Alternation-based generalizations are stored in the mental grammar: Evidence from a sorting task experiment*

FLORENT PEREK

Abstract

According to constructional approaches, grammar consists of an inventory of symbolic pairings of a syntactic form with an abstract meaning. Many of such so-called constructions can be perceived as having highly similar meanings: such pairs have been discussed under the name of alternations, especially in the domain of argument structure, for example the widely documented dative alternation (e.g. John gave Mary a book *vs.* John gave a book to Mary*). This paper explores what status such pairs of constructions can be given in construction grammar, on the basis of a sorting task experiment.*

Construction grammar traditionally recognizes generalizations of a common syntactic form over semantically similar sentences, but the status of higher-level generalizations of a common meaning over syntactically different forms is rarely discussed. In our study, we devised a sorting task that subjects could resolve by relying on generalizations of either of these two kinds. We find that subjects rely on alternation-based generalizations more often than purely constructional ones in their sorting behavior. We suggest these results show that generalizations of a common meaning between formally different constructions are plausible categories stored by speakers and should be given more attention in construction grammar research.

Keywords: *construction grammar; argument structure; alternations; generalizations; sorting task.*

1. Introduction: syntactic alternations and construction grammar

Languages are replete with pairs of syntactic constructions that are semantically similar and can accommodate a common set of lexical items to fulfill roughly

* Email: ⟨florent.perek@frias.uni-freiburg.de⟩.

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equivalent functions.[1] Countless examples from various domains of syntax can be cited, but in no research area have such pairs received more attention than in the study of argument structure. So-called ARGUMENT STRUCTURE ALTERNATIONS capture the notion that some verbs can be used with different syntactic realizations of the same set of arguments.[2] The dative alternation and the locative alternation in English are classic examples of such phenomena. The dative alternation offers two different ways to encode events of transfer of a theme to a recipient, either in a physical sense (e.g. with *give*) or in an abstract sense (e.g. with verbs of communication like *tell*).[3] For many verbs describing such events, the theme and recipient arguments can be realized either as two post-verbal noun phrases (the ditransitive or double-object variant), as in (1a) and (2a) below, or as a post-verbal noun phrase and a prepositional phrase headed by *to* (the *to*-dative or prepositional dative variant), as in (1b) and (2b).

(1) a. Mary gave John a book.
    b. Mary gave a book to John.

(2) a. John told Mary a joke.
    b. John told a joke to Mary.

The variants of the dative alternation clearly share much of their respective meanings and can be largely seen as paraphrases, although they do present subtle semantic differences. Most notably, the ditransitive variant is often argued to be the only 'truly dative' variant, while the *to*-dative variant is considered as a locative construction primarily describing caused motion (cf. Pinker 1989, Goldberg 1995). Hence, in the ditransitive variant, the first NP argument is a true recipient and therefore must be animate, while in the other variant, the referent of the prepositional phrase is rather a goal argument, which with some verbs may take a recipient interpretation in case it is animate. When both variants are available, they are often interchangeable, and the choice of one variant in a given situation has been shown to depend on various properties of the alternating arguments themselves, such as their discourse accessibility (given vs. new) and their relative lengths; cf. *inter alia* Collins (1995), Bresnan et al. (2007) and the references therein.

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2. See Guerrero Medina (2011) for many studies of argument structure alternations within various modern frameworks.

3. With the proviso that many lexical items can be used with only one of these constructions, even when both combinations would make perfect sense. The problem of such cases of partial productivity does however not concern us here.

The locative alternation[4] displays similar properties, in that it offers two different ways of encoding an event of caused change of location of some object, called the theme. In one variant (hereafter the locative variant), the theme is realized as the direct object and the location is mentioned in a path expression (typically a prepositional phrase); cf. (3a) and (4a). In the other variant (hereafter the *with*-variant), the location is realized as the direct object and the theme as a prepositional phrase headed by *with*; cf. (3b) and (4b).

(3) a. John sprayed paint onto the wall.
b. John sprayed the wall with paint.

(4) a. John loaded hay into the truck.
b. John loaded the truck with hay.

More so than the dative alternation, the locative alternation seems to involve a tangible difference in meaning. The sentence pairs (3) and (4) exemplify the so-called "holistic/partitive effect", described by Anderson (1971: 389) as "a matter of whether the whole of something is affected by the action described by the sentence, or just a part of it is affected". In other words, the *with*-variant triggers a holistic interpretation implying that the location has been totally affected, whereas it need not be in the other variant. Hence, (3b) implies that the wall is totally covered with paint, and (4b) implies that the truck is full of hay.

While such comments are in order for these two examples, the correlation of the *with*-variant with the holistic effect has probably been overstated in earlier treatments of the alternation, as there exist similar pairs of sentences for which the holistic interpretation is not the relevant semantic difference. Jeffries and Willis (1984: 717) note that "the holistic/partitive relationship can be readily neutralised simply by [. . .] choosing different lexical items to fill the NP slots". They report the following pairs of sentences:

(5) a. The English boy sprinkled the hot water with tea.
b. The Japanese boy sprinkled tea on the hot water.

(6) a. The fireman sprayed the fire with water.
b. The fireman sprayed water on the fire.

In the *with*-variants (5a) and (6a), it is hard to imagine how the location argument could be more affected than in the locative variants (5b) and (6b). Jeffries

4. What we refer to here as the locative alternation is actually known in the literature as the *spray/load* alternation, thus named with reference to the two verbs that are commonly used to illustrate it. The *spray/load* alternation is one member of a family of several so-called locative alternations (cf. Levin 1993: 2.3) that offer different ways of encoding events of motion of a theme vis-à-vis some location. For the sake of simplicity, we will use the term 'locative alternation' to refer exclusively to the *spray/load* alternation throughout this article.

and Willis argue that this is because of our world knowledge of the objects denoted by the NPs. The scenario of tea making evoked by sentences (5a) and (5b) "causes us to envisage a restricted surface area of hot water which would most likely be covered by tea in both instances" (Jeffries and Willis 1984: 717). Similarly, (6a) and (6b) are both compatible with an outcome in which most of the fire did not get any water on it, because "fires do not have well defined edges and the question of whether the whole fire is affected is difficult to answer" (1984: 718).

Such cases show that the holistic effect is not inherently associated with the *with*-construction; otherwise examples (5a) and (6a) would be semantically incoherent. Yet, this does not imply that the variants of the locative alternation are synonymous constructions. They do differ semantically, but the difference lies at a more abstract level, in that the variants of the locative alternation describe the same event but reflect a different construal of this event. The locative variant construes the event as an action by the agent on the theme, causing it to move, whereas the *with*-variant construes it as an action affecting the location, and the motion of the theme is merely the means whereby this effect is brought about. The latter construal calls for a significant effect that the agent intends to bring about on the location, but this effect does not always relate to the spatial extent of the final configuration of the theme vis-à-vis the location, as in the wall-painting scenario of (3b) and the truck-loading scenario of (4b). In (5a), the intended effect is turning water into tea; in (6a), it is the extinguishing of the fire. On this account, the holistic interpretation can be seen as a mere pragmatic effect of each construal. In sum, the variants of the locative alternation share a substantial part of their constructional meaning, and can be largely seen as two constructional options for the description of events of caused motion involving alternate construals.

This paper addresses the question of how such pairs of semantically related constructions should be dealt with in construction grammar. In most constructional models of argument structure, alternations as such have no independent theoretical status. This is in striking contrast with earlier transformational (e.g. Larson 1988) or lexicalist (e.g. Jackendoff 1975, Pinker 1989) accounts, in which specific operations were posited to derive one variant of an alternation from the other variant. Construction grammarians strongly argue against derivational accounts (whether those derivations are at the syntactic or semantic level) and instead put forward a monostratal view of grammar, in which linguistic forms of any degree of schematicity are directly paired with meaning. Hence, variants of an alternation are seen as independent constructions, i.e. they are pairings of a different syntactic form with a (usually) different abstract meaning, and whether a verb is said to enter into an alternation depends on whether it is semantically compatible with both constructions (see for example Ruiz de Mendoza Ibáñez and Mairal Usón [2011] for a detailed account of the

English causative alternation along these lines). This position is clearly stated in Goldberg's (2002: 329) *surface generalizations hypothesis*:

> There are typically broader syntactic and semantic generalizations associated with a surface form than exist between the same surface form and a distinct form that it is hypothesized to be syntactically or semantically derived from.

In other words, Goldberg emphasizes the importance of generalizations based on the same form and meaning, but downplays generalizations over formally different patterns, even if they can be shown to be semantically and/or syntactically related. She therefore takes a strong stance against derivational theories, in line with the commitments of construction grammar. Following the surface generalization hypothesis, most research in construction grammar focuses on contrasting alternating constructions, by showing in which respect(s) they differ, at the semantic as well as discursive levels (e.g. Gries 2003). But few models try to capture their similarity, and the alternation itself is rarely considered as more than a mere pre-theoretical observation.

While we agree that it is important to describe constructions in their own right, we may still wonder whether a grammar containing only independent constructions provides an accurate picture of speakers' linguistic knowledge. Surely, speakers are aware that there can be different ways to convey the same message, and use this knowledge wittingly. But a construction grammar focusing exclusively on the constructions and disregarding possible relations between them fails to capture that knowledge. A similar observation is made by Cappelle (2006):

> [. . .] by averting our attention from regular alternations in a language (to focus on the poles of the alternations only), we may fail to represent an important component of the language user's linguistic knowledge. This would be a serious shortcoming of Construction Grammar, which advertises itself as a theory within which all linguistic data of a language can be accommodated: "To adopt a constructional approach is to undertake a commitment in principle to account for the entirety of each language" (Kay and Fillmore 1999: 1).

Goldberg herself (2002) does not totally deny paraphrase relations (which is basically what many alternations are) any role in grammar or language use. She acknowledges that their "statistical use [. . .] in actual discourse contexts is critical to unlocking Baker's paradox of partial productivity",[5] and that they

5. Goldberg is referring here to the mechanism of statistical preemption, proposed to explain how children figure out that a verb cannot occur in some argument structure in view of its repeated use in another less felicitous structure. See Goldberg (2006: 5.1) and Goldberg (2011) for more details.

"can also be seen to be relevant to on-line choices made in production" (Goldberg 2002: 329). Thus, there does seem to be room in construction grammar for generalizations over formally different constructions. As a matter of fact, proposals to integrate alternations in constructional representations are not unheard of. For example, Goldberg (1995: 91) posits a link of "S-synonymy" between the variants of the dative alternation. Although little is said about what such links truly are, how they emerge and what role they play in grammar, language use and language development, they do capture the speakers' awareness that two constructions have the same "descriptive" meaning, i.e. that they can be used to describe the same set of situations. Along the same lines, Cappelle (2006: 18) proposes to describe the (near-)equivalence of constructions by modeling them as "allostructions", defined as "variant structural realizations of a construction that is left partially underspecified" (we return to Cappelle's proposal in the concluding section of this article). But apart from these rare exceptions, very few construction grammarians consider generalizations based on alternation relations.

In this paper, we add to this line of research by presenting empirical evidence that alternations should be considered part and parcel of grammar, in the sense that generalizations over formally distinct constructions expressing similar kinds of events are plausibly stored along with generalizations based on surface similarity in both form and meaning. We devised a sorting task experiment, in which native speakers were asked to sort sentences into groups according to their overall meaning. The set of sentences to be sorted contains both construction-based and alternation-based generalizations as possible sorting strategies, and the instructions forced subjects to make a choice between either kind of generalization. As our results show, not only do speakers readily perceive the semantic similarity between variants of an alternation and use it to form an alternation-based group, but they chose this kind of strategy strikingly more often than that based on simple constructional generalizations. While the question of the cognitive reality of alternation-based generalizations should certainly be addressed with additional kinds of evidence, the results of our study suggest that such generalizations over formally different constructions constitute coherent and perceptible categories that might well be part of a speaker's linguistic knowledge.

In the next section, we present an earlier sorting task experiment by Bencini and Goldberg (2000), which inspired our own study. Bencini and Goldberg investigated whether the semantics of constructions is a significant determinant of sentence meaning, along with verbs. In Section 3, we present our own experiment, which consists of an adaptation of Bencini and Goldberg's (2000) study with a different kind of dataset, to test whether a generalization based on an alternation can be another significant determinant of sentence meaning, along with purely constructional generalizations. We conclude in Section 4 that

the results of our experiment are better accounted for by a grammar which contains alternation-based generalizations.

2. Constructions as a sorting criterion

Bencini and Goldberg (2000) question the common assumption that the verb is the main determinant of sentence meaning. They cite an earlier study by Healy and Miller (1970), who compared the relative contribution of verbs and subject arguments to sentence meaning through a sorting task experiment. Healy and Miller created twenty-five sentences by crossing five transitive verbs with five subject arguments; all sentences had the same patient argument. They then asked participants to sort the sentences according to their similarity in meaning, and found that participants sorted sentences together more often when they had the same verb than when they had the same subject argument. Healy and Miller conclude that the verb is the main determinant of sentence meaning.

However, Healy and Miller did not consider another possible source of meaning beside verbs: the syntactic construction with which the verb is used. In construction grammar (Goldberg 1995; 2006), constructions convey meaning independently of the verbs embedded in them. Sentences with the same construction thus constitute a coherent semantic category. If constructions indeed contribute aspects of meaning to the sentence, it is expected that speakers in a semantic sorting task similar to Healy and Miller's (1970) would group together sentences with the same construction.

To test this hypothesis, Bencini and Goldberg (2000) reproduced Healy and Miller's (1970) experiment with a different set of stimuli: they crossed four verbs chosen from different semantic fields (*get*, *slice*, *take*, *throw*) with four constructions (the transitive construction, the ditransitive construction, the caused-motion construction and the resultative construction). The semantic divergence between verbs insured that subjects could not plausibly resort to some shared aspects of verbal meaning to put sentences with different verbs in the same category.

They asked seventeen native speakers of English to sort the sixteen sentences into four groups. It is clear that subjects can use two sorting strategies: either to rely on the meaning of verbs which is shared between instances of that verb in different constructions, or to rely on the meaning of constructions (hypothesized by construction grammar), which is shared by instances of that construction with different verbs.

They found that many subjects do sort by constructions, even more so when they are explicitly reminded in the instructions that expressions with the same words can mean various different things. Gries and Wulff (2005) obtained similar results from a replication of this experiment with native speakers of German learning English as a foreign language. These findings suggest that

verbs are not the sole determinants of sentence meaning, and Bencini and Goldberg conclude that "constructions are psychologically real linguistic categories that speakers use in comprehension" (p. 649–650).

3. Alternations as a sorting criterion

In our study, we used the same experimental paradigm as Bencini and Goldberg (2000) with a different set of sentences which includes the factor of alternations: specifically, instead of contrasting verbal vs. constructional sorting, we investigated whether the presence of possible alternation relations has an influence on the way speakers categorize sentences.

3.1. *Hypotheses*

The experiment presented in this section weighs the relative likelihood of two competing hypotheses on the kind of generalizations that grammar contains: the constructional hypothesis and the alternations hypothesis.

The **constructional hypothesis** predicts that there are only construction-based generalizations. The semantic similarity between variants of an alternation may be noticed by speakers, but it does not lead to the storing of a generalization. Contructional generalizations over expressions which share aspects of both form and meaning are in any case more robust than generalizations over different forms and (possibly) slightly different (yet related) meanings.

The **alternations hypothesis** predicts that there are also alternation-based generalizations in the mental grammar of speakers (like Goldberg's [1995] synonymy links or Cappelle's [2006] allostructions). Such generalizations are based on semantic similarities between formally distinct constructions and capture the fact that a given event type may be expressed in various ways. They constitute a higher level of generalization than regular constructions, and may be involved in language processing, development, and change.

3.2. *Stimuli*

Our stimuli set is based of four sentence types related by two alternations: (i) the ditransitive and the *to*-dative constructions, related by the aforementioned dative alternation, and (ii) the caused-motion and the *with*-applicative constructions, related by the locative alternation. Importantly, these four sentence types instantiate only three constructions from the perspective of construction grammar, since *to*-datives are arguably metaphorical uses of the more general caused-motion construction, relying on the construal of transfer of ownership as physical transfer (cf. Goldberg 1995: 3.4.2). The four sentence types and the relations holding between them (either through constructional inheritance or alternations) are represented in Figure 1. We created four sentences of each type.

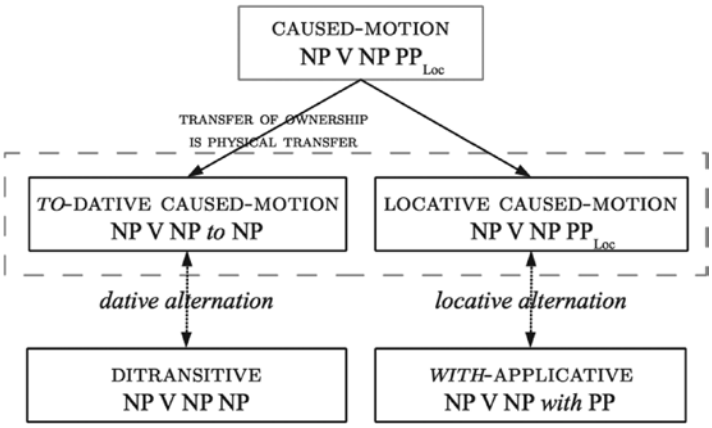

Figure 1. *Constructions and alternations in our stimuli set*

Now, how should we use this dataset to obtain evidence for either of the hypotheses given in Section 3.1? If we leave the number of possible sorting categories open, subjects will probably sort according to the four sentence types or perhaps make even finer-grained distinctions. But this is not likely to help us discriminate between the two hypotheses. We must force them to make more abstract generalizations, at a level where they would have to rely on the similarity between instances of a construction or of variants of an alternation, and thus instruct them to sort sentences into a given, and fairly limited, number of groups. Since, as we mentioned earlier, the dataset consists of at most three constructions (in the strict sense, i.e. abstraction of the *same* form and meaning), a sensible option would be to ask them to make three groups. Given this instruction, the constructional generalization over the *to*-datives and locative caused-motion sentences is liable to be noticed by subjects, which would promote a group following this generalization. But the semantic generalization over variants of either alternation might be more readily available, and a group containing formally distinct constructions might be preferred over a caused-motion group relying on a possibly weaker generalization. The extent to which subjects rely on either of these expected sorting strategies should allow us to decide which of the two hypotheses is more likely. According to the constructional hypothesis, there are only construction-based generalizations; subjects might see the similarity between the variants of an alternation, but the constructional generalization should be more directly available and stronger. Thus, most subjects should sort the locative caused-motion and *to*-dative sentences together. Under the alternation hypothesis, there are also alternation-based generalizations; subjects should thus easily see the possible generalization between instances of variants of an alternation, and prefer this generalization if

Table 1. *Stimuli set for the sorting task*

ditransitive	*to*-dative	caused-motion	*with*-applicative
Kim lent Rose something.	Audrey kicked something to Sue.	Lyn splashed something on Maggie.	Dana plastered Marge with something.
Barbara served Claire something.	Nancy threw something to Juliet.	Michelle sprinkled something over Sarah.	Pat rubbed Helen with something.
Paula passed Liz something.	Rachel tossed something to Anna.	Linda sprayed something on Jessica.	Meg brushed Shannon with something.
Anita offered Kate something.	Jennifer chucked something to Tara.	Beth injected something into Lisa	Laura dabbed Jane with something.

they find it stronger than the purely constructional one. Hence, many subjects (if not most) should sort together either the ditransitives and the *to*-datives, or the caused-motion and the *with*-applicative sentences.

The sixteen sentences of our stimuli set can be found in Table 1, sorted by sentence type. As can be seen in this table, we tried to keep the differences between sentences to a minimum by reducing the variability in the expression of the three arguments, in order to prevent subjects from focusing on irrelevant sorting dimensions and develop parasitic sorting strategies. All sentences include two human arguments (agent and recipient/goal), which were referred to by thirty-two different female first names. The exact nature of the third argument (the theme, i.e. the object that is given or moved) was left unspecified, as it was always referred to by the indefinite pronoun *something*. Indeed, preliminary tests showed that subjects are susceptible to select particular features of the theme arguments (such as liquid vs. solid) for their sorting, rather than properties of the events themselves. Replacing all themes by *something* saw a drastic decrease of this tendency, even though the verbs themselves obviously impose more or less stringent restrictions on the nature of the theme. With these precautions, we ensured that all that is left for speakers to sort is the kind of event that each sentence describes (whether it be determined by the verb, construction or alternation that the sentence exemplifies).

As for the verbs, we could not use the same design as Bencini and Goldberg (2000) (i.e. crossing four verbs with the four sentence types), as there are no verbs which can be used in all four constructions. Therefore we decided that each of the sixteen sentences should exemplify a different verb. Our first intention was to use eight widely different verbs for each alternation, but it proved impossible, at least for the locative alternation. First, the set of alternating verbs in the locative alternation is fairly limited semantically, in that they are all somehow verbs of caused-motion: it is therefore difficult to find eight

verbs which are maximally different, and the criteria to decide whether they are different enough are unclear. Second, since our locative sentences contain an animate goal, many verbs cannot be used felicitously in one or both variant(s) of the alternation (for example *heap* and *pile*, cf. the awkwardness of *Sue heaped|piled Sarah with books*), which further reduces the list of candidates. To get around this problem, we decided to use semantically similar verbs for each sentence type, picked from the semantically coherent classes posited by Pinker (1989). The ditransitive sentences contain verbs of giving (*pass*, *lend*, *offer*, *serve*), the *to*-dative sentences contain verbs of "instantaneous imparting of force in some manner causing ballistic motion" (*throw*, *toss*, *chuck*, *kick*), the caused-motion sentences contain verbs of "[caused] ballistic motion in a specified spatial distribution along a trajectory" (*inject*, *splash*, *spray*, *sprinkle*), and the *with*-applicative sentences contain verb of "simultaneous forceful contact and motion of a mass against a surface" (*brush*, *dab*, *plaster*, *rub*).

Obviously, the verbs in each class are very similar in meaning, which would suggest that subjects will be likely to sort together sentences of the same sentence type, though not on the basis of shared constructional semantics, but of the similarity between the lexical meaning of the verbs. This is however not a problem for our purpose, since a verb-based strategy will work only up to a point. Namely, sorting according to semantic verb classes leads to four groups, and since we ask subjects to make three groups, they will have to decide which two groups they will merge, or come up with another sorting strategy. This is where event-level semantics come into play: subjects will have to find more abstract commonalities between the kind of interactions that the sentences describe. In the dataset, at least three types of inter-sentential abstraction are possible: the abstraction "cause something to change locations" over the *to*-dative and caused-motion sentences, the very similar abstraction "cause something to go on or in somebody" over the caused-motion and *with*-applicative sentences, and the abstraction "cause someone to have something" over the ditransitive and *to*-dative sentences.

The stimuli sentences were printed on 15 × 10.5 cm white cards in black 18 pt Arial font. Each card was uniquely numbered on the backside (from 1 to 16) for later reference, following a random sequence, so as to avoid that sentences 1 to 4 correspond to one construction, then 5 to 8 to another etc., and that subjects notice the sentence types from the numbering pattern.

3.3. *Participants*

The participants were 26 native speakers of English, all students at the University of Freiburg (either as exchange students or as regular students), aged between 19 and 33 (22 on average). All of them were offered a compensation

for their participation, except for two subjects who took the experiment for course credit.

Most of them come from the main English-speaking countries, chiefly the United Kingdom and the United States, with a minority from Australia and Canada. In a questionnaire given at the beginning of the experimental session, they were asked to report their country of origin and the variety of English they claim to speak, for us to test for possible effects of dialectal variation. As it turns out, we did not find any substantial differences between varieties as far as the overall sorting behavior of subjects is concerned.

3.4. *Procedure*

We followed the same procedure as Bencini and Goldberg (2000). After filling out a form of consent and a questionnaire, the subjects were given a pile of cards, which was shuffled in each trial. They were asked to read the sentences and write for each of them a paraphrase on a response sheet which was provided to them. As in Bencini and Goldberg (2000), this was to ensure that they read the sentences carefully and paid attention to their meaning, and more generally that all subjects performed the same sentence processing task prior to the sorting task proper.

Participants were then asked to sort the cards into three groups according to the overall meaning of the sentence. In the instructions given to them verbally, we added the caveat that they should not pay attention to the words individually (i.e. compare the words in each sentence and group together sentences with semantically similar words), but that they should consider the meaning of the sentence as a whole. The participants were allowed as much time as they needed to fulfill both the paraphrasing task and the sorting task.

When the participants were done with their sorting, we asked them to explain their strategy to us, i.e. what made sentences belong together in each group, and what differed between groups. An outline of their comments was written down by the experimenter as they were talking.

3.5. *Results*

The sortings performed by each subject must be evaluated with respect to the two hypotheses that we formulated on the nature of grammatical generalizations. Under the constructional hypothesis, speakers form grammatical categories on the basis of the generalization of a common form with a common abstract meaning. This hypothesis predicts that subjects will be able to sort by constructions, yielding the following three groups: the caused-motion group (containing all *to*-datives and locative caused-motion sentences), the ditransitive group (containing all ditransitive sentences) and the *with*-applicative group (containing all *with*-applicative sentences). This is the constructional sorting.

Under the alternation hypothesis, in addition to constructional categories, speakers store higher-level generalizations over constructions related by an alternation. Our dataset exemplifies two of such generalizations, motivated by the dative alternation and the locative alternation. The alternations hypothesis predicts that subjects will be able to sort by constructions *and* alternations, and thus will have two additional available sorting strategies: the dative sorting and the locative sorting. A dative sorting corresponds to the following three groups: a dative group (all *to*-datives and all ditransitives), a caused-motion group (all locative caused-motion sentences) and a *with*-applicative group (all *with*-applicative sentences). A locative sorting corresponds to the following three groups: a locative group (all locative caused-motion and *with*-applicative sentences), a ditransitive group (all ditransitive sentences) and a *to*-dative group (all *to*-dative sentences).

Among our twenty-six subjects, four produced a locative sorting, one produced a dative sorting, and none produced a constructional sorting. This might look as if both our hypotheses have little predictive power (even less so for the constructional hypothesis). However, restricting this counting to the idealized sortings predicted by the hypotheses is a very restrictive way of evaluating the results, which does not entail that the generalizations predicted by either hypothesis do not exist. As a matter of fact, we observed that many subjects do not sort the whole set according to the same kind of criteria, in our case, event-level semantics. Several subjects produced a group that actually matches an alternation, but the other eight sentences were not necessarily sorted according to constructional meaning. If we only look at whether sortings contain a group based on an alternation or on the caused-motion construction, we find that six subjects produced a group containing all datives and eleven subjects produced a group containing all locatives. No subject produced a group containing all caused-motion sentences, but three did produce a group containing all four *to*-dative sentences and three caused-motion sentences, which can be considered as a near-constructional sorting. Finally, six subjects used various other sorting strategies which do not follow either constructions or alternations, and for which the resulting groups contain a mix of sentences of different types. An examination of the post-experiment explanations provided by these subjects reveals that they sorted either according to a very specific semantic feature of the verbs (such as the degree of forcefulness, or whether it involves contact or a liquid, etc.), or according to some subjective evaluation of the events described by the sentences (such as whether they see it as something good, bad or neutral vis-à-vis the other human participant). In any case, the sortings of this type do not match either the constructional or the alternations hypothesis.

The distribution of sorting strategies according to this looser classification is summarized in Table 2. It appears that only a minority of subjects (3 on 26) sorted the stimuli following the abstract caused-motion construction. On the

Table 2. *Distribution of sorting strategies*

Sorting strategy	Subjects
dative	6
locative	11
constructional	3
other	6

other hand, sortings based on a generalization over variants of an alternation were much more frequent, and within that category there seems to be a preference for a sorting based on the locative alternation (11 vs. 6 subjects).

Even though this first evaluation of the results allows us to already observe a clear trend, it must be admitted that by focusing exclusively on sorting characteristics that we expected to find, we ignored many finer-grained details that could also provide evidence in favor of or against our starting hypotheses. In particular, this coarse classification resulted in a fourth group of sorters that were not categorizable according to our predictions, but these subjects may also have been using an alternation-based or constructional generalization of a more limited scope when they ignored the event-level semantics associated to each sentence type. To give a more complete picture of the sorting results, we relied on another method used by both Bencini and Goldberg (2000) and Gries and Wulff (2005). Following Lassaline and Murphy (1996), Bencini and Goldberg quantified to what extent the sorting behavior on their subjects relied on verbal meaning or on constructional meaning by computing two deviations scores measuring how many sentences needed to be recategorized in a given sorting solution to obtain a perfect verb-based or construction-based sorting. They then performed significance tests on the resulting mean scores.

Along the same lines, we counted for each subject the number of sentences that needed to be recategorized in their sorting in order to obtain a group based on the locative or dative alternations, or on the caused-motion construction. We call these deviation scores respectively *LDev*, *DDev* and *CDev*. We obtained the mean values of 2.3 for *LDev*, 3.46 for *DDev*, and 4.57 for *CDev*. *LDev* is significantly lower than *CDev* (paired $t(25) = 4.5299$; $p = 0.0001$). *DDev* is only marginally significantly lower than *CDev* (paired $t(25) = 2.0382$; $p = 0.0522$). These results confirm that participants were overall more influenced by the semantic similarity involved in both alternations than by the semantic similarity found between instances of the abstract caused-motion construction, although the evidence appears to be weaker for the dative alternation. The difference between *DDev* and *LDev* is not significant (paired $t(25) = 1.6779$; $p = 0.1058$), showing that both alternations seem to be equally salient as possible sorting strategies.

Finally, to complement the analysis by subject presented above, we also analyzed our results from the perspective of the stimuli themselves, to give an account of the semantic similarity between sentences as reflected by the sortings, and of the corresponding semantic generalizations. To do so, we followed Gries and Wulff (2005) in submitting our data to hierarchical clustering.[6] Hierarchical clustering is an unsupervised learning technique aimed at the classification of a set of objects into homogenous categories (cf. Aldenderfer and Blashfield 1984), according to a set of numerical variables against which each object (here, each sentence) is characterized. In our case, it is a vector recording how many times a sentence was sortered together with each of the other sentences in our stimuli set; in other words, the more frequently two sentences end up together in the same group, the more semantically similar they are considered. The pairwise distances between sentences are calculated following a distance metric (here, the euclidean, or geometric, distance), and submitted to the hierarchical clustering algorithm, which proceeds in several recursive passes by merging in each pass the two most similar clusters into a higher-level cluster, until there is only one cluster containing all objects; the distance between clusters is assessed according to which linkage criterion is chosen. The output of the hierarchical clustering algorithm is thus, as the name indicates, a hierarchy of clusters.

The results of the cluster analysis are presented in a dendrogram in Figure 2.[7] This kind of diagram arranges objects (here, the stimuli sentences) according to their similarity, and as it were, traces the history of cluster mergers by the algorithm, from the earliest one at the very bottom of the graph, to the last one at the top. More similar sentences are grouped earlier by the algorithm, and appear lower in the tree. Clusters are recursively merged at a more distant level of similarity as we go higher in the tree.

Two observations can be made from the results of the cluster analysis. First, at the bottom of the diagram, we find four sets of sentences that stand out as they are clustered particularly early: these groups are respectively composed of (from left to right) the three caused-motion sentences with *sprinkle*, *spray* and *splash*, the three *with*-applicative sentences with *dab*, *brush* and *rub*, the three ditransitive sentences with *lend*, *offer* and *serve*, and all four *to*-dative

6. We used the `hclust` function of the R environment ⟨http://www.r-project.org/⟩ [accessed March 2012].
7. We used the euclidean distance and complete linkage to generate Figure 2. However, it should be noted that the same clustering structure can be obtained with single, average and Ward linkage and/or the Manhattan distance. Thus, the sentence clusters produced by the analysis do not depend on specific parameters of the clustering algorithm, which suggests that the sorting tendencies they reflect are not generated by some specific analysis but correspond to actual behavioral properties found in the dataset.

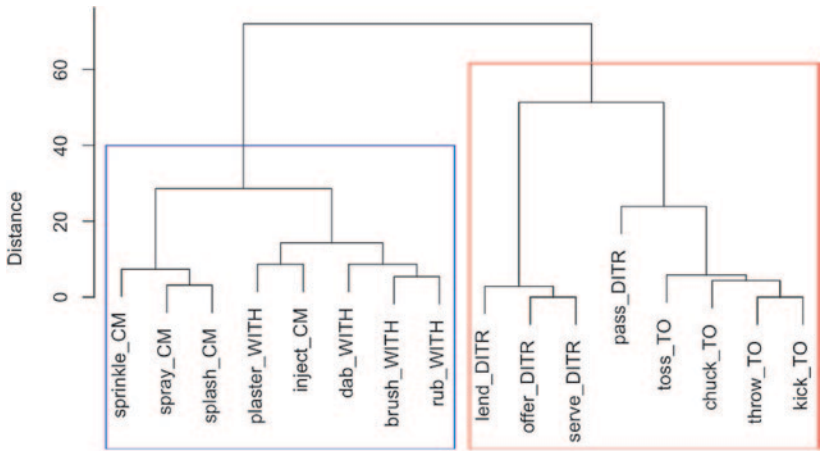

Figure 2. *Cluster dendrogram of the stimuli sentences; the labels indicate the verb and construction used in each sentence (DITR = ditransitive, TO = to-dative, CM = locative caused-motion, WITH = with-applicative)*

sentences.[8] This means that a large majority of our subjects chose to put these sentences in the same group, which, not incidentally, contain verbs from the coherent semantic classes that we used in our stimuli. While this observation does not directly relate to our main question, it confirms that subjects behaved like we expected: they primarily noticed the semantic similarity between verbs of the same class, and chose to put them together. However, this strategy yields four groups, which is one more than what they were instructed to make. They therefore had to either rearrange their sorting or choose to merge two verb-based groups, which is arguably where the semantic similarity between variants of an alternation or instances of the caused-motion construction comes in.

Secondly, if we now look at the higher levels of the tree, we see that the dataset is clearly split into two broad categories (surrounded by boxes in the dendrogram) containing respectively all locative sentences and all dative sentences.[9] Correspondingly, no cluster at any level of similarity contains a

8. This leaves three sentences that are more distantly related to these groups: the *with*-applicative use of *plaster*, the caused-motion use of *inject* (which constitute a cluster of their own), and the ditransitive use of *pass*. Interestingly, we can observe that the latter two are more closely related to sentences instantiated by another construction, which means that in those cases the constructional meaning is not taken into account. We comment on these cases in Section 3.7, which deals with the role of verb meaning.
9. This impressionistic observation can be confirmed by applying the so-called elbow criterion to choose the 'right' number of clusters, as in Gries and Wulff (2005: 193). This method consists in plotting the percentage of variance explained by the classification as a function of the

caused-motion and a *to*-dative sentence. This shows that the abstract caused-motion construction exerted little influence in judgments of semantic similarity, while both alternation-based generalizations clearly prevailed. In sum, the results of the cluster analysis strongly support the alternations hypothesis.

To summarize our findings, the three kinds of quantitative analysis applied to our results, namely (a) the distribution of broadly-defined sorting types, (b) the deviation scores from the expected sortings, and (c) a cluster analysis of the stimuli sentences according to how often they are categorized together, all point to a preference for a semantic generalization based on either the locative or dative alternation over the abstract caused-motion construction. In the next section, we turn to a more qualitative analysis of the results by examining the descriptions of groups provided by subjects in the post-experiment interviews.

3.6. *Analysis of the post-experiment interviews*

Regarding the quantitative analysis reported in the previous section, it might be argued that there is no guarantee that subjects producing similar sortings actually shared a common sorting strategy (i.e. with the same underlying generalizations): two subjects might well apply distinct sorting criteria and still eventually provide similar groups. To control for this, it is important to compare the quantitative analysis with the qualitative data collected through the post-experiment interviews. As it turns out, the descriptions given by subjects largely match our expectations.

Table 3 reports how subjects who produced a locative group (i.e. containing all caused-motion and *with*-applicative sentences) described this group (the numbers on the left correspond to each subject's unique identifier). It appears that seven subjects (highlighted with boldface in the left-hand column) out of eleven used purely locative terms in their description. All seven used typical verbs of caused-motion: mostly *put* (subjects 03, 06, 10 and 24), but also *apply* twice (22 and 26), and *transfer* once (08). This means that they indeed considered that the semantic commonality between the eight locative sentences is the notion that an agent causes something to move, which corresponds to the meaning shared by the variants of the locative alternation. They also frequently mentioned the type of resulting spatial configuration of the theme and goal arguments. Most of them mentioned a "contact with surface" relation, either through the verb *apply* or the preposition *on*. In addition, two of them also

number of clusters, and identifying the point at which an elbow or a sharp bend occurs, which indicates that increasing the number of clusters beyond this point is not worth the improvement. We found that the gain in the percentage of variance explained by the classification drops drastically (from about 20% to 6%) when the number of clusters exceeds 2.

Table 3. *Descriptions of the locative groups by the eleven locative sorters. Boldface font is used to highlight important content, commented on in the text.*

03	something not very pleasant [is] done to another person, but [is] not necessarily wanted by the recipient, [it does] not [involve] possession of something but something is **put on** the person
04 **06**	something [is] being done to somebody else something [is] **put on** the person or **inside** the person, it has something to do with the body
08	something is **transferred** but the recipient has a passive role
09	physical events, with a result, an end-effect, it involves the body
10	physically **putting** something **on** or **in** somebody
12	[involves] close contact with the other person
22	something is **applied to** them
23	something almost malicious, a one-way action, like pranks or jokes
24	someone is **putting** a substance **on** somebody else, whatever it is: solid, fluid, liquid
26	[there is] direct contact, usually some kind of substance [is] being **applied to** someone else

noticed that this spatial configuration is at odds with the caused-motion use of *inject* (for which the relation is rather one of containment), and accordingly added the preposition *inside* or *in* (subjects 06 and 10), showing that they effectively abstracted away from the meaning of individual verbs and only kept the notion of caused motion vis-à-vis some landmark, regardless of the resulting spatial configuration.

The descriptions provided by the remaining four locative sorters were either too vague to qualify as a good definition of the meaning of the locative alternation (cf. 04 and 09), or made obvious mention to another semantic criterion not directly related to the alternation (cf. 12 and 23). Interestingly, subject 04's description in terms of "something [. . .] done to somebody else" reminds one of the construal imposed by the *with*-applicative variant (i.e. an action on the goal), but since it does not explicitly mention the idea of caused motion, it is not clear whether it does qualify as a definition of the kind we expect for the locative alternation. By the same token, it is interesting to note that subject 03 also provided a similar description as "something [. . .] done to another person", in addition to the description mentioned above involving caused motion with the verb *put*: this can be interpreted as meaning that this subject identified both construals involved by the two variants of the locative alternation.

Table 4. *Descriptions of the dative groups by the six dative sorters. Boldface font is used to highlight important content, commented on in the text.*

01	things [are] **given** directly or violently
14	something [is] **passing** from one person to another
15	someone [is] **giving** something tangible to somebody
17	somebody **gives** something to somebody else
18	one person **gave** something to another person
20	an object was **exchanged**, went from one person's **possession** to another's

Table 4 reports how subjects who produced a dative group (i.e. containing all ditransitive and *to*-dative sentences) described this group. It turns out that these descriptions are even more alike than those of the locative groups, as nearly all of them clearly relate to the idea of giving. Out of the six dative sorters, four precisely used the verb *give* (01, 15, 17 and 18), one the similar verb *pass* (14), and one the verb *exchange* (20). In addition, the latter also explicitly mentioned the notion of "possession", and, interestingly, captured the idea of giving in terms of motion, which is something that linguists often do. Similarly, the description provided by subject 14 seems to focus more on the motion of the theme than on the agent's action. Such descriptions are reminiscent of the metaphor 'TRANSFER OF OWNERSHIP IS PHYSICAL TRANSFER' which is argued to motivate the use of a caused-motion syntax (i.e. the *to*-dative) to express events of giving. We cannot be sure whether these subjects had this metaphor in mind, but in any case, it is worth noting that they used this definition, more in line with the *to*-dative, to encompass the ditransitives, and not the other way around, as the other subjects did. What is more, despite the locative construal of events of giving which transpires in these descriptions, this metaphor did not provide a basis for a caused-motion group including the *to*-datives and the purely locative caused-motion sentences. In sum, the descriptions provided by dative sorters are all in line with the meaning "cause someone to receive" associated with the variants of the dative alternation.

Finally, the definitions of the caused-motion group provided by the three constructional sorters are reported in Table 5. As a general observation, it appears that these descriptions are generally less well-articulated and accurate, probably because the relationship between the *to*-dative and caused-motion sentences is more ineffable and might not be so easily captured in concrete terms for non-specialists. Yet, subject 02 did mention that the sentences in this group involve interactions "at a distance", i.e. involving caused motion. Subject 05 explained it in terms of "indirect contact", which, when asked, s/he

Table 5. *Descriptions of the caused-motion groups by the three constructional sorters*

02	[actions performed] at a distance
05	involves indirect contact
25	two people interacting, they don't touch each other, something is done to someone else, it has to do with sports

clarified as contact being made between two people not directly but with the intervention of some object or substance used by the first person, which is another way of putting "caused motion of some object to some goal". Subject 25's comment that the two protagonists "don't touch each other" arguably relates to the same idea.

We can conclude that the post-experiment interviews largely confirm our interpretation of the quantitative results presented in the previous section, in that in most cases the semantic explanation put forward by each subject corresponds to the semantic commonality between variants of an alternation or instances of a construction. In the next section, we turn to the influence of verb meaning in our subjects' sortings and address the question of whether it could constitute a possible confound.

3.7. *The role of verb meaning: a possible confound?*

As one of our anonymous reviewers aptly points out, there is a possible confound in our dataset: the meaning of the verbs could perhaps explain the sorting behavior of subjects, in that they would put a given sentence in a group because the verb in this sentence is semantically similar to the other verbs in the group, regardless of the constructions with which these verbs are used. As a matter of fact, there is some evidence that subjects do at times rely on the meaning of the verb, especially with regard to how they sort the sentences that do not fall in either their dative, locative, or caused-motion group. For example, many subjects (6) among the locative sorters interpreted the verb *pass* in its "ballistic" reading (as in *pass the ball*) instead of its intended 'giving' sense (as in *pass the salt*), and accordingly sorted the ditransitive sentence containing *pass* with the more similar verbs of throwing used in the *to*-dative rather than with the other ditransitive sentences, thus ignoring possible (though subtle) semantic differences induced by each construction. Similarly, a recurrent tendency among dative sorters (3 subjects) was to put the caused-motion use of *inject* in the *with*-applicative group, by virtue of the fact that an act of injecting involves contact between the agent and the recipient of the injection, just like the action described by the verbs used in the *with*-applicative sentences (viz. *brush*, *dab*, *rub* and *plaster*).

It should not be surprising that subjects attend to verb meaning: after all, it was shown by Healy and Miller (1970) to be an important determinant of verb meaning, and even when controlling for constructional semantics, Bencini and Goldberg (2000) did find some extent of verb-based sorting. However, the real question is whether the tendency of subjects to sort variants of an alternation together can be explained by the semantics of the verb used instead of shared event-level meaning. To do so, they would have to consider all eight sentences as being united by semantic properties attributable to the verb alone, independently of the particular construction with which they are used. It seems unlikely in the case of the ditransitive verbs vs. the *to*-dative verbs, as the two classes used have arguably little in common. All that unites the dative sentences is that they involve a recipient, but verbs of throwing only do so when used in the *to*-dative or ditransitive construction. The distinction between verb classes is perhaps less clear-cut in the case of the caused-motion vs. *with*-applicative verbs: even though the gestures performed by the agent and the potential props involved are quite different in each verb class, it might be argued that the actions referred to by many verbs from both classes are similar with respect to the fact that they can be performed in the same real-world contexts (for example, care-taking), and, more importantly, that they lead to a similar result (namely, some substance being spread or scattered on the surface of an object for *spray*, *splash*, *sprinkle*, *brush*, *rub* and *plaster*). Thus, the overall preference for the locative alternation over the dative alternation happens to be correlated with a potential difference in similarity between pairs of verb classes. That being said, even though the role of verb meaning could explain this preference, it does not necessarily account for why subjects chose to sort by relying on an alternation over a construction in the first place. In fact, if verb meaning was a decisive criterion to merge different sentence types, we would expect constructional sortings to be more frequent than at least dative sortings, since there is an evident semantic dimension of verb meaning shared between the *to*-dative verbs and the caused-motion verbs (especially *splash* and *spray*) that is yet rarely drawn upon by our subjects, namely the notion of translational motion. Only one subject arguably noticed this, as he put these verbs with *pass*, obviously understood in its ballistic reading. For the two other constructional sorters, it is not clear whether they based their strategy on the semantics of the caused-motion construction or on the translational motion feature of the verbs, since both of them excluded *inject* from the caused-motion group.

The influence of verbal semantics as a motivation for sorting together sentences with verbs from different classes can be more concretely evaluated by looking at the definitions provided by subjects. Remember that our intention when designing the dataset was to provide subjects with clearly identifiable verb-based groups (which also matched constructions), two of which they had to merge to obtain a three-group sorting. It is clear from the discussion of post-

experiment interviews presented in the previous section that they mostly did so on the basis of event-level semantics, as very few subjects mentioned semantic characteristics that are unambiguously attributable to the meaning of the verbs alone. Only two of the six dative sorters used words relating to motion in their descriptions of the dative group (cf. subjects 14 and 20 in Table 4). A similar comment applies to the locative sorters, as their descriptions rarely included precisions that unequivocally refer to the semantics of particular verbs; the only remarks that could qualify as such are comments like "it involves the body" or "close/direct contact", each occurring only twice (subjects 06, 09, 12 and 26) among the eleven locative sorters (cf. Table 3). Subject 23 described the locative group as containing "pranks or jokes", which qualifies as a description in terms of the contexts in which the actions described by the verbs are performed, although it seems to be a very personal judgement. But as was shown in the previous section, subjects more consistently defined this group in terms of putting or applying. Thus, verbal meaning did not seem to exert much influence on the decision to merge sentences instantiating variants of an alternation, compared to event-level semantics.

While there are arguably good reasons to assume that subjects based their sortings primarily on event-level semantics, it must be admitted that the influence of verb meaning is hard to evaluate with precision. This confound could however not be totally avoided given the requirements of our stimuli set, which perhaps calls for a replication of this experiment with a different set of stimuli that avoids this confound (if such a set exists at all). That being said, we can certainly learn a lot about the organization of constructional knowledge from the results of this study, which we will turn to in the last section of this article. Before that, we address the question of whether our results could be accounted for by following the approach to syntactic alternations endorsed by Frame Semantics.

3.8. *Comparison with the frame-semantic approach to alternations*

In this section, we compare our results with another major approach to verb valency and argument structure in Cognitive Linguistics: Frame Semantics. As its name indicates, Frame Semantics (FS) is a theory of word meaning that revolves around the concept of semantic frame, defined by Fillmore (1985: 223) as "some single coherent schematization of experience or knowledge". A semantic frame makes reference to a particular scenario within which certain aspects or entities, called frame elements (FEs), are highlighted; FEs are basically the FS equivalent of the traditional notion of thematic roles. FS primarily aims at a semantic characterization and classification of words (particularly, though not exclusively, verbs) in terms of semantic frames. A lexical unit (LU) is defined as a pairing of a lemma with a particular semantic frame; in FS ter-

minology, a LU is said to *evoke* a frame. The FrameNet project[10] is the lexicographic pendant of FS: it provides a database of semantic frames derived from careful analysis of example sentences extracted from the British National Corpus and freely accessible online. As of February 2012, FrameNet contains 12411 LUs (including 4766 verbs) attached to 1138 frames.

Syntactic alternations, defined as alternative realizations of the same set of arguments of a verb, are not captured as such in FS; rather, they are considered as an epiphenomenon that results from the fact that the same verb stem corresponds to several different lexical units, each evoking a different frame. For example, following Boas (2010; 2011), the two variants of *load* in the locative alternation correspond to two distinct LUs: the caused-motion variant evokes the `Placing` frame, while the *with*-variant evokes the `Filling` frame. The observation that a given verb enters into the locative alternation is thus translated in FS as a mere case of verbal polysemy (cf. also Nemoto [2005] for a similar conclusion). Yet, the relatedness of variants of an alternation may still be captured through relations between frame. As Boas (2010: 70–71) puts it:

> While FrameNet provides no explicit link or connection between the valence patterns of the two LUs, there exists a frame-to-frame relation between the frames evoked by the two LUs, i.e. the `Filling` frame uses the `Placing` frame. Thus, syntactic alternations are accounted for in terms of frame-to-frame relations and the valencies of pairs of lexical units evoking frames that are semantically related.

The "uses" relation between the Filling frame and the Placing frame captures the fact that "the endpoint of a filling event requires a number of placing events that temporally precede this endpoint" (Boas 2011: 218). In sum, in Frame Semantics, a syntactic alternation does not amount to a relation between LUs themselves, but to a relation between the frames they evoke,[11] which is only identified as a (semi-)regular pattern because many verb stems evoke both frames.

On this account, categories of sentences instantiating different constructions may well emerge only by virtue of the relation between frames evoked by the verbs, but not necessarily because the constructions themselves are perceived as semantically similar. This idea obviously relates to the verb meaning confound discussed in the previous section. We argued that verb meaning was not likely to exert much influence on the sortings, on the grounds that the verb meanings were after all quite different in each sentence type, and, more

10. ⟨https://framenet.icsi.berkeley.edu⟩ [accessed March 2012].
11. See also Iwata (2005) for a similar account of the locative alternation in terms of different but related construals of the same abstract scene. García Velasco (2011) makes similar proposals concerning the English causative alternation.

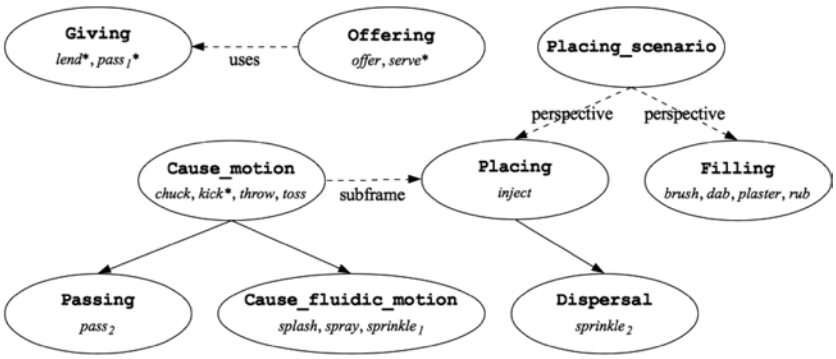

Figure 3. *Semantic frames evoked by the verbs in our stimuli set (source: FrameNet). Plain arrows indicate inheritance links, dashed arrows indicate other types of relations, labelled accordingly.*

importantly, on the basis of the group descriptions provided by our subjects, which rarely included information clearly related to the verbs. However, we did not take frame-semantic considerations into account, so the question must be asked whether the FS approach could provide an alternative explanation of our results, without resorting to cross-constructional generalizations.

To check this, we looked up the FrameNet database for the semantic frames evoked by the verbs used in our stimuli sentences. The resulting set of frames and the relations between them are summarized in Figure 3. Three of our verbs, *kick*, *lend* and *serve*, were not found in their relevant meanings in FrameNet, so we had to attach them ourselves to an appropriate frame; these verbs are marked with a star in Figure 3. The *to*-dative use of *kick* straightforwardly evokes the `Cause_motion` frame, by analogy with the other verbs of throwing. We assumed that *serve* evokes the `Offering` frame (or possibly an elaboration thereof), since its meaning also conveys the idea of "making something available to somebody", like *offer*. Since *lend* has basically the same meaning as *give*, with the proviso that it refers to only temporary transfer of possession, we attached it to the `Giving` frame. Two other verbs, *pass* and *sprinkle*, were ambiguous between two frames in the stimuli sentences, therefore we took both options into consideration and split these verbs into two LUs, each marked in Figure 3 by a different subscript. *Sprinkle*$_1$ evokes the `Cause_fluidic_motion` frame, and *sprinkle*$_2$ evokes the `Dispersal` frame. As to the verb *pass*, it is reported in FrameNet as being the sole LU in the `Passing` frame, but according to the definition of the frame and since it inherits the `Cause_motion` frame, it seems that this LU corresponds to the throwing sense of *pass* rather than its giving sense. Just as we did with *sprinkle*, we split this verb into two entries, *pass*$_1$ evoking the `Giving` frame, and *pass*$_2$ evoking the `Passing` frame.

Since a majority of our subjects chose to sort the caused-motion and *with*-applicative sentences together, we should expect the frames evoked by the verbs in these sentences to be particularly closely related in the FrameNet hierarchy. These frames are however on the whole quite scattered: while the `Filling` frame and the `Placing` frame (evoked by *inject* and, through inheritance, by *sprinkle*$_2$) are quite close by virtue of being two perspectives on the abstract `Placing_scenario` frame,[12] the other verbs are more distantly related since the `Cause_fluidic_motion` frame is but a cousin of the `Placing` frame: it inherits the `Cause_motion` frame, which `Placing` is a subframe of.[13] Be that as it may, the similarity of these sentences can still arguably be traced back to more or less direct relations between frames. What is more surprising is that there is clearly more semantic coherence between the verbs used in the *to*-dative and caused-motion constructions, since all frames evoked by the former verbs inherit (either fully or partially through a subframe link) the `Cause_motion` frame evoked by the latter. Yet, these verbs are very rarely sorted together into what we called a caused-motion group.

The dative alternation receives a different treatment from the locative alternation. In FrameNet, the double-object and prepositional variant are recorded as alternative realizations of the same set of frame elements for a number of LUs both in the `Giving` and `Offering` frames and in the `Cause_motion` frame. Hence, the dative alternation is not captured in terms of verbal polysemy like the locative alternation, which predicts that speakers should not perceive any semantic difference between sentences instantiating different variants of the alternation, beyond of course the difference between the frame-semantics of their verbs. Therefore, we should expect the frequent tendency of our subjects to sort together the ditransitive and *to*-dative sentences to correlate with a fairly close relatedness of the `Giving`[14] and `Cause_motion` frames, but thus is not the case: from all the frames mentioned in Figure 3, they are by far the most distant; in fact they are only related at the most abstract level in the frame hierarchy (viz. they inherit the `Event` frame), which amounts to saying that they are not related at all.

12. This account slightly differs from that presented by Boas (2010; 2011), mentioned earlier. We presume that this might be because of a change in FrameNet that was made after these studies were written.
13. The subframe link is akin to a inheritance link, except that only a part of the parent frame is inherited by the child frame; hence, it captures metonymical relations between frames. Here, the subframe link between `Cause_motion` and `Placing` captures the fact that the latter only profiles the end-point of a full event of caused motion, namely the arrival of the theme at the goal.
14. Since the `Offering` frame uses the `Giving` frame, for the sake of simplification we subsume the former into the latter.

In sum, Frame Semantics, as it is currently implemented in the FrameNet database, falls short of explaining the pattern of results of our sorting task in terms of relations between frames. Contrary to what should be found, the two most closely related frames evoked by our verbs actually correspond to the least frequent sorting strategy (the constructional sorting); conversely, sentences with verbs evoking more distantly related or even totally unrelated frames are frequently sorted together by our subjects. There thus seems to be more than relatedness of frames, as the FS approach would have it, to the semantic similarity of our stimuli sentences as reflected by our subjects' sortings. Of course, this does not as such invalidate the FS approach to verb meaning. Instead, this apparent failure might be due to the fact that FrameNet does not as yet capture the notion of construction. Efforts are currently being made to complement the frame hierarchy with information about constructions (cf. Boas 2010, Fillmore et al. to appear) using the same descriptive apparatus. Once the constructions used in our dataset are covered by FrameNet, construction-to-construction and possibly construction-to-frames relations might better correlate with our results.

4. Discussion

In this study, we used a sorting task paradigm to investigate how speakers categorize sentences. We exposed 26 native speakers of English to a set of 16 sentences instantiating three argument structure constructions: (a) the caused-motion construction, (b) the ditransitive construction, and (c) the *with*-applicative construction. Importantly, the caused-motion sentences we used fall into either of two semantic types: locative caused-motion sentences and *to*-dative caused-motion sentences. While the caused-motion sentences of both types can be unified under the same constructional meaning 'physical transfer', each type also shares a substantial part of their meaning with one of the other constructions appearing in the stimuli set. Namely, the *to*-dative type is similar to the ditransitive construction with respect to the shared notion of 'transfer of possession', and the locative type is similar to the *with*-applicative construction in that they both describe events of (physical) change of location. In fact, sentences of both types could be rephrased with the other construction, with little variation in meaning,[15] which is what prompted researchers to describe these pairs of constructions as variants of a syntactic alternation, in this case called the dative alternation and the locative alternation respectively.

15. As a matter of fact, one of our subjects spontaneously issued this comment concerning the caused-motion sentence with *inject*.

What we were concerned with in this study is whether and to what extent speakers perceive the semantic relatedness of sentences instantiating different constructions. We asked our subjects to sort the stimuli set into three groups. It is already expected that they notice the semantic similarity between the two types of caused-motion sentences, since previous research has shown that constructional meaning is a relevant dimension of sentence categorization. There is no reason to doubt that they are also able to notice the similarity between variants of either alternation, but the question is whether (and to what extent) some of them would actually resort to this similarity in their sorting and prefer it over the caused-motion construction, thus forming an alternation-based group of sentences. As we reported at length in the last section, subjects rarely used the caused-motion construction in their sortings. They much more frequently presented a sorting solution in which the variants of one of the alternations were together in one group. In other words, alternation-based generalizations are reflected in the sorting behavior of our subjects much more often than the purely constructional ones. This result is more in line with the alternations hypothesis, spelled out in Section 3.1: speakers are evidently able to formulate broader generalizations of a constructional meaning shared by formally distinct constructions, and in our case they use the former more often than the latter in categorizing the stimuli sentences.

The generalizations that subjects relied on to sort the stimuli sentences are modeled as a constructional network in Figure 4, following a notation similar to that of Goldberg (1995), Langacker (2000) and Cappelle (2006), to name only but a few. In this diagram, pairings of form with meaning (i.e. constructions) are represented by plain boxes. For abbreviatory purposes, we did not include a description of the meaning of each construction, we simply refer to it through the construction's name. A full specification of each constructional meaning would include a description of the kind of event it refers to (for example, and event of transfer of a theme from the agent to a recipient for the ditransitive construction), but should also include the finer-grained distinctions mentioned in Section 1, such as semantic properties of the arguments (e.g. that

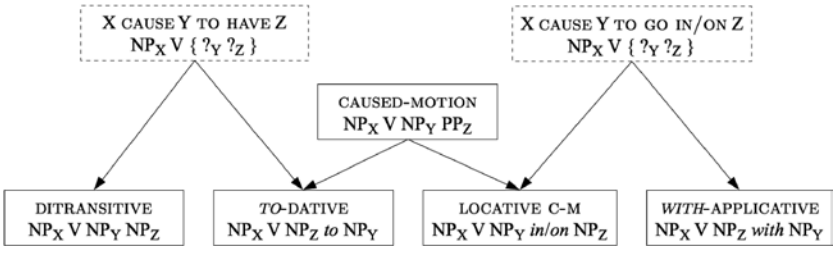

Figure 4. *Constructional network of the dative and locative alternation and their variants*

the argument marked by a Y subscript in the ditransitive construction is a recipient and should therefore be animate), discourse profiles (i.e. information about the discourse accessibility of the arguments), or event construals (e.g. the fact that the locative caused-motion and the *with*-applicative construction respectively construe the event of caused change of location as an action affecting the theme or affecting the location). Inheritance relations are represented by arrows and indicate that the child construction (at the pointy end of the arrow) is more specific than the parent construction, in that the former describes particular aspects of the form and/or meaning of the latter in more details. For example, the *to*-dative and locative caused-motion constructions inherit the form and meaning of the general caused-motion construction, but add specifications concerning the spatial relation between the theme and location arguments, namely one of path-to-goal for the former (marked by the preposition *to* in the form of the construction), and one of containment or contact-with-surface for the former (respectively marked by the prepositions *in* and *on*[16]). Note that the general caused-motion construction may subsume other sub-constructions (for example, encoding the removal of the theme from a source location), but only these two are relevant to our discussion. Following Goldberg (1995), we intend these inheritance links to symbolize default inheritance, in that the information inherited from the parent construction is redundantly duplicated in the specification of the children constructions, although a model relying on complete inheritance (i.e. without redundant information) could just as well capture the same data; actually the issue of default vs. complete inheritance is not truly relevant to the kind of generalizations we wish to describe here.

In addition to constructions, Figure 4 contains two alternation-based generalizations, represented as dash-lined boxes. Loosely following the notation introduced by Cappelle (2006), we represent these generalizations as pairings of (i) a constructional meaning abstracted from the meaning of the variants of the alternation, with (ii) an underspecified form which contains only the commonalities between variants, and thus leaves unspecified the syntactic

16. Of course, this is clearly a semantic constraint and should therefore not be encoded in the formal pole of the construction; what is more, many other prepositions are possible, like *into*, *inside*, *over*, or *against*. We use this notation as a mere shorthand, since Figure 4 does not describe the semantics of constructions; a more accurate characterization would specify the possible spatial relations in the meaning of the construction. Also, not all kinds of caused-motion sentences are allowed to be rephrased with the *with*-variant, which has much to do with the spatial relation instantiated by the preposition: this is chiefly why we need to represent this restriction somehow in the diagram. On a related note, the name "locative caused-motion" is perhaps too general to be entirely appropriate, since this construction is meant to capture the generalization over our caused-motion sentences, which do not exemplify the whole range of locative relations; again, we use this label anyway for abbreviatory purposes.

type (marked by question marks in our diagram) and linear order (marked by curly brackets) of the post-verbal complements. We call these higher-level alternation-based constructions CONSTRUCTEMES.[17] The dative constructeme (on the left) pairs the meaning 'Agent CAUSE Recipient TO HAVE Theme' with a syntactic form in which the Agent is realized as subject and the Recipient and Theme arguments receive underspecified syntactic realizations. The locative constructeme (on the right) pairs the meaning 'Agent CAUSE Theme TO GO IN/ON Location' with a similar syntactic form. The ditransitive and *to*-dative constructions, on the one hand, and the locative caused-motion and *with*-applicative constructions, on the other hand, inherit respectively the dative and locative constructemes; following Cappelle's (2006) terminology, they are ALLOSTRUCTIONS[18] of these constructemes. The allostructions fully specify their syntactic form and add semantic and pragmatic information to the meaning inherited from the constructeme (not indicated in the diagram). Letter subscripts indicate the different linear ordering of arguments specified in each allostruction.

Returning to the central question of this paper, can these results allow us to affirm that alternation-based generalizations are stored in the mental grammar? The fact that speakers do perceive variants of an alternation as closely related in meaning is certainly a prerequisite for the actual storing of such cross-constructional generalizations, like the constructemes of Figure 4, but it is in no way a sufficient condition. Indeed, it might be argued that the generalizations that subjects made in the context of the experiment do not necessarily correspond to categories that they actually store as part of their mental grammar, and that these generalizations are "ad hoc" categories (Barsalou 1983) that result from conscious reasoning about how the meanings of different sentences relate. As one of our reviewers points out, sorting tasks are highly reflective and open to strategic responding; these limitations should be duly acknowledged.

Such comments are in order, but it can still be argued that stored categories should be more readily available than those created "on the fly", and thus expected to be used more often. Since alternation-based generalizations were relied on much more often in the sorting task than constructional ones, it is reasonable to hypothesize that they correspond to stored generalizations. The statistical bias towards alternation-based generalizations is all the more striking considering that our dataset arguably favors a constructional sorting. First, a constructional sorting is the only solution which appeals to a similar degree of abstractness: since we asked subjects to make three groups, the three

17. This term was suggested by Bert Cappelle, although it is not used in Cappelle (2006).
18. Through analogy with the terms 'allophone' and 'phoneme'.

constructional generalizations exemplified by the dataset more neatly and readily fits a three-way distinction, whereas an alternation-based sorting resorts to more abstract generalizations and thus involves different levels of generality.[19] Second, the verbs we used in the *to*-dative sentences (verbs of "ballistic motion": *throw*, *chuck*, *toss*, *kick*) also favor a categorization of this sentence type with the other instances of the caused-motion construction. *To*-datives sentences with these verbs straddle the border between a caused change of possession reading and an interpretation in terms of physical caused motion of a theme to some person, which means that the pure caused-motion interpretation is more readily available with these verbs than with more abstract ones such as *tell* or *promise*. Despite this bridge that we placed on purpose, subjects were still reluctant to group the *to*-datives with the caused-motion sentences.

Furthermore, two recent priming experiments provide supporting evidence for the existence of alternation-based generalizations. In cognitive psychology, priming refers to the phenomenon whereby prior exposure to a stimuli A influences (usually positively) the processing of a subsequent stimuli B or increases the likelihood of producing a particular response, and is usually taken as evidence that the two stimuli (or the stimuli and the response type) are related at some level in cognition. Priming effects have also been identified in language, notably with the phenomenon of syntactic priming (Bock 1986), whereby exposure to a particular syntactic structure increases the production of utterances with the same structure. Goldwater et al. (2011) investigate priming effects in the dative alternation with children. They find that exposure to dative primes increases subsequent production of both kinds of dative structures relative to a baseline (i.e. without priming). In line with previous findings, responses matching the structure of the primes are more frequent than mismatching ones, but this effect depends on the semantic similarity between prime and target, and increases with the age of the child; as it turns out, 4-year olds are equally likely to produce either variant of the dative alternation after exposure to both types of primes when similarity is low. Goldwater et al. conclude that "semantic representations (independent of sequence) are primed in structural priming tasks" (2011: 168). In a similar study, Vasilyeva and Waterfall (2011) investigate the priming of transitive vs. passive constructions with speakers of Russian. They find that, compared to the transitive prime condition, exposure to passives not only increases the production of the same construction both by children and adult speakers, but also the production of a number of other constructions that, while formally different from the primes, fulfill the same discourse function, namely emphasizing the patient argument. The authors conclude that "what gets primed is [. . .] a particular way of look-

19. I am indebted to Bert Cappelle for making this point.

ing at and interpreting a given situation that is captured by the priming sentence" (2011: 20): in other words, a construal, independent of the form it is paired with.

The results of both studies remarkably dovetail with ours. They both show that formally distinct but semantically similar constructions can prime each other, which is evidence that they are indeed related at some level of representation in the mental grammar of speakers. These results suggest that the linguistic knowledge of speakers might well contain a higher level of generalizations composed of highly abstract constructional meanings detached from any particular form, which is tantamount to the notion of constructemes. In sum, these findings strengthen our argument that the sorting tendencies displayed by our subjects are revealing of readily available generalizations between constructions with a different form and a common meaning.

An obvious theoretical consequence of that proposal is that it weakens the assumption that variants of an alternation should be considered as independent constructions, since they may be explicitly subsumed by a cross-constructional generalization. The long-standing relunctance of construction grammarians to include syntactic alternations in the set of entities stored in linguistic knowledge probably stems from the fact that they were the hallmark of earlier transformational and derivational analyses, and therefore are seen with some suspicion by proponents of a monostratal approach to grammar. But a constructional approach does not necessarily exclude an account of semantic similarity and syntactic correspondences between constructions, as "regularities that speakers can extract from a number of analogical usage events" (Cappelle 2006: 3–4). Our finding that speakers perceive variants of an alternation as highly similar provides evidence of their awareness that these constructions are alternative ways to encode a particular category of events. Including alternations explicitly in the grammar serves to capture this knowledge, whether they are modelled as lexical rules (as in Pinker's 1989 account), as synonymy links (as in Goldberg 1995), or as allostructions, as in Cappelle (2006) and this article. Just like some construction grammarians acknowledge (albeit controversially, cf. Goldberg 2006: chapter 8) the existence of purely formal generalizations, i.e. generalizations of common formal features independently of a shared meaning, like the subject-auxiliary inversion construction (Fillmore 1999), we argue that a thorough description of the constructicon should also include semantic generalizations that are (at least partly) independent of syntactic form.

In essence, the semantic relatedness of constructions could as well be captured by direct links between contructions, like Goldberg's synonymy links. However, one benefit of the allostructions model is that it does not require to posit a new type of construction-to-construction relation, since it relies on the more basic and widely accepted taxonomic relation. In addition, this model is more flexible than synonymy links with regard to the description of how

the constructions are related: the constructemes capture the level at which constructions are semantically equivalent and the allostructions specify exactly how these constructions differ from each other. Under that view, the allostructions model offers a constructional framework in which onomasiological variation in syntax can be captured: the constructeme captures the onomasiological field that this portion of the constructicon is concerned with, while the allostructions capture the parameters of variation each variant is subject to, including descriptive meaning, construal, and discourse considerations.

That being said, the question arises as to why speakers would actually store such generalizations. After all, an ample body of research substantiates the claim that grammatical knowledge is better seen as organized around generalizations of limited scope rather than highly abstract schemas (cf. *inter alia* Boas 2003; Bybee and Eddington 2006; Zeschel 2009; Perek in press); since alternation-based generalizations correspond to the highest level of abstraction, they seem at odds with this conception of grammar. We suggest that speakers plausibly form cross-constructional categories for the same reason as they form any category: because they are useful to them. For one thing, organizing the construction into groups of semantically related constructions provides straightforward pathways to productivity: they provide speakers with an indication as to what the possible forms of their language might be, in that the occurrence of some verb in a particular allostruction triggers the expectation that this verb can also be used in the other allostructions of the constructeme. Such a process seems to be at play in the course of language acquisition, for example with children erroneously using verbs in a variant of the dative alternation in which they are not allowed by the conventions of their language, e.g. *Don't say me that* (Gropen et al. 1989). Similar phenomena are also attested in adult speech, albeit to a much lesser extent (cf. Pinker 1989: 153–160). What is more, as we briefly mentioned in Section 1, it is suggested in usage-based accounts of language acquisition that children recover from such errors through repeated exposure to the use of a verb in the conventional but less felicitous construction (according to such contextual considerations as information structure), a mechanism referred to as statistical premption (cf. Goldberg 2006: 5.1). Interestingly, this mechanism presupposes that children notice the relatedness of formally distinct constructions (which they do, as shown by Goldwater et al. 2011), a fact which is readily captured by positing a level of constructemes. The influence of alternations can also be observed on the diachronic plane, as there are cases of language change involving variation in the scope of an alternation. For example, while the use of *provide* in the double-object construction is still disallowed in present-day British English, this is no longer the case in some post-colonial varieties, as it is reported to be gaining acceptance in American English and is perfectly acceptable in contemporary Indian English (cf. Mukherjee and Hoffmann 2006). Such cases point

to the fact that speakers arguably recognize the equivalence of constructions in synchrony and exploit this knowledge to increase the encoding capacities of their language.

There are clearly many other cognitive aspects of alternations that are yet to be explored. Notwithstanding, we hope to have shown that viewing alternations as a higher level of grammatical generalizations is a thought-worthy (and yet under-studied) avenue of research which deserves more attention in the construction grammar literature.

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Albert-Ludwigs Universität Freiburg &
Université Lille III

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