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ARTICLE

When complementation gets specific: A study of collocational preferences in verb–object combinations in Norwegian

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Abstract

This study investigates to what extent there are collocational preferences in the verb–object combinations of a large corpus of Norwegian and how important recurrent combinations are in usage. The material has been extracted from a large web-corpus of 700 million tokens and consists of dependency-based verb–object combinations. The overall importance of collocational preferences is demonstrated by the fact that the most frequent 5% of the verb–object combinations account for as much as 64% of the verb–object tokens in the material. The database of verb–object combinations contains measures of collocational strength and thereby allows us to model the mutual strength between the exemplars in the clusters found with individual verbs. Based on some studies of individual verbs and verb pairs, it seems safe to assume that speakers do distinguish between and prefer certain conventional verb–object combinations to other equally grammatical, equally transparent and equally understandable alternatives, and that speakers have access to complementation information at the level of exemplars.

Keywords: collocational preferences; complementation; corpus-based; Norwegian; verb–object combinations

1. Introduction

To what extent are there collocational preferences in the verb–object combinations of a large corpus of Norwegian, how important are recurrent combinations in usage, and what can the collocational preferences of individual verbs tell us about verbal complementation in general? The aim of the present article is to shed some light on these questions, focusing on dependency-based verb–object combinations in the NoWaC corpus of web-documents in Norwegian Bokmål (Guevara 2010). The corpus contains approximately 700 million tokens, and the availability of corpora of this size allows for new empirical studies of word co-occurrences in Norwegian.

Verbal complementation has typically been treated either from the traditional lexical perspective under labels such as argument structure (Grimshaw 1990, Bresnan 2001, Levin & Rappaport Hovav 2005), subcategorisation and selection

(e.g. Chomsky 1965), and valency (e.g. Ágel 2000) or, more recently, also from a constructional perspective in terms of argument structure constructions (e.g. Goldberg 1995, 2006; Perek 2015). Typically, these approaches consider complementation at a rather abstract level, although the constructional approach tends to be more interested in the whole spectrum of abstractness, from specific exemplars to highly abstract generalisations. In the present investigation the aim is to complement such studies by focussing on the more concrete level of collocational preferences: We focus here on complementation in terms of specific verb–object combinations and on the collocational preferences found in such combinations. This focus is compatible both with a lexical and a constructional model of complementation; the focus is on verbs and at the same time on verbs in the transitive construction.

A crucial point is that the difference between specific word combinations in the verb–object relation on the one hand and valency on the other, is a difference in the level of abstractness at which co-occurrences are handled, and this is true regardless of whether one adheres to a lexical or to a constructional model of complementation. As argued by Herbst (2010:226), '[c]ollocation and valency represent different facets of the same phenomenon'.

In clauses (or constructions) containing verbs and direct objects in the form of NPs, speakers are always exposed to combinations of specific verbs and nouns, and exposure to such combinations are necessarily the basis for speakers representations of complementation of this kind. It follows from this that in order to account for complementation, we need to model these exposures. Since verb–NP–object combinations are always realised by concrete verbs and nouns, the association strength between them in a large corpus can be measured, as is normally done in studies of collocations.

A useful distinction that has emerged in corpus linguistics (Sinclair 1991) is the one between the open-choice principle and the idiom principle. Whereas a notion like argument structure is clearly based on the open-choice principle, speakers seem in many cases to have clear intuitional preferences even between fully grammatical, semantically transparent and equally understandable alternatives. Recently, Goldberg (2019) discusses an example like *Explain me this* in English, which is felt by native speakers to be much less conventional than the alternative *Explain this to me*. Such preferences call for rather specific representations and are best accounted for in terms of what Sinclair (1991) calls the idiom principle, which does not imply that preferred alternatives are semantically non-transparent. Rather, the idiom principle implies that speakers have access to rather specific representations in their production and comprehension of language, and that multiword units can constitute single choices. The idiom principle is highly compatible with exemplar categorisation and representation, and these notions are further disussed in Section 2, where it is argued that they can be fruitfully applied to account also for collocational preferences in verb–object combinations.

In Section 3, the computational work that was carried out in order to build a database of corpus-based verb–object combinations is presented. As already mentioned, the combinations were extracted from the NoWaC corpus of web-documents (Guevara 2010), and the corpus has been lemmatised, annotated with part-of-speech tags (i.e. POS-tagged) and parsed. Based on computations in R,

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the overall importance of recurring verb–object combinations and collocational preferences in such combinations are discussed in Section 4, and the database is also the foundation for studies of the collocational preferences of some individual verbs and verb pairs, presented in Section 5. It is suggested that collocation measures allow us to model the mutual strength of the verb–object exemplars in the complementation clusters associated with individual verbs. Finally, in Section 6, a brief discussion is followed by some concluding remarks.

2. Open-choice vs. idiom principle and exemplar representations

The distinction between the open-choice principle and the idiom principle is due to Sinclair (1991, 2004) and his work based on large electronic corpora. We will now take a closer look at these notions and relate them to verb–object combinations viewed in terms of abstract argument structure and to such combinations viewed in terms of concrete combinations of verb and noun.

The notion of argument structure is based on the open-choice principle. The notion has been adopted from mathematical logic, where arguments are the variables in formulae such as P(x,y), where the predicate P takes two arguments, x and y. In principle, the argument variables can be filled by any entity, and a grammatical model of this kind is based on open choice in the filling of argument slots: 'Any tree structure shows it clearly: the nodes on the tree are the choice points. Virtually all grammars are constructed on the open-choice principle' (Sinclair 1991:109–110). Certainly, this is not as true today as it was 30 years ago, especially with the rise of corpus linguistics and usage-based models (Langacker 1987, 2000; Barlow & Kemmer 2000), where representations of the language system are seen as directly influenced by usage, and with the rise of exemplar-based models of linguistic categorisation (Bybee 2010, 2013), it is more broadly acknowledged that the idiom principle plays a very important role in language.

Collocations represent par excellence examples of the idiom principle at work: 'On some occasions, words appear to be chosen in pairs or groups and these are not necessarily adjacent' (Sinclair 1991:115). Empirical approaches to complementation suggest that speakers have access to various types of complementation knowledge. First of all, they know in which syntactic patterns predicators conventionally occur. Secondly, they know that there may be clear preferences also for the exact lexical fillers of the complement slots that are available in a pattern (Herbst 2007, Haugen 2013, Goldberg 2019). This is the crucial point that a database of verb–object combinations allows us to investigate further.

The classical approach to restricting open choice within syntactic categories, found both in early versions of generative grammar (e.g. Chomsky 1965) and in german valency grammars (e.g. Helbig 1992) is to posit selectional restrictions, which are typically coarse-grained semantic features, like ± ANIMATE, ± HUMAN, ± ABSTRACT, etc. In some cases, such general semantic features are useful. Consider for example the strongest collocates of the verb *spise* 'eat' in Table 1. We will return to the details of this table in Section 4. For now, the important point is that the object nouns are ranked according to the strength of their collocational association with the verb (log-likelihood (Dunning 1993), given in the rightmost

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Table 1. Strongest object collocates of *spise* 'eat'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
spise	middag 'dinner'	366	4,853	850	2,490,957	3,436
spise	mat 'food'	422	4,853	3,459	2,490,957	2,750
spise	frokost 'breakfast'	253	4,853	600	2,490,957	2,356
spise	lunsj 'lunch'	219	4,853	488	2,490,957	2,073
spise	frukt 'fruit'	138	4,853	547	2,490,957	1,110
spise	fisk 'fish'	171	4,853	1,435	2,490,957	1,097
spise	godteri 'sweets'	86	4,853	159	2,490,957	856
spise	pizza 'pizza'	78	4,853	334	2,490,957	613
spise	sjokolade 'chocolate'	71	4,853	401	2,490,957	514
spise	taco 'taco'	43	4,853	67	2,490,957	450

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

column in Table 1 and other tables): the greater the number in the rightmost column, the stronger the collocational association. The objects of *spise* can be subsumed under more general semantic features like FOOD and MEAL.

From work on valency dictionaries, however, it is well known that for most verbs it is notoriously difficult to capture specific restrictions on complements through positing general semantic categories. Herbst (2007) discusses the treatment of semantic valency in two large valency dictionaries – for English (Herbst et al. 2004) and for German (Schumacher et al. 2004) – and states that:

> What is interesting about the lexicographical treatment of the non-formal side of the characterization of complements in VDE [Valency Dictionary of English] or VALBU [Valenzwörterbuch deutscher Verben] is that both dictionaries make use of general categories such as *someone* or *derjenige* (which can be seen as equivalent to Helbig's [1992] semantic feature + HUM) but nevertheless find it necessary to give relatively specific lists of lexical items such as *door*, *window etc.* or *Kommision*, *Bürgerinitiative*. Very often this is because no suitable label can be found as in the case of the note for the verb *set* in VDE
>
> **A person^{I} can set someone^{III} something such as a deadline, a target, a task, a test, an examination, etc^{II}.** (Herbst 2007:26; bold for emphasis in the original)

A plausible way of accounting for this kind of specific preferences in complementation (the Roman numerals in the quote above refer to the different complements of the verb) is to allow for exemplar representations. As Bybee (2013:52) points out, exemplar models are models where it is proposed that the memory of experiences with language is similar to the memory of experiences in general, which means that each experienced token has an impact on the overall mental representation of the phenomenon in question. In constructional terms, the difference between an exemplar-based model of complementation and abstract selectional features can be described as follows:

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> A schematic slot in a construction might consist of a list of all the items that have occured in that slot (as predicted by an exemplar model), or it might be considered a set of abstract semantic features that constrains the slot, as usually proposed. It could, of course, be both. However, the importance of the specific exemplars that have occurred in the construction can be seen … in cases where a single abstract feature does not characterize a class or explain its extension. (Bybee 2013:57)

When we study the specific lexical fillers of the object slot of the verb and the strength of their collocational association, we study the complementation of the verb in terms of an exemplar cluster. The main idea behind such a model is that:

> [R]ather than making reference to a general semantic feature when using a construction, the speaker may very well reference a particular lexical item that has already been used in the construction and stored in memory. (Bybee 2013:58)

As we see in Table 1, a verb in our verb–object combinations is associated with a list of exemplars which is ordered according to the strength of association between verb and object (measured as log-likelihood). Arguably, this approach yields not only a precise description of collocational preferences in such combinations; it can also account for the probabilistic nature of complementation choices and the different strengths of association between a verb and its habitual complements. Based on studies of individual verbs and verb pairs, I will argue that the corpus-based strength of collocational association in many cases coincide with clear intuitional preferences between equally grammatical and equally understandable alternatives.

The open-choice principle and exemplar-based models can be said to represent the extreme ends on a continuum of schematicity from the most schematic to the most specific, respectively. In between there are various possibilities for intermediate degrees of specificity, which are readily accounted for in constructional approaches to complementation. As Goldberg (2006:46) points out, an exemplar-based model does not remove the need for abstraction; not all information available from instantiations is stored, and 'exemplar models fail to explain how exactly items cohere as a category' (Goldberg 2006:47). There are certainly cases where more schematic generalisations can be done, and where more schematic semantic categories seem plausible, see the discussion of the verb *spise* 'eat' in Table 1 above. The point that will be made here, however, is that specific collocational preferences are also part of the picture.

The study of collocational preferences in verb–object combinations also allows us to explore more fully idiomatic combinations in the sense of combinations lacking semantic transparency. Consider for example the Norwegian verb *brenne* 'burn'. Fully transparent combinations with this verb are examples like the following:

(1) vi brenner lys. (NoWaC)
we burn candles
'We burn candles.'

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There are, however, also strongly associated combinations where verb + noun yield more idiomatic meanings. One example is the object *bro* 'bridge', which occurs in the idiomatic expression *brenne alle broer* 'lit.: burn all bridges, break all contact' as in (2a) below. Other strong object collocates of *brenne* are the nouns *straffe* 'penalty', *sjanse* 'chance' and *straffespark* 'penalty kick', see the examples in (2b, c).

(2) a. jeg vil heller ikke brenne alle broer. (NoWaC)
I will also not burn all bridges
'I do not want to break all contact.'

b. de brente straffe på 2-0. (NoWaC)
they burned penalty on 2-0
'They missed a penalty at 2-0.'

c. vi brente mange sjanser og hadde fortjent flere mål! (NoWaC)
we burned many chances and had deserved more goals
'We missed a lot of chances and deserved more goals!'

The use of this verb as in (2b, c) seems to be restricted to 'missing possibilities for scoring a point in ball games'. Expressing other types of failure is not conventional; one cannot say, for example, **Han brente 2,40* 'He burned 2.40' about an athlete in high jump. Such idiomatic and semi-idiomatic uses of a verb are also a part of speakers' knowledge about these verbs, and a clear advantage of an exemplar-based model is that it can account equally well for transparent as well as non-transparent, contextually more skewed combinations; in exemplar models, contextual information is hypothesised to be part of the representations kept in memory (Bybee 2010, Goldberg 2019).

The database of verb–object combinations is presented in the following section, where we first take a look at collocations in general.

3. Extraction of verb–object combinations and collocational preferences

3.1 On collocations, methodology and tools

'Collocations of a given word are statements of the habitual or customary places of that word' (Firth 1957:181) is often cited as the founding definition of the notion of collocation.

To be extreme, any two linguistic entities that co-occur within the boundaries of a linguistically significant domain (e.g. a phrase, sentence, paragraph, text or discourse) might be treated as a potential collocation.

In computational approaches to collocations, the key notions are frequency of occurrence and association. Given any two linguistic entities that co-occur within the boundaries of a linguistically significant domain, those that occur with a higher than chance frequency are said to be lexically associated or attracted. Therefore, if one can reliably measure and quantify the extent of lexical association between words, it becomes possible to sort the candidate pairs by the strength of their mutual attraction. A number of statistical methods to measure lexical association have been devised and perfected over the years; a full overview of such methods is well beyond the aims of the present article, but the reader is referred to Evert (2005, 2008) for in-depth treatment.

In order to be reliable, the measurements of association in word combinations must be based on representative and solid frequency counts, such as those obtained

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from large electronic corpora. The NoWaC corpus of Norwegian Bokmål (Guevara 2010) contains approximately 700 million tokens from web-documents. The representativity of a corpus is always a difficult question that needs to be discussed, and of course it would be interesting to do comparisons across different corpora in the future. Guevara (2010) estimates NoWaC to contain between 3–15% of the indexed online Bokmål at the time of extraction, and there is reason to believe that the corpus, containing texts from the general *.no domain, is a reasonably representative web-corpus. In its current version, the corpus (v. 1.1) is annotated with POS tags from the Oslo–Bergen tagger (latest releaseversion, Johannessen et al. 2012).

The classical approach to the extraction of collocations is what Evert (2005) calls distance-based co-occurrences, where collocation candidates are typically extracted by exploiting a combination of POS-tags and a contextual window of up to four or five words (as suggested by Sinclair 1991). In recent years, however, relation-based co-occurrences have become a more common basis for extraction (Uhrig, Evert & Proisl 2018). In such approaches, the co-occurring words are typically in a syntactic relation, which in our case will be a verb–object dependency relation, which is the type of syntactic relation used in the available treebank, see below.

Relational co-occurrences share important features with collostructional analysis, more specifically with covarying collexeme analysis (Stefanowitsch & Gries 2005). The main difference is that whereas the relational co-occurrence analysis computes the associations between words in a syntactic (in our case dependency) relation, the covarying collexeme analysis computes the associations between words in a more abstract and independently established construction. As discussed in the introduction, however, the collocations as studied in the present investigation are also collocations within the transitive construction.

Since the first Norwegian dependency treebank, NDT v. 1.0 (containing about 300,000 tokens, about 20,000 sentences), was made available (see Solberg 2013), it was possible to train parsing models for Norwegian with the Maltparser software (Nivre, Hall & Nilsson 2006). The parsing model that was used in the final experiment was trained on 75% of the sentences in the treebank. Estimation of the parser's parameters was carried out on 10% of the sentences, while the system's performance was validated on the remaining 15%. The sentences in the treebank had been randomly shuffled prior to the experiments. The best resulting models used the 'stacklazy' algorithm from Maltparser, and obtained a labeled attachment score (LAS) of 0.864, a value that is very much in line with the state of the art. LAS is a standard evaluation metric in dependency parsing, and the score shows the percentage of words that are assigned the correct syntactic head as well as the correct dependency label. The score indicates the high quality of the data in the NDT treebank. The parsed version of NoWaC was computed on the cluster facilities owned by the University of Oslo in just over 10 hours and using an allowance of 24Gb RAM. The corpus contains approximately 33.5 million sentences (dependency trees).

3.2 Extracting combinations, computing lexical associations, and cleaning of the data

With the annotated, lemmatised and parsed corpus in place, for each finite verb (i.e. each sentence head) in each main sentence in the corpus the object dependents

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bearing the POS tag 'common noun' were extracted. Altogether approximately 2.5 million verb–direct object combination tokens (0.53 million types) were obtained. The candidate lists were then processed with the UCS toolkit v. 0.6 in order to compute the measure of association for each combination (more on this below). In addition to the dependency relation observed for each candidate pair, the information used for the computation comprises the conjoined frequency of the pair and the independent frequencies of each lemma, both within the verb–object dependency relation (i.e. the basis for all calculations is the 2.5 million extracted verb–object tokens).

Given the Zipfian distribution of words in a linguistic corpus, most candidate pairs in the data had very low frequencies and would be useless for any statistical measure of significance. A frequency filter was thus introduced in order target the combinations where the strongest associations between verb and object are most likely to be found: Only the verb–object pairs that co-occur at least 10 times in the corpus were kept. This filter yielded a final figure of 26,425 verb–object combinations (types) out of 1.6 million tokens, which means that as much as 64% of the 2.5 million tokens originally obtained are still represented in the material, despite the 10-occurrences threshold. We will return to this interesting finding in Section 4 below.

For measurement of the statistical associations between the collocations, log-likelihood values (Dunning 1993) were computed. Uhrig et al. (2018) evaluate different association measures for collocation extraction across a range of syntactic relations, using the *Oxford Collocations Dictionary for Learners of English*, 2nd edition (OCD2 2009) as the gold standard of comparison. Log-likelihood comes out on top overall, and as the best performing measure when it comes to the verb–object relation, see Uhrig et al. (2018:125).

As far as I know, there are no previous studies of this kind for Norwegian, and unfortunately, no collocations dictionary is available for Norwegian, which means that there is no standard against which the extracted verb–object combinations could be evaluated automatically. Therefore, a manual cleaning of the 26,425 verb–object combinations has been carrried out, to evaluate and secure the quality of the data. The cleaning resulted in a revised dataset, containing 20,964 verb–object combinations. In addition, the studies of individual verbs and verb pairs to be presented in Section 5 below, in themselves represent some in depth evaluations of the data.

The cleaning of the data was carried out in two steps. First, the 360 combinations lemmatised as the verb *le* 'laugh' are actually occurrences with the imperative form of the verb *lese* 'read'; hence, the verbs of these combinations were changed to *lese* 'read'. One of these combinations, originally *le sak*, now lemmatised as *lese sak* 'read case' is an extreme outlier, probably because of the high frequency of this combinations in media texts and in hyperlinks. In the original data, this combination has a log-likelihood value of 692,126, compared to a log-likelihood value of 168,278 for the second highest combination. In the computations to follow, this extreme value has been neutralised, and the combination *lese sak* 'read case' has been given a log-likelihood value of 6,000, in line with the second strongest combination with *lese*, *lese anmeldelse* 'read review' (log-likelihood 5,921). Another outlier is the combination *skrive venn* 'write friend' (log-likelihood 168,278), which seems to be due to the

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fact that *skrive* 'write' in the phrase *skriv ut* 'print' frequently occurs adjacent to the frequent phrase *tips en venn* 'tell a friend'. Since *venn* 'friend' is intuitively not a possible NP object of *skrive* 'write' at all, this combination was deleted.

The extreme log-likelihood values of the two outliers above also means that other combinations with *sak* 'case' and *venn* 'friend' as objects get artificially low log-likelihood scores. Negative log-likelihood values for combinations with these objects have therefore been set to 0. The first computations on the material were carried out after the preliminary cleaning described above.

In a second step, a more thorough cleaning was carried out, where the number of verb–object types was reduced from 26,424 to 20,964 combinations. The cleaned data set thereby contains 20,964 verb–object combinations where the objects are all intuitively possible NP objects of the 955 verbs. The cleaning resulted in a reduction of the number of verbs from 1,183 to 955, and was carried out as follows:

- 185 verbs that intuitively do not take NP objects were deleted (see Table A1 in the appendix; examples of combinations with such verbs are: *falle oljepris* 'fall oil price', *flykte hals* 'flee neck', *kjefte kort* 'yell card').
- An additional 45 verbs were deleted (see Table A1 in the appendix), where an NP object is intuitively possible, but where the collocation candidates extracted are seemingly not complements of this kind (examples of combinations with these verbs are *beslutte styre* 'decide board', *mette fett* 'fill fat', *sminke hjelp* 'make up help').
- All non-noun object candidate extractions were deleted.
- Additional combinations where the extracted object candidate is not an intuitively possible NP object of the respective verb, were deleted.

4. Some frequencies and overall collocational preferences in the corpus

The large data set on which the present investigation is based, allows us to say something about the importance of recurring verb–object combinations and how collocational strength is distributed among the combinations. As already mentioned in Section 3, the point of departure of the investigation was ca 2.5 million verb–object tokens, out of which there were ca 0.53 million types. As the focus was the strongest collocation candidates among these combinations, a threshold of occurring at least 10 times in the corpus was set. This filtering reduced the number of types to 26,425, i.e. to ca 5% of the original 0.53 million types. Interestingly, however, the 26,425 types passing the threshold of at least 10 occurrences, account for as many as 1.6 million of the verb–object tokens, i.e. 64% of the tokens, see Figure 1. In other words, the 5% verb–object types where the strongest collocational associations are expected to be found account for as much as 64% of the tokens, which means that recurring verb–object combinations strongly dominate usage as represented in the corpus. Hence, collocational preferences seem, overall, to play a very important role in verb–object combinations.

Since the original 0.53 million types have not been manually cleaned, we do not have exact relative figures for the cleaned data. However, if we take the reduction in tokens (by 215,794 tokens) from the filtered, raw material to the both filtered and

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Table 2. Statistical summary of verb–object frequencies.

Number	Value
Minimum	10
1st Quartile	13
Median	19
Mean	61
3rd Quartile	37
Maximum	14,144

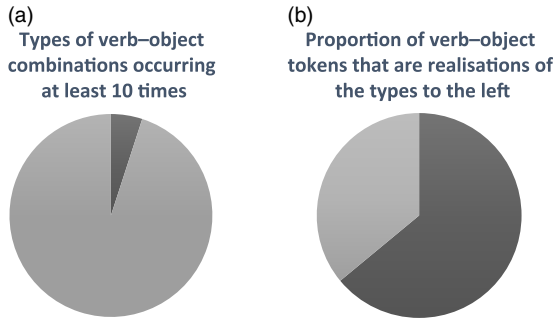

Figure 1. Verb–object-combinations: types and tokens (based on the numbers in the filtered, raw material).

cleaned material as a point of departure for the calculation, the tokens in the cleaned material (1,388,921) account for 61% of the total number of tokens, which is very much in line with the calculation above.

Let us now take a closer look at the overall frequencies of the verb–object combinations occurring at least 10 times in the corpus. The computations presented below have been carried out on the cleaned data set, using the R environment for statistical computing. When we ignore the extreme outlier *lese sak* 'read case' which has a frequency of 113,548, see 3.2 above, the frequencies of the combinations are distributed as shown in Table 2. We see that ¾ of the verb–object combinations have a frequency between 10–37, and that the variation is great in the 4th quartile, with the maximum frequency as high as 14,144. One thousand eight hundred and seventy-eight (1,873) combinations (8.9%) have a frequency of 100 or higher, 308 (1.5%) a frequency of 500 or higher, and 139 (0.7%) a frequency of 1,000 or higher.

More interesting for the measurement of collocational strength, however, is the log-likelihood values of the verb–object combinations. These values are distributed as shown in Table 3. The maximum value belongs to the combination *forbeholde rett* 'reserve right', where the verb *forbeholde* occurs almost exclusively with this object. There is a large gap from this combination to the second strongest, *legge vekt* 'put weight', which has a log-likelihood of 57,034.

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Table 3. Statistical summary of the log-likelihood values of the verb–object combinations.

Number	Value
Minimum	–5,372
1st Quartile	2
Median	31
Mean	153
3rd Quartile	98
Maximum	146,771

Table 4. Verb–object combinations with highest log-likelihood values.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
forbeholde	rett	14,144	14,257	20,942	2,490,957	146,771
legge	vekt	7,104	34,150	7,976	2,490,957	57,034
se	bilde	12,813	92,415	28,219	2,490,957	48,342
ta	kontakt	9,333	117,870	12,707	2,490,957	43,265
spille	rolle	5,295	18,711	8,621	2,490,957	41,990
se	video	6,236	92,415	7,377	2,490,957	35,225
sende	appell	3,899	26,107	4,336	2,490,957	33,326
stille	krav	3,497	6,241	9,916	2,490,957	31,510
skrive	kommentar	5,027	44,931	9,971	2,490,957	27,282
diskutere	person	3,061	8,384	6,481	2,490,957	27,191
ta	tid	9,139	117,870	25,285	2,490,957	24,824
sette	pris	3,829	22,101	9,171	2,490,957	24,498
legge	merke	3,034	34,150	3,832	2,490,957	22,403
ha	lyst	9,121	573,872	9,901	2,490,957	21,834
finne	sted	4,085	55,099	7,693	2,490,957	20,957
si	nei	2,382	18,559	3,954	2,490,957	18,365
trenge	hjelp	2,494	28,273	3,637	2,490,957	18,059
gi	beskjed	3,257	101,107	3,760	2,490,957	18,055
ta	utgangspunkt	3,782	117,870	5,139	2,490,957	17,388
skrive	mening	3,502	44,931	8,207	2,490,957	17,356

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

An overview of the 20 strongest combinations in terms of log-likelihood is given in Table 4. The high association strength of some of these combinations, such as *se bilde* 'see picture', *se video* 'see video', *sende appell* 'send appeal', *skrive kommentar*

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Table 5. Statistical summary of the mean log-likelihood values of the verbs.

Number	Value
Minimum	4
1st Quartile	101
Median	150
Mean	219
3rd Quartile	241
Maximum	3,920

'write comment', and *skrive mening* 'write meaning' might be due to the nature of the corpus, whereas other combinations seem to be more neutral in terms of text type. Combinations like *forbeholde rett* 'reserve right', *legge vekt* 'put weight', *ta kontakt* 'contact', *stille krav* 'demand', *ta tid* 'take time', *sette pris* 'appreciate', *legge merke* 'notice', *finne sted* 'take place', *trenge hjelp* 'need help', *gi beskjed* 'tell' and *ta utgangspunkt* 'take as starting point' are intuitively very strongly associated combinations independently of context and text type. As mentioned in Section 3.1, it would certainly be interesting to do the study also based on other corpora in the future.

In addition to the overall collocational strengths of the combinations, it is interesting to take a look at how the collocational strength is distributed among the verbs. There is no established measurement for the overall collocational strength of the verbs in a corpus, and a range of different computations are of course possible. Below, the overall collocational strength of the verbs is measured in terms of the mean log-likelihood value of their verb–object combinations. If we exclude two verbs with extreme outliers, *forbeholde* 'reserve' (mean log-likelihood 146,771, see also above) and *sensurere* 'censor' (mean log-likelihood 7,931),[1] we end up with the statistics in Table 5.

The mean log-likelihood values are distributed among the verbs as shown in Figure 2. An interval of 50 has been used up to 400, thereafter an interval of 100 up to 1,000, and finally 1,000–4,000. We see that a mean value from 50 up to 300 is the most common, but also that the variation in mean collocational strength is relatively large, from a minimum of four up to almost 4,000 (excluding the two outliers discussed above).

A list of the verbs with the highest mean log-likelihood values is given in Table 6. When we throw a glance at the number of NP object types connected to these verbs, it is tempting to hypothesise a correlation between a high log-likelihood mean and a low number of objects. A Pearsons *r* calcuation of number of objects and log-likelihood mean for the material as a whole, however, comes out with as weak a correlation as –0.0067, which basically means an absence of correlation between the two variables. Hence, a verb occurring with few objects in the material is not more likely to have a high mean log-likelihood value than a verb occurring with a large range of objects.

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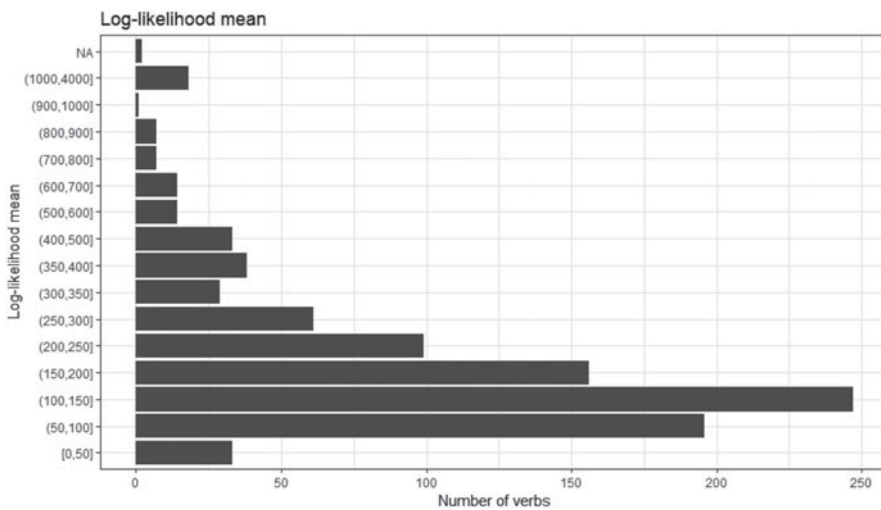
Table 6. Verbs with the highest mean log-likelihood values in their verb–object combinations.

Verb	Log-likelihood mean	No. objects	Verb	Log-likelihood mean	No. objects
leve 'live'	3,920	3	heade 'head'	1,025	4
ekspedere 'attend to'	2,289	1	stifte 'become aquainted'	1,006	2
bane 'pave'	2,152	1	skje 'happen'	966	1
si 'say'	1,734	24	tjene 'earn, serve'	863	12
vinke 'wave'	1,618	2	smile 'smile'	850	1
sitere 'cite'	1,512	4	avsi 'pronounce'	842	2
levne 'leave'	1,451	2	avbryte 'interrupt'	841	2
automatisere 'automate'	1,437	1	innfri 'fulfil'	818	2
fortelle 'tell'	1,428	11	angre 'regret'	810	1
ettertrakte 'desire'	1,324	1	fremme 'promote'	807	16
stille 'put'	1,315	26	tiltre 'take up'	782	2
trille 'role'	1,263	2	opptjene 'acquire'	781	1
fraskrive 'disclaim'	1,189	1	sone 'serve time'	770	3
fatte 'make, grab'	1,078	7	entre 'enter'	737	4
krysse 'cross'	1,072	9	time 'time'	712	1
diskutere 'discuss'	1,038	36	takke 'thank'	710	15



Note: The numbers separated by commas refer to the value intervals used in the diagram.

Figure 2. Mean log-likelihood values, distributed over verbs.

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4.1 Preliminary discussion

What do the results presented above tell us about verb–object combinations, primarily, and about the complementation of verbs in general? First, recurrent verb–object combinations, i.e. combinations passing the 10-occurrences threshold dominate usage; as noted above, the 5% of the types passing this threshold account for as many as 64% of the verb–object tokens. Secondly, the overall collocational strengths of the verbs, measured as the mean log-likelihood value of their verb–object combinations, is unequally distributed among the verbs. Hence, overall collocational strength is subject to great lexical variation.

Large-scale empirical studies of valency, both for verbs (Helbig & Schenkel 1973, Boas 2003, Herbst et al. 2004, Schumacher et al. 2004, Faulhaber 2011) and for polyvalent adjectives (Herbst 1983, Sommerfeldt & Schreiber 1983, Daugaard 2002, Haugen 2015), show that it is common for these valency carriers to occur in several different valency patterns. At the same time, these large-scale corpus investigations also suggest that the range of patterns in which individual valency carriers occur, is highly restricted and to a large extent idiosyncratic, also at the specificity level of grammatical categories such as NPs, PPs, clauses and infinitive constructions, which is normally the main focus in valency studies. Here, it has been demonstrated not only (i) that recurrent conventional combinations seem to dominate usage also at the level of concrete verb–object combinations but also (ii) that there is great variation in the overall collocational strength of the verb–object combinations of individual verbs. Valency and collocational preferences of the kind studied here indeed provide problems par excellance for any strict division between lexicon and grammar, as complementation is (i) found to a large extent to be lexically determined and (ii) to a large extent to be based on recurring concrete combinations.

In the following section some more detailled studies of individual verbs and closely related verb pairs will be presented.

5. Some individual verbs and verb pairs

We will now zoom in on some individual verbs and verb pairs. First, we will discuss the relationship between the open-choice principle and the idiom principle (Section 5.1), and then we will take a closer look at how collocational preferences can distinguish between semantically similar verbs (Section 5.2). As mentioned above, the more detailled studies presented in this section also provide some deeper evaluations of the extracted material. The verbs in the database are presented in tables with their NP objects sorted in descending order based on log-likelihood value, and the numbers and calculations are based on all the verb–object examplars extracted from the corpus. Hence, the tables display clusters of verb–object combinations for the individual verbs, and the mutual collocational strengths of the combinations. As we shall see, there is reason to argue that collocational preferences in concrete verb–object combinations need to be accounted for in the modelling of verbal complementation.

5.1 Open-choice vs. idiom principle

We will first consider the relationship between the open-choice and the idiom principle. An example of a verb whose objects seem to be almost entirely open choice is

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Table 7. The strongest object collocates of *mangle* 'lack'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
mangle	kunnskap 'knowledge'	206	6,573	4,335	2,490,957	817
mangle	spiller 'player'	102	6,573	3,174	2,490,957	327
mangle	dokumentasjon 'documentation'	52	6,573	806	2,490,957	236
mangle	kompetanse 'competence'	59	6,573	2,185	2,490,957	170
mangle	dybde 'depth'	27	6,573	256	2,490,957	149
mangle	data 'data'	40	6,573	1,071	2,490,957	139
mangle	overtramp 'violations'	14	6,573	23	2,490,957	136
mangle	vilje 'will'	38	6,573	1,010	2,490,957	133
mangle	stemme 'voice'	52	6,573	2,327	2,490,957	132
mangle	opplysning 'information'	48	6,573	1,963	2,490,957	129
mangle	gressklipper 'lawnmower'	13	6,573	28	2,490,957	116
mangle	arbeidskraft 'labor'	22	6,573	245	2,490,957	114
mangle	antirefleksbelegg 'anti-reflex-coating'	13	6,573	31	2,490,957	112
mangle	evne 'ability'	50	6,573	2,907	2,490,957	104
mangle	penge 'money'	91	6,573	10,090	2,490,957	96
mangle	spesialist 'specialist'	15	6,573	99	2,490,957	94
mangle	innsikt 'insight'	27	6,573	1,000	2,490,957	78
mangle	sidestykke 'parallel'	10	6,573	38	2,490,957	75
mangle	fart 'speed'	30	6,573	1,484	2,490,957	71
mangle	kvalifikasjon 'qualification'	12	6,573	107	2,490,957	68
mangle	gnist 'spark'	11	6,573	78	2,490,957	68
mangle	strategi 'strategy'	25	6,573	1,029	2,490,957	67
mangle	brikke 'piece'	16	6,573	299	2,490,957	67
mangle	presisjon 'precision'	11	6,573	91	2,490,957	64
mangle	tempo 'pace'	20	6,573	623	2,490,957	64
mangle	utstyr 'equipment'	27	6,573	1,343	2,490,957	63
mangle	selvinnsikt 'self-knowledge'	10	6,573	77	2,490,957	60
mangle	empati 'empathy'	10	6,573	82	2,490,957	58
mangle	navn 'name'	51	6,573	5,332	2,490,957	58
mangle	medisin 'medicine'	19	6,573	641	2,490,957	58

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

mangle 'lack', allthough there are considerable differences in association strength (measured in log-likelihood) between the collocates. The 30 strongest object collocates of this verb are provided in Table 7. The three collumns in the middle of the table give frequency of the combination (F1-2), frequency of the verb (F1), and

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frequency of the noun (F2), respectively. The basis for all calculations is the 2.49 million extracted tokens (N) in the verb–object dependency relation.

It is indeed difficult to come up with a noun that would not be possible in the object slot of this verb. However, also with *mangle* 'lack' there are idiomatic, less transparent combinations. An interesting example is *mangle sidestykke* 'be unparalleled':

(3) en militær aksjon som mangler sidestykke (NoWaC)
a military action which lacks parallel
'an unparalleled military action'

It is interesting to note, given the data in Table 7, that about 32% of the examples of *sidestykke* in the database co-occur with *mangle*. It is not conventional, for example, to say that something **har sidestykke* 'has a parallel'. There is, however, one other verb with which *sidestykke* is even more strongly associated, namely *savne* 'miss' (log-likelihood: 221), which accounts for the 68% remaining combinations with this noun in the material. Hence, the noun *sidestykke* shows a very strong tendency to co-occur with these two verbs. We also note that the idiomatic (in the sense of non-transparent) combination *mangle sidestykke* is not at all the strongest collocational preference of *mangle* (measured in log-likelihood). The strongest combination, *mangle kunnskap* 'lack knowledge' is both much more frequent (206 versus 10) and has a much higher log-likelihood value (817 versus 75), which means that log-likelihood does not target semantic non-transparent combinations specifically. Rather, the findings seem to be more in accordance with the broader understanding of idiomaticity in Sinclair's (1991) idiom principle, see the discussion in Section 2 above. Nevertheless, examplar clusters such as those in Table 7 seem to be a good point of departure to identify also non-transparent combinations.

Overall, the objects of the verb *mangle* 'lack' seem to be almost entirely open choice, however, and this verb has a relatively low mean log-likelihood value of 51, based on 103 object types. When we now turn to the verb *kaste* 'throw', we observe a higher incidence of idiomatic combinations among the strongest collocates, and this verb has a mean log-likelihood value of 315, based on 31 object types. We remember from Section 2 that the mean log-likelihood value of all verbs is 219 (see Table 5 above). As is evident from Table 8, the strongest collocates of *kaste* are included in idiomatic expressions like *kaste et blikk på noe* 'glance at something', *kaste lys over noe* 'shed light on something', and *kaste skygge over noe* 'cast a shadow over something', whereas the perhaps most prototypical use of *kaste*, as in *kaste stein* 'throw stone', occurs with a slightly lower value of association (log-likelihood).

Consider, however, also a combination like *kaste jakka* 'take off the jacket', which has an idiomatic flavour, but is not frequent enough (12) to get a very high log-likelihood score (56). Again, less transparent combinations are not necessarily the ones that are most strongly associated, although the strongest collocates of *kaste* are indeed idiomatic. Here is an example with *kaste jakka*:

(4) lufta er varm og god, og vi måtte kaste jakka. (NoWaC)
air.DEF is warm and good and we had.to throw jacket.DEF
'The air is nice and warm, and we had to take of our jackets.'

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Table 8. The strongest object collocates of *kaste* 'throw'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
kaste	blikk 'glance'	307	2,893	1,472	2,490,957	2,678
kaste	lys 'light'	192	2,893	2,339	2,490,957	1,285
kaste	skygge 'shadow'	115	2,893	352	2,490,957	1,115
kaste	glans 'shine'	96	2,893	187	2,490,957	1,042
kaste	stein 'stone'	114	2,893	579	2,490,957	972
kaste	terning 'dice'	53	2,893	189	2,490,957	493
kaste	kampestein 'boulder'	19	2,893	21	2,490,957	244
kaste	mat 'food'	61	2,893	3,459	2,490,957	220
kaste	ball 'ball'	83	2,893	8,967	2,490,957	202
kaste	brannfakkel 'firebrand'	17	2,893	27	2,490,957	194
kaste	hode 'head'	48	2,893	2,250	2,490,957	190
kaste	hemning 'inhibition'	21	2,893	103	2,490,957	180
kaste	kort 'card'	32	2,893	964	2,490,957	154
kaste	glass 'glass'	19	2,893	533	2,490,957	94
kaste	sten 'stone'	11	2,893	91	2,490,957	82
kaste	forbannelse 'curse'	10	2,893	59	2,490,957	82
kaste	pinne 'stick'	12	2,893	163	2,490,957	77
kaste	egg 'egg'	18	2,893	1,025	2,490,957	65
kaste	jakke 'jacket'	12	2,893	389	2,490,957	56
kaste	flue 'fly'	11	2,893	364	2,490,957	51
kaste	flaske 'bottle'	12	2,893	509	2,490,957	50
kaste	skjorte 'shirt'	10	2,893	346	2,490,957	45
kaste	dritt 'dritt'	10	2,893	485	2,490,957	39
kaste	sko 'shoe'	12	2,893	890	2,490,957	37
kaste	ting 'thing'	31	2,893	9,070	2,490,957	26
kaste	frispark 'free kick'	10	2,893	1,425	2,490,957	19
kaste	aksje 'stock'	11	2,893	1,800	2,490,957	19
kaste	folk 'people'	23	2,893	7,218	2,490,957	17
kaste	penge 'money'	27	2,893	10,090	2,490,957	15
kaste	rest 'rest'	10	2,893	1,969	2,490,957	14

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

To *kaste jakka* normally does not mean that you necessarily throw it at all, but rather that the jacket is simply taken off, and such meanings of specific verb–object combinations are hard to pin down if complementation is handled in terms of

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Table 9. The strongest object collocates of *avlegge* 'submit'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
avlegge	visitt 'visit'	38	214	57	2,490,957	646
avlegge	eksamen 'exam'	28	214	655	2,490,957	297
avlegge	ed 'oath'	20	214	160	2,490,957	256
avlegge	embetseksamen 'degree'	12	214	83	2,490,957	157
avlegge	stemme 'vote'	14	214	2,327	2,490,957	92
avlegge	doktorgrad 'ph.d.'	10	214	609	2,490,957	86
avlegge	rapport 'report'	11	214	2,834	2,490,957	63

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

general syntactic and/or semantic categories. As Sinclair (1991:71) argues, 'Intuitively, we feel that some instances of a word are quite independently chosen, while in other cases we feel that the word combines with others to deliver a single multi-word unit of meaning'. As we have already seen, however, and as we shall see below, collocational preferences are also found among combinations that are otherwise fully transparent, equally grammatical and equally understandable.

Finally in this section we will discuss a verb whose object slot seems to be very restricted, namely *avlegge* 'submit'. Even though the database is restricted to collocates that occur at least 10 times in NoWaC, and there are more objects attested with this verb than the ones represented among the strongest collocates, the data do suggest that the object slot is subject to very specific restrictions, which exemplar representations let us account for in a straightforward manner. For example, one can *avlegge sin stemme* 'vote', but one cannot **avlegge sin mening* 'give one's opinion'. Furthermore one can *avlegge rapport* 'report', but one cannot *avlegge informasjon* 'inform' or *avlegge en tekst* 'submit a text', for example. Hence, there are very specific restrictions on the nouns that can occur as objects with this verb, and the best description we can give might just be a list of the most significant exemplars, as provided in Table 9.

Even though *avlegge* 'submit' is more restricted in its range of objects (seven object types) than was the case with *kaste* 'throw' (31 object types), its strongest verb–object combinations are much less frequent than the strongest combinations of *kaste* 'throw', and the mean log-likelihood value of *avlegge* is also somewhat lower at 228, which is still considerably higher than the open-choice verb *mangle* 'lack', which we saw above has a mean log-likelihood value of 51. For these verbs, then, open-choice correlates with a low mean log-likelihood value, but it is not the case, as we also saw for the material as a whole in Section 4, that high mean log-likelihood necessarily correlates with a low number of object types. As we just saw, *avlegge* has a lower mean log-likelihood value than *kaste*. Consider also a case like *spille* 'play', which has a mean log-likelihood as high as 601, and which still occurs with 131 object types. This is due to very strongly associated combinations such as *spille rolle* 'play role' (log-likelihood 41,990), *spille kamp* 'play match' (log-likelihood 9,228), *spille fotball* 'play football' (log-likelihood 4,710), *spille hovedrolle* 'play leading part' (log-likelihood 2,971), and *spille musikk* 'play music' (log-likelihood 1,411) in the top part of the cluster,

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which result in a high mean log-likelihood value, despite the fact that the weakest combinations with this verb in fact have negative log-likelihood scores. Examples are combinations like *spille menneske* 'play human being' (log-likelihood –20) and *spille person* 'play person' (log-likelihood –22). In conclusion, it indeed seems that the degree of open choice versus idiomaticity has to be assessed based on the verb–object clusters of individual verbs, which underscores the large lexical variation discussed for the material as a whole in Section 4.

The limited studies of individual verbs and verb pairs presented in this section suggest that specifying complementation in terms of general syntactic and semantic categories does not suffice to account for verbal complementation as attested in usage. Collocational preferences seem to be of great importance, also for syntactic combinations that are normally accounted for at the grammatical pole of the lexicon-grammar. As Sinclair (1991) argues, the idiom principle might be more important in language than the open-choice principle. We will see this more clearly when we consider closely related alternatives with semantically similar verbs in the following section.

5.2 Differences between semantically similar verbs

Verb–object collocations are very useful in distinguishing among semantically similar verbs. Consider for example the verbs in Table 10, *bytte* and *skifte*, both meaning 'change', which are intuitively very close in meaning.

The verb *bytte* occurs with 22 objects passing the 10-occurrences threshold, whereas *skifte* occurs with 18 such objects. Out of these, four nouns are common, whereas the rest differ between the two verbs. This already provides a good basis for distinguishing between them.

Let us start with some of the collocates that differ among the two verbs. Consider first the combination *skifte retning* 'change direction', which is much more conventional with *skifte* than with *bytte*:

(5) a. Frisparket skifter retning. (NoWaC)
free-kick.DEF changes direction
'The ball changes direction.'
b. ?Frisparket bytter retning.
free-kick.DEF changes direction

The same is true for the combination *skifte mening* 'change opinion':

(6) a. Underveis skifter han imidlertid mening. (NoWaC)
along.the.way changes he however opinion
'Along the way, however, he changes his mind.'
b. ?Underveis bytter han imidlertid mening.
along.the.way changes he however opinion

Preferences such as those in (5) and (6) above involve alternatives that are fully grammatical, semantically transparent, and fully understandable. Still, the (a)-alternatives are clearly preferred in both cases, and preferences such as these need to be accounted for. As Goldberg (2019) argues, people treat language as a normative

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Table 10. The strongest object collocates of the verbs *bytte* and *skifte*, both meaning 'change'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
bytte	bank 'bank'	144	1,887	663	2,490,957	1,387
bytte	plass 'place'	125	1,887	8,337	2,490,957	518
bytte	navn 'name'	82	1,887	5,332	2,490,957	342
bytte	harddisk 'harddisk'	18	1,887	258	2,490,957	129
bytte	flue 'fly'	14	1,887	101	2,490,957	120
bytte	klubb 'club'	23	1,887	1,054	2,490,957	111
bytte	vann 'water'	28	1,887	2,915	2,490,957	91
bytte	side 'side'	30	1,887	5,413	2,490,957	68
bytte	keeper 'keeper'	12	1,887	476	2,490,957	61
bytte	farge 'colour'	16	1,887	1,959	2,490,957	47
bytte	jobb 'job'	20	1,887	4,019	2,490,957	42
bytte	batteri 'battery'	10	1,887	661	2,490,957	41
bytte	hest 'horse'	13	1,887	1,809	2,490,957	35
bytte	spiller 'player'	16	1,887	3,174	2,490,957	34
bytte	skole 'school'	11	1,887	1,783	2,490,957	27
bytte	aksje 'stock'	11	1,887	1,800	2,490,957	27
bytte	uke 'week'	15	1,887	5,296	2,490,957	18
bytte	stilling 'position'	10	1,887	2,435	2,490,957	18
bytte	dag 'day'	22	1,887	10,276	2,490,957	17
bytte	ord 'word'	12	1,887	5,222	2,490,957	11
bytte	rolle 'role'	14	1,887	8,621	2,490,957	6
bytte	ting 'thing'	10	1,887	9,070	2,490,957	1
skifte	navn 'name'	296	1,556	5,332	2,490,957	2,146
skifte	farge 'colour'	95	1,556	1,959	2,490,957	650
skifte	retning 'direction'	48	1,556	673	2,490,957	365
skifte	beite 'graze'	17	1,556	45	2,490,957	191
skifte	karakter 'character'	34	1,556	1,800	2,490,957	167
skifte	kanal 'channel'	22	1,556	501	2,490,957	145
skifte	eier 'owner'	21	1,556	561	2,490,957	132
skifte	bleie 'diaper'	12	1,556	71	2,490,957	113
skifte	jobb 'job'	29	1,556	4,019	2,490,957	90
skifte	dekk 'tyre'	12	1,556	209	2,490,957	86
skifte	mening 'meaning'	34	1,556	8,207	2,490,957	72

(*Continued*)

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Table 10. (*Continued*)

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
skifte	fokus 'focus'	23	1,556	3,661	2,490,957	65
skifte	taktikk 'tactics'	10	1,556	257	2,490,957	63
skifte	stilling 'position'	19	1,556	2,435	2,490,957	61
skifte	tema 'subject'	15	1,556	1,992	2,490,957	47
skifte	time 'hour'	12	1,556	4,796	2,490,957	15
skifte	plass 'place'	12	1,556	8,337	2,490,957	6
skifte	tid 'time'	12	1,556	25,285	2,490,957	-1

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

enterprise. As members of a speech community, we normally strive to talk the way others do, and we are able to judge utterances as more or less in accordance with conventional usage in the speech community.

Psychologically, Goldberg (2019 and elsewhere) argues that we can distinguish between closely related constructions based on what she calls statistical preemption, which seems to fit nicely with preferences between alternatives such as those in (5) and (6). Statistical preemption is hypothesised to happen when two different constructions compete to convey the same meaning in the same context. In such cases, the more entrenched alternative will be felt to be the right, more conventional way of expressing the meaning in point, even though both alternatives are equally grammatical and understandable. For Goldberg, statistical preemption is used to explain the partial productivity of verbs in different ranges of argument structure constructions, and it might be an interesting mehanism to account also for alternatives among closely related examplar clusters within the same argument structure construction, of the kind we have studied in this section. Hence, the reason we prefer *skifte mening* 'change opinion' (log-likelihood 72) instead of *bytte mening* (not attested in the material) might be due to statistical preemption.

In the cases we have discussed, intuitional preferences seem to coincide with association measures, which suggests that collocation analyses might be an interesting point of departure for exploring the mutual strength of exemplar representations, also in terms of mental representations. Combinations with strong collocational associations tend also to be intuitively more conventional than the same objects with the alternative verb.

As already mentioned, there are also some strong object collocates that are common among the two verbs. As we see in Table 10, the nouns *plass* 'place', *navn* 'name', *jobb* 'job', and *stilling* 'position' all turn up among the strongest collocates of both verbs. For the combination *bytte plass* 'change place' (log-likelihood 518) the association is much stronger than is the case for *skifte plass* 'change place' (log-likelihood 6), and there is also an intuitive difference in preference among these alternatives.

For the remaining common objects, however, *navn* 'name', *jobb* 'job', and *stilling* 'position', they seem to a much higher extent to be equally conventional alternatives, and more specific contexts are needed to distinguish between them. Starting with

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the object *navn*, we see that this object is both more frequent with *skifte* than with *bytte* (296 versus 82 occurrences) and has a much stronger log-likelihood (2,146 versus 382). On the other hand, *navn* is a highly ranked object of both verbs (1 versus 3) and, intuitively, both alternatives are at least close to equally conventional according to the native speaker intuition of the author, perhaps with a slight preference for *skifte navn*. A slight preference is also felt for *skifte stilling* (19 occurrences, log-likelihood 61) over *bytte stilling* (10 occurrences, log-likelihood 18), whereas *bytte jobb* (20 occurrenes, log-likelihood 42) and *skifte jobb* (29 occurrences, log-likelihood 90) seem intuitively very hard to separate in many contexts. A context where these alternatives are not interchangable, however, is if I ask *Skal vi bytte jobb?* 'Do you want to change jobs?', which can mean a mutual exchange of jobs, whereas this is not possible with *Skal vi skifte jobb?* 'Do you want to change jobs?', which can only mean that we both change to different jobs that none of us have at the moment of speaking. Even though close to equal alternatives exist, however, we can certainly distinguish between *bytte* and *skifte* on the basis of their strongest object collocations.

Finally, also with the verbs in this section we find strongly idiomatic, non-transparent combinations; the collocate *beite* 'graze' of *skifte* is a case in point:

(7) No har ho skifta beite. (NoWaC)
now has she changed graze
'Now, she has changed her job.'

Let us now consider another verb pair, namely *anvende* and *benytte*, both meaning 'make use of', see Table 11. These are also semantically very similar verbs, but the database suggests that the latter collocates strongly with objects such as *anledning* 'occasion' and *sjanse* 'chanse', which are not associated with the former.

Some examples are provided in (8):

(8) a. Resten av spillerne benytter sjansen til å ta
rest.DEF of players.DEF use chance.DEF to to take
en drikkepause. (NoWaC)
a drink.break
'The rest of the players take the opportunity to drink.'

b. ?Resten av spillerne anvender sjansen til å ta
rest.DEF of players.DEF use chance.DEF to to take
en drikkepause.
a drink.break

c. Benytt anledningen til å se denne klassikeren. (NoWaC)
use occasion.DEF to to see this classic.DEF
'Take the opportunity to see this classic.'

d. ?Anvend anledningen til å se denne klassikeren.
use occasion.DEF to to see this classic.DEF

Native speakers of Norwegian are very unlikely to produce utterances such as those in (8b, d), which demonstrates that they probably have access to exemplar-level complementation preferences for these verbs.

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Table 11. The strongest object collocates of *anvende* and *benytte*, both meaning 'make use of'.

Lemma1	Lemma2	F1-2	F1	F2	N	Log-likelihood
anvende	kunstnerleksikon 'artist encyclopedia'	24	502	24	2,490,957	410
anvende	karakterskala 'grading scale'	13	502	45	2,490,957	168
anvende	forskning 'research'	20	502	1,264	2,490,957	136
anvende	kunnskap 'knowledge'	21	502	4,335	2,490,957	94
anvende	begrep 'concept'	12	502	1,127	2,490,957	72
anvende	teori 'theory'	11	502	1,289	2,490,957	61
anvende	metode 'method'	11	502	1,456	2,490,957	59
anvende	penge 'money'	11	502	10,090	2,490,957	19
benytte	anledning 'occasion'	1,251	5,837	3,636	2,490,957	10,770
benytte	bokstavkarakter 'letter grade'	121	5,837	143	2,490,957	1,345
benytte	sjanse 'chance'	221	5,837	6,479	2,490,957	786
benytte	sensor 'examiner'	47	5,837	283	2,490,957	316
benytte	metode 'method'	70	5,837	1,456	2,490,957	294
benytte	teknologi 'technology'	43	5,837	978	2,490,957	173
benytte	karakterskala 'grading scale'	19	5,837	45	2,490,957	169
benytte	ridning 'riding'	18	5,837	41	2,490,957	162
benytte	begrep 'concept'	43	5,837	1,127	2,490,957	161

F1-2 = frequency of verb + noun, F1 = frequency of verb, F2 = frequency of noun, N = verb–object tokens

Summing up, we have seen in our zooming in on a few individual verbs and verb pairs, that although the variation among verbs is considerable, the idiom principle seems to play an important role in verbal complementation. Due to the great variation, however, it seems clear that the assessment of the relationship between the open-choice and the idiom principle needs to be carried out on the basis of detailed studies of individual verbs. We have also seen that studying the exemplar clusters of semantically similar verbs allows us to specify the differences between them in a way that would be difficult on the basis of abstract semantic categories. The comparison of closely related verb pairs also highlights the fact that clear collocational preferences are found between alternatives that are otherwise fully grammatical, semantically transparent and equally understandable.

6. Concluding remarks

In this article, a database of verb–object combinations semi-automatically extracted from a large electronic corpus has been presented. A database of this kind could be of interest not only to theoretically oriented linguists, but also to lexicographers and language teachers. While we have concentrated on extraction of verbal complements, similar extractions can be used to retrieve additional datasets for other important linguistic patterns, such as adjective–noun combinations. A great part

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of the merit is due to a number of freely available tools for NLP and to freely available resources for Norwegian: NoWaC, the NDT treebank, the Oslo–Bergen tagger, Maltparser and the UCS toolkit.

The database has been used to explore a bottom–up approach to verbal complementation in terms of specific verb–object combinations. Following Herbst (2010), it has beed argued that valency and collocations refer to closely related phenomenon in language, differing mainly in their level of abstractness. As large-scale valency studies have shown, verbs normally appear in a range of different valency patterns; at the same time, however, such patterns are to a large extent idiosyncratically restricted, which means that verbal complementation seems to a high degree to be lexically determined. The overall importance also of collocational preferences in verb–object combinations is clearly demonstrated by the fact that the 26,425 verb–object types passing the 10-occurrences threshold (in the filtered, raw material), which amounts to 5% of the verb–object types, account for as much as 64% of the 2.5 million tokens we started out with. It has also been demonstrated that the collocational strength of individual verbs, measured in terms of the mean log-likelihood values of their verb–object combinations, is subject to great variation.

In addition to the overall importance of recurring combinations, we have explored the verb–object combinations of some individual verbs and some verb pairs. Clearly, collocational preferences in usage, as represented in the corpus, play an important role in verb–object combinations. In the cases we have explored in depth, it also seems safe to assume that speakers do distinguish between and prefer certain conventional verb–object combinations to other equally grammatical, equally transparent and equally understandable alternatives, and that speakers have access to complementation information at the level of exemplars. Hence, rich memory of specific verb–object combinations seem to be needed in a plausible account of complementation. Needless to say, however, it remains to be explored to what extent measured collocational associations are in accordance with speaker intuitions for the material as a whole.

The database of verb–object combinations constitutes a solid empirical basis for accurate descriptions of the differences between semantically similar transitive verbs, and measures of collocational strength allow us to model the mutual strength between the exemplars in the clusters. In my view, exemplar clusters of the strongest noun collocates of verbs can yield more accurate descriptions of verb–object combinations than approaches operating with general syntactic and/or semantic features only, and I would argue that the role of collocational preferences in grammatical relations should be explored further also for a language like Norwegian.

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Note

1 The verb *forbeholde* 'reserve' occurs in the material only with the object *rett* right, which is very frequent in the expression *forbeholde NP rett* 'reserve the right' which yields a very high log-likelihood mean. For *sensurere* 'censor', which occurs with two different objects in the material, the high mean is due to the combination *sensurere sexblogg* 'censor sex blog', which is a strong collocation in the corpus.

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Appendix. The verbs removed in the cleaning of the data

Table A1. List of intransitive and transitive verbs removed in the cleaned data.

Intransitive				Transitive
ake	forbli	kunne	sole	adskille
ale	fordampe	kverulere	sove	beslutte
ande	forekomme	kyle	spane	bone
ante	foreligge	late	sprite	borde
arbeide	forholde	lenke	stage	datere
ase	forsere	less	stamme	ekte
avansere	forske	lest	stige	forpakte
base	forsvinne	lete	stinke	forvirre
bate	fungere	ligge	stupe	frakoble
befinne	funke	lite	sukke	frigi
bidra	fyke	live	summe	gomle
bla	gange	loe	suse	greie
bli	gifte	lyve	sva	hele
blomstre	gire	marsjere	svirre	herpe
bo	glefse	maste	syne	innsende
bolne	glimre	matte	synes	kjemme
bone	haste	megle	synke	ligne
borde	hauge	meine	syte	likne
bortkaste	havne	meske	taxe	lose
burde	heie	minne	tennes	lyde
by	hekke	omkomme	tikke	mette
dale	helde	oppholde	tilbakelegge	more
dalle	helge	opptre	tille	mose
delta	henvende	psyke	times	opplyse
dette	herje	rage	titte	oppstarte
disputere	herske	rase	tordne	prime
done	hete	reagere	trave	prove
dreie	hipe	rede	trenges	providere
due	hope	regne	trives	relatere
duge	horse	renne	trone	rocke
dukke	huge	reve	trylle	signe
eksistere	idest	rinne	tulle	skrape

(*Continued*)

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Table A1. (*Continued*)

Intransitive				Transitive
eksplodere	innbringe	ryke	type	sminke
ene	inntreffe	rykke	ugle	spa
ese	ise	sake	utebli	spende
eve	isne	sale	utkomme	stable
falle	jukse	sees	vaie	style
fallere	kikke	ses	vandre	tilse
false	kille	ska	vanke	tro
fare	kjefte	skamme	vare	tru
faste	klage	skilles	vedde	utheve
feile	kollapse	skinne	venne	utligne
fenge	kollidere	skreve	ville	utlikne
file	komme	skue	vime	utvelge
finnes	konkludere	skulle	virke	vekte
flykte	kose	slite	vokse	
fokusere				

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