	Zjistil jsem, že z toho Kamily eshopu opravdu minule objednali bojler bez příslušenství a záruky.	Či eshop to byl?
14	noun-adj	gen	Zjistil jsem, že z toho eshopu Kamily opravdu minule objednali bojler bez příslušenství a záruky.	Či eshop to byl?
15	adj-noun	adj	Zaslechla jsem, že z toho starého šuplíku nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Jaký šuplík to byl?
15	noun-adj	adj	Zaslechla jsem, že z toho šuplíku starého nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Jaký šuplík to byl?
15	adj-noun	gen	Zaslechla jsem, že z toho Ivetě šuplíku nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Či šuplík to byl?
15	noun-adj	gen	Zaslechla jsem, že z toho šuplíku Ivetě nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Či šuplík to byl?
16	adj-noun	adj	Poznamenal jsem, že z toho parapetu úzkého fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Jaký parapet to byl?
16	noun-adj	adj	Poznamenal jsem, že z toho parapetu úzkého fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Jaký parapet to byl?
16	adj-noun	gen	Poznamenal jsem, že z toho Kristýny parapetu fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Či parapet to byl?
16	noun-adj	gen	Poznamenal jsem, že z toho parapetu Kristýny fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Či parapet to byl?
17	adj-noun	adj	Zapomněl jsem, že z toho zeleného košíku nakonec potom vybrali flašky s vínem a medovinou.	Jaký košík to byl?
17	noun-adj	adj	Zapomněl jsem, že z toho košíku zeleného nakonec potom vybrali flašky s vínem a medovinou.	Jaký košík to byl?
17	adj-noun	gen	Zapomněl jsem, že z toho Alžběty košíku nakonec potom vybrali flašky s vínem a medovinou.	Či košík to byl?
17	noun-adj	gen	Zapomněl jsem, že z toho košíku Alžběty nakonec potom vybrali flašky s vínem a medovinou.	Či košík to byl?
18	adj-noun	adj	Poznamenala jsem, že z toho modrého slovníku snad předtím vytrhli stránku s kulturou a realíema.	Jaký slovníček to byl?
18	noun-adj	adj	Poznamenala jsem, že z toho slovníku modrého snad předtím vytrhli stránku s kulturou a realíema.	Jaký slovníček to byl?
18	adj-noun	gen	Poznamenala jsem, že z toho Michaly slovníku snad předtím vytrhli stránku s kulturou a realíema.	Či slovníček to byl?
18	noun-adj	gen	Poznamenala jsem, že z toho slovníku Michaly snad předtím vytrhli stránku s kulturou a realíema.	Či slovníček to byl?
19	adj-noun	adj	Zjistila jsem, že z toho žlutého stanu opravdu nejdřív vynesli stoly bez lavic a nádobí.	Jaký stan to byl?
19	noun-adj	adj	Zjistila jsem, že z toho stanu žlutého opravdu nejdřív vynesli stoly bez lavic a nádobí.	Jaký stan to byl?
19	adj-noun	gen	Zjistila jsem, že z toho Barbory stanu opravdu nejdřív vynesli stoly bez lavic a nádobí.	Či stan to byl?
19	noun-adj	gen	Zjistila jsem, že z toho stanu Barbory opravdu nejdřív vynesli stoly bez lavic a nádobí.	Či stan to byl?
20	adj-noun	adj	Řekl jsem, že z toho bílého trezoru nejspíš všichni odnesli závěť se smlouvama a diplomama.	Jaký trezor to byl?
20	noun-adj	adj	Řekl jsem, že z toho trezoru bílého nejspíš všichni odnesli závěť se smlouvama a diplomama.	Jaký trezor to byl?
20	adj-noun	gen	Řekl jsem, že z toho Veroniky trezoru nejspíš všichni odnesli závěť se smlouvama a diplomama.	Či trezor to byl?
20	noun-adj	gen	Řekl jsem, že z toho trezoru Veroniky nejspíš všichni odnesli závěť se smlouvama a diplomama.	Či trezor to byl?

Experiment 7 – experimental items

ItemNo	Position	Type	Item	Question
1	adj-noun	adj	Zaslechla jsem, že do toho dolního bytu asi včera ubytovali partu s reprákem a štenětem.	Jaký byt to byl?
1	noun-adj	adj	Zaslechla jsem, že do toho bytu dolního asi včera ubytovali partu s reprákem a štenětem.	Jaký byt to byl?
1	adj-noun	gen	Zaslechla jsem, že do toho Terezy bytu asi včera ubytovali partu s reprákem a štenětem.	Či byt to byl?
1	noun-adj	gen	Zaslechla jsem, že do toho bvty Terezy asi včera ubytovali partu s reprákem a štenětem.	Či byt to byl?
2	adj-noun	adj	Zaslechla jsem, že do toho hlasitého klubu prej ráno zavolali policajty se psama a zásahovkou.	Jaký klub to byl?
2	noun-adj	adj	Zaslechla jsem, že do toho klubu hlasitého prej ráno zavolali policajty se psama a zásahovkou.	Jaký klub to byl?
2	adj-noun	gen	Zaslechla jsem, že do toho Martiny klubu prej ráno zavolali policajty se psama a zásahovkou.	Či klub to byl?
2	noun-adj	gen	Zaslechla jsem, že do toho klubu Martiny prej ráno zavolali policajty se psama a zásahovkou.	Či klub to byl?
3	adj-noun	adj	Poznamenala jsem, že do toho oranžového koktejlu nejspíš včera nezamíchali cukr s pepřem a smetanou.	Jaký koktejl to byl?
3	noun-adj	adj	Poznamenala jsem, že do toho koktejlu oranžového nejspíš včera nezamíchali cukr s pepřem a smetanou.	Jaký koktejl to byl?
3	adj-noun	gen	Poznamenala jsem, že do toho Andrey koktejlu nejspíš včera nezamíchali cukr s pepřem a smetanou.	Či koktejl to byl?
3	noun-adj	gen	Poznamenala jsem, že do toho koktejlu Andrey nejspíš včera nezamíchali cukr s pepřem a smetanou.	Či koktejl to byl?
4	adj-noun	adj	Zapomněla jsem, že do toho slaného koláče zřejmě minule nedali sýr s paprikou a rajčaty.	Jaký koláč to byl?
4	noun-adj	adj	Zapomněla jsem, že do toho koláče slaného zřejmě minule nedali sýr s paprikou a rajčaty.	Jaký koláč to byl?
4	adj-noun	gen	Zapomněla jsem, že do toho Elišky koláče zřejmě minule nedali sýr s paprikou a rajčaty.	Či koláč to byl?
4	noun-adj	gen	Zapomněla jsem, že do toho koláče Elišky zřejmě minule nedali sýr s paprikou a rajčaty.	Či koláč to byl?
5	adj-noun	adj	Řekla jsem, že do toho koženého penálu prostě hned schovali zapalovač s cigárama a trávou.	Jaký penál to byl?
5	noun-adj	adj	Řekla jsem, že do toho penálu koženého prostě hned schovali zapalovač s cigárama a trávou.	Jaký penál to byl?
5	adj-noun	gen	Řekla jsem, že do toho Heleny penálu prostě hned schovali zapalovač s cigárama a trávou.	Či penál to byl?
5	noun-adj	gen	Řekla jsem, že do toho penálu Heleny prostě hned schovali zapalovač s cigárama a trávou.	Či penál to byl?
6	adj-noun	adj	Zjistila jsem, že do toho horkého moštu taky potom nepřidali zázvor s rakytníkem a hřebíčkem.	Jaký mošt to byl?
6	noun-adj	adj	Zjistila jsem, že do toho moštu horkého taky potom nepřidali zázvor s rakytníkem a hřebíčkem.	Jaký mošt to byl?
6	adj-noun	gen	Zjistila jsem, že do toho Renaty moštu taky potom nepřidali zázvor s rakytníkem a hřebíčkem.	Či mošt to byl?
6	noun-adj	gen	Zjistila jsem, že do toho moštu Renaty taky potom nepřidali zázvor s rakytníkem a hřebíčkem.	Či mošt to byl?
7	adj-noun	adj	Zjistila jsem, že do toho drahého obchodu snad hned zavedli pokladny bez obsluhy a hotovosti.	Jaký obchod to byl?
7	noun-adj	adj	Zjistila jsem, že do toho obchodu drahého snad hned zavedli pokladny bez obsluhy a hotovosti.	Jaký obchod to byl?
7	adj-noun	gen	Zjistila jsem, že do toho Moniky obchodu snad hned zavedli pokladny bez obsluhy a hotovosti.	Či obchod to byl?
7	noun-adj	gen	Zjistila jsem, že do toho obchodu Moniky snad hned zavedli pokladny bez obsluhy a hotovosti.	Či obchod to byl?
8	adj-noun	adj	Zapomněla jsem, že do toho fialového kufru asi včera zandali taštičku s jízdenkama a klíčem.	Jaký kufr to byl?
8	noun-adj	adj	Zapomněla jsem, že do toho kufru fialového asi včera zandali taštičku s jízdenkama a klíčem.	Jaký kufr to byl?
8	adj-noun	gen	Zapomněla jsem, že do toho Denisy kufru asi včera zandali taštičku s jízdenkama a klíčem.	Či kufr to byl?
8	noun-adj	gen	Zapomněla jsem, že do toho kufru Denisy asi včera zandali taštičku s jízdenkama a klíčem.	Či kufr to byl?
9	adj-noun	adj	Řekla jsem, že do toho okrového paneláku prej loni postavili výťah bez okýnka a zrcadla.	Jaký panelák to byl?
9	noun-adj	adj	Řekla jsem, že do toho paneláku okrového prej loni postavili výťah bez okýnka a zrcadla.	Jaký panelák to byl?
9	adj-noun	gen	Řekla jsem, že do toho Imany paneláku prej loni postavili výťah bez okýnka a zrcadla.	Či panelák to byl?
9	noun-adj	gen	Řekla jsem, že do toho paneláku Imany prej loni postavili výťah bez okýnka a zrcadla.	Či panelák to byl?
10	adj-noun	adj	Zaslechla jsem, že do toho tmavého sklepa asi někdy uskladnili pytle s bramborama a cibulí.	Jaký sklep to byl?
10	noun-adj	adj	Zaslechla jsem, že do toho sklepa tmavého asi někdy uskladnili pytle s bramborama a cibulí.	Jaký sklep to byl?
10	adj-noun	gen	Zaslechla jsem, že do toho sklepa Nikolý asi někdy uskladnili pytle s bramborama a cibulí.	Či sklep to byl?
10	noun-adj	gen	Zaslechla jsem, že do toho sklepa Nikolý asi někdy uskladnili pytle s bramborama a cibulí.	Či sklep to byl?
11	adj-noun	adj	Řekla jsem, že do toho špinavého batohu fakt potom zabalili notebook bez obalu a folie.	Jaký batoh to byl?
11	noun-adj	adj	Řekla jsem, že do toho batohu špinavého fakt potom zabalili notebook bez obalu a folie.	Jaký batoh to byl?
11	adj-noun	gen	Řekla jsem, že do toho Zuzany batohu fakt potom zabalili notebook bez obalu a folie.	Či batoh to byl?
11	noun-adj	gen	Řekla jsem, že do toho batohu Zuzany fakt potom zabalili notebook bez obalu a folie.	Či batoh to byl?
12	adj-noun	adj	Zapomněla jsem, že do toho lesklého hmečku prý kdysi schovali desetik s řetízem a náramkem.	Jaký hmeček to byl?
12	noun-adj	adj	Zapomněla jsem, že do toho hmečku lesklého prý kdysi schovali desetik s řetízem a náramkem.	Jaký hmeček to byl?
12	adj-noun	gen	Zapomněla jsem, že do toho Markěty hmečku prý kdysi schovali desetik s řetízem a náramkem.	Či hmeček to byl?
12	noun-adj	gen	Zapomněla jsem, že do toho hmečku Markěty prý kdysi schovali desetik s řetízem a náramkem.	Či hmeček to byl?
13	adj-noun	adj	Poznamenala jsem, že z toho mělkého bazénku opravdu ráno vyndali vosy s broukami a smetím.	Jaký bazének to byl?
13	noun-adj	adj	Poznamenala jsem, že z toho bazénku mělkého opravdu ráno vyndali vosy s broukami a smetím.	Jaký bazének to byl?
13	adj-noun	gen	Poznamenala jsem, že z toho Simony bazénku opravdu ráno vyndali vosy s broukami a smetím.	Či bazének to byl?
13	noun-adj	gen	Poznamenala jsem, že z toho bazénku Simony opravdu ráno vyndali vosy s broukami a smetím.	Či bazének to byl?
14	adj-noun	adj	Zjistila jsem, že z toho rychlého eshopu opravdu minule objednali bojler bez příslušenství a záruky.	Jaký eshop to byl?
14	noun-adj	adj	Zjistila jsem, že z toho eshopu rychlého opravdu minule objednali bojler bez příslušenství a záruky.	Jaký eshop to byl?
14	adj-noun	gen	Zjistila jsem, že z toho Kamily eshopu opravdu minule objednali bojler bez příslušenství a záruky.	Či eshop to byl?
14	noun-adj	gen	Zjistila jsem, že z toho eshopu Kamily opravdu minule objednali bojler bez příslušenství a záruky.	Či eshop to byl?
15	adj-noun	adj	Zaslechla jsem, že z toho starého šuplíku nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Jaký šuplík to byl?
15	noun-adj	adj	Zaslechla jsem, že z toho šuplíku starého nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Jaký šuplík to byl?
15	adj-noun	gen	Zaslechla jsem, že z toho Ivety šuplíku nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Či šuplík to byl?
15	noun-adj	gen	Zaslechla jsem, že z toho šuplíku Ivety nějak nakonec vydolovali nitě s korálkami a špendlíkami.	Či šuplík to byl?
16	adj-noun	adj	Poznamenala jsem, že z toho úzkého parapetu fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Jaký parapet to byl?
16	noun-adj	adj	Poznamenala jsem, že z toho parapetu úzkého fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Jaký parapet to byl?
16	adj-noun	gen	Poznamenala jsem, že z toho Kristýny parapetu fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Či parapet to byl?
16	noun-adj	gen	Poznamenala jsem, že z toho parapetu Kristýny fakt odpoledne ukradli pekáč s kachnou a kuřetem.	Či parapet to byl?
17	adj-noun	adj	Zapomněla jsem, že do toho zeleného košíku nakonec potom nedali flašky s vínem a medovinou.	Jaký košík to byl?
17	noun-adj	adj	Zapomněla jsem, že do toho košíku zeleného nakonec potom nedali flašky s vínem a medovinou.	Jaký košík to byl?
17	adj-noun	gen	Zapomněla jsem, že do toho Alžběty košíku nakonec potom nedali flašky s vínem a medovinou.	Či košík to byl?
17	noun-adj	gen	Zapomněla jsem, že do toho košíku Alžběty nakonec potom nedali flašky s vínem a medovinou.	Či košík to byl?
18	adj-noun	adj	Poznamenala jsem, že z toho modrého slovníku snad předtím vytrhli stránku s kulturou a reáliemi.	Jaký slovníček to byl?
18	noun-adj	adj	Poznamenala jsem, že z toho slovníku modrého snad předtím vytrhli stránku s kulturou a reáliemi.	Jaký slovníček to byl?
18	adj-noun	gen	Poznamenala jsem, že z toho Michaly slovníku snad předtím vytrhli stránku s kulturou a reáliemi.	Či slovníček to byl?
18	noun-adj	gen	Poznamenala jsem, že z toho slovníku Michaly snad předtím vytrhli stránku s kulturou a reáliemi.	Či slovníček to byl?
19	adj-noun	adj	Zjistila jsem, že z toho žlutého stanu opravdu nejdřív vynesli stoly bez lavic a nádobi.	Jaký stan to byl?
19	noun-adj	adj	Zjistila jsem, že z toho stanu žlutého opravdu nejdřív vynesli stoly bez lavic a nádobi.	Jaký stan to byl?
19	adj-noun	gen	Zjistila jsem, že z toho Barbory stanu opravdu nejdřív vynesli stoly bez lavic a nádobi.	Či stan to byl?
19	noun-adj	gen	Zjistila jsem, že z toho stanu Barbory opravdu nejdřív vynesli stoly bez lavic a nádobi.	Či stan to byl?
20	adj-noun	adj	Řekla jsem, že z toho bílého trezoru nejspíš včera odnesli závěť se smlouvama a diplomama.	Jaký trezor to byl?
20	noun-adj	adj	Řekla jsem, že z toho trezoru bílého nejspíš včera odnesli závěť se smlouvama a diplomama.	Jaký trezor to byl?
20	adj-noun	gen	Řekla jsem, že z toho Veroniky trezoru nejspíš včera odnesli závěť se smlouvama a diplomama.	Či trezor to byl?
20	noun-adj	gen	Řekla jsem, že z toho trezoru Veroniky nejspíš včera odnesli závěť se smlouvama a diplomama.	Či trezor to byl?

Appendix 2

Consent form

Souhlas s účastí na experiment

Tímto potvrzují, že

a) jsem se seznámil/a s informacemi o cílech a průběhu výše popsaného výzkumu; b) dobrovolně souhlasím s účastí své osoby v tomto výzkumu; c) rozumím tomu, že se mohu kdykoli rozhodnout ve své účasti na výzkumu nepokračovat; d) jsem srozuměn s tím, že jakékoliv užití a zveřejnění dat a výstupů vzešlých z výzkumu nezakládá můj nárok na jakoukoliv odměnu či náhradu, tzn. že veškerá oprávnění k užití a zveřejnění dat a výstupů vzešlých z výzkumu poskytují bezúplatně.

Zároveň prohlašuji, že a) souhlasím se zveřejněním anonymizovaných dat a výstupů vzešlých z výzkumu a s jejich dalším využitím; b) souhlasím se zpracováním a uchováním osobních a citlivých údajů v rozsahu v tomto informovaném souhlasu uvedených ze strany Univerzity Karlovy, Filozofické fakulty, IČ: 00216208, se sídlem: nám. Jana Palacha 2, 116 38 Praha 1, a to pro účely zpracování dat vzešlých z výzkumu, pro účely případného kontaktování z důvodu zpracování dat vzešlých z výzkumu či z důvodu nabídky účasti na obdobných akcích a pro účely evidence a archivace; a s tím, že tyto osobní údaje mohou být poskytnuty subjektům oprávněným k výkonu kontroly projektu, v jehož rámci výzkum realizován; c) jsem seznámen/-a se svými právy týkajícími se přístupu k informacím a jejich ochraně podle § 46 a § 49 zákona č. 110/2019 Sb., o ochraně osobních údajů a o změně některých zákonů, ve znění pozdějších předpisů, tedy že mohu požádat Univerzitu Karlovu v Praze o informaci o zpracování mých osobních a citlivých údajů a jsem oprávněn/-a ji dostat a že mohu požádat Univerzitu Karlovu v Praze o opravu nepřesných osobních údajů, doplnění osobních údajů, jejich blokaci a likvidaci.

Výše uvedená svolení a souhlasy poskytují dobrovolně na dobu neurčitou až do odvolání a zavazují se je neodvolat bez závažného důvodu spočívajícího v podstatné změně okolností.