The Dative Illusion as an Argument for Lexicalist Argument Structure*

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1 Introduction: Argument Structure and the Dative Alternation

A particularly fruitful way of studying language processing has been to study cases when comprehenders arrive at unfaithful representations of linguistic input—so-called linguistic illusions. Here, I present a previously unnoted linguistic illusion arising at the level of argument structure: participants in two plausibility judgement studies failed to enforce a restriction requiring inanimate goal arguments in double object constructions with dative verbs when the goal argument had been extracted. However, this illusory licensing only occurred with a subclass of verbs allowing an alternative argument structure with which the extracted goal would have been licensed. Existing theories of how linguistic illusions arise have difficulty accounting for this result. Furthermore, since this illusion only occurs with a subclass of dative verbs, the results here support a lexicalist approach to their argument structure.

As is well-known, English dative verbs display an interesting asymmetry in their argument structures: the possible goal arguments they can take depends on the construction they occur in (Gropen *et al.* 1989; Krifka 1999, 2004; Pinker 2007; Rappaport Hovav & Levin 2007; Viau 2006). This is shown in (1)–(2):

(1) *Animate goal*:
    a. John sent a package to Bill. (= Prepositional Dative (PD))
    b. John sent Bill a package. (= Double Object (DO) Dative)

(2) *Inanimate goal*:
    a. John sent a package to London.
    b. # John sent London a package.

Here, the (a) sentences occur in the prepositional dative (PD) construction, while the (b) examples show the double object (DO) construction. (1) shows that with an animate goal, both constructions are acceptable. However, (2) shows that with an inanimate goal, only the PD construction is allowed, with the DO construction being ruled out. Note that (2b) is acceptable on a reading where *London* stands for something like *the people at the London office*—but on such a reading, *London* metonymically refers to something animate, so the generalization still holds.

This pattern has led to a generalization that the DO construction is only allowed if the goal is a potential possessor of the theme. In turn, this generalization has led to the proposal that each construction carries a different meaning, as follows:

(3) *The Uniform Multiple Meaning Approach to the Dative Alternation* (Harley 2002; Rappaport Hovav & Levin 2007, *a.m.o.*):

    a.   DO = "AGENT causes GOAL to have THEME"

    b.   PD = "AGENT causes THEME to { go to / be at } GOAL"

Such a proposal treats the DO construction as meaning "cause-to-have," with the PD construction meaning "cause-to-go." An equivalent way of putting things is that the DO construction requires a (potential) possessor goal, while the PD construction takes a locative goal. We can assume that animate, possessor goals can be thought of in terms of their locations (explaining why possessors are allowed in the PD construction), but that mere locations cannot be thought of as possessors.

These sorts of meanings are intended as kind of abstract templates, with different verbs interacting with them in different ways. For instance, some dative verbs, like *promise*, have a meaning that is better paraphrased as "intend-to-cause-to-have," rather than "cause-to-have."

(4)   John promised Bill a book.   ($\neq$ John caused Bill to have a book.)

Such minor differences are presumably built into the lexical semantics of the verb, or into our world knowledge regarding the practicalities of different types of events, and can be safely placed aside.

Different theories of argument structure formalize the Uniform Multiple Meaning Approach to the dative alternation in different ways. In this way, we can distinguish between three different kinds of theories of argument structure: lexicalist, neo-constructionist, and constructionist.

In lexicalist approaches to argument structure, words' lexical entries specify the syntactic categories and associated semantic roles of each of their arguments (Müller & Wechsler 2014; Wechsler 1995). Examples of lexicalist theories of argument structure include Head-Driven Phrase Structure Grammar (HPSG) (Pollard & Sag 1994) and Lexical Functional Grammar (LFG) (Dalrymple 2001), both of which also happen to be lexicalist theories of syntax as a whole. An HPSG-style formalization of the dative alternation as presented above might look like this (cf. Wechsler 1995):

(5)   a.   *send*, DO:
$$\begin{bmatrix} \text{SUBCAT} & \left\langle \text{DP}_x, \text{DP}_y, \text{DP}_z \right\rangle \\ \\ \text{ROLES} & \left\langle \left[\text{AG}[x] \right], \left[\text{REC}[y] \right], \left[\text{TH}[z] \right] \right\rangle \end{bmatrix}$$

     b.   *send*, PD:
$$\begin{bmatrix} \text{SUBCAT} & \left\langle \text{DP}_x, \text{DP}_z, \text{PP}[to]_y \right\rangle \\ \\ \text{ROLES} & \left\langle \left[\text{AG}[x] \right], \left[\text{LOC}[y] \right], \left[\text{TH}[z] \right] \right\rangle \end{bmatrix}$$

(5) shows two (partial) lexical entries for *send*: one for each of the PD and DO constructions. In each case, the SUBCATegorization matrix specifies the number and syntactic categories of each argument the verb takes, while the thematic ROLES matrix specifies the thematic role of each argument. The mapping between the subcategorization matrix and the thematic roles matrix is encoded by the subscripts on each argument. The difference between the two lexical entries describes the restrictions on the dative alternation: in (5a), *send* selects three DPs, and assigns the thematic roles AGENT, RECIPIENT, and THEME (note that the recipient may simply be an intended recipient, as receipt of the theme is not entailed by *send*). In contrast, (5b) selects two DPs and a PP headed by *to*, and assigns the thematic roles AGENT and THEME to the DPs, and LOCATION to the PP. This, then, is a way of expressing the hypothesis above: DO *send* encodes a caused possession meaning by virtue of its assigning a RECIPIENT thematic role, and PD *send* encodes a caused motion meaning by virtue of its assigning a LOCATION thematic role.

In contrast, for neo-constructionist approaches what it means for a DP to bear a particular θ-role is no more and no less than its being in a particular position relative to a particular functional head. This necessitates a hypothesis about the syntax of these functional heads and where they occur relative to each argument and the verb to formalize (3). Here's an example of one such approach (cf. Harley 2002, 2011):

(6)

θ-role		Position of DP
AGENT	$\approx$	Spec,vP
THEME	$\approx$	Comp,P_{HAVE} or Spec,P_{LOC}
LOCATIVE GOAL	$\approx$	Comp,P_{LOC}
RECIPIENT	$\approx$	Spec,P_{HAVE}

(7) a. *send*, DO: b. *send*, PD:
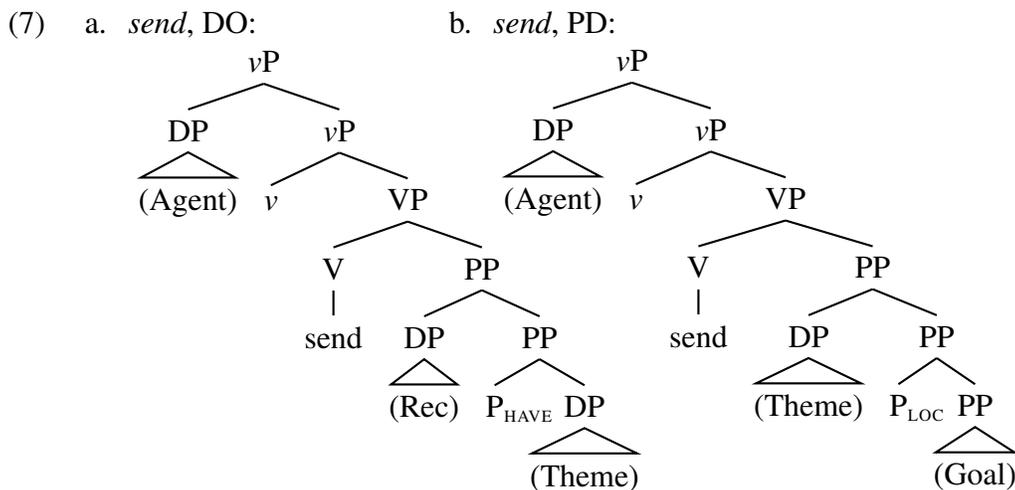
To account for the dative alternation, a neo-constructionist style approach would posit two functional heads, P_{HAVE} and P_{LOC}, that differ in the thematic roles they assign to their complement and their specifier as shown in (6). Such an analysis implies the structures shown in (7) (Harley 2002). Something worth noting is that

there is a large possible variety of neo-constructionist style approaches, depending on the specifics of the functional heads proposed and the positions associated with each thematic role. In addition, few neo-constructionists take a purely neo-constructionist approach; most use some mix of lexicalist and neo-constructionist solutions to different problems depending on what seems best. Nevertheless, some approaches to the dative alternation do take a neo-constructionist approach like the above (cf. Harley 2002; Pesetsky 1995) Later, when I argue against a neo-constructionist style approach to different classes of dative verbs, it should be kept in mind that I am arguing against a *purely* neo-constructionist style approach to the argument structure of these verbs, and not against a neo-constructionist approach to any such problem, or to this approach to syntax in general.

Finally, in constructionist approaches to argument structure, DPs receive thematic roles based on where they occur in a construction, which contributes its own thematic roles. Goldberg (1995) presents such an approach:

(8)　　a.　　*Caused Possession Construction*:

Sem	CAUSE-RECEIVE	<	AG	REC	PAT	>
	|		|	┊	|	
	PRED	<				>
	↓		↓	↓	↓	
Syn	V		SUBJ	OBJ	OBJ$_2$	

　　　　b.　　*Caused Motion Construction*:

Sem	CAUSE-MOVE	<	CAUSE	GOAL	THEME	>
	|		|	┊	┊	
	PRED	<				>
	↓		↓	↓	↓	
Syn	V		SUBJ	OBL	OBJ	

One way of thinking about constructionist approaches is that they attempt to generalize across the kind of lexical entries found in a lexicalist approach. As such, we find much of the same information expressed in this formalization as was found in the lexicalist approach. Each construction contains a list of the sem(antic) roles it occurs with. A solid line from the semantic role to the PREDicate line indicates that the semantic role provided by the construction associates with one provided by the predicate itself. A dashed line indicates that the construction adds that thematic role to those provided by the predicate. The predicate and thematic roles are then linked to their syn(tactic) function. The difference between the caused possession and caused motion constructions is that the caused motion construction adds a RE-CIPIENT role that it assigns to the first object position, while the caused motion construction adds GOAL and THEME roles that it maps to oblique and object positions, respectively. Plugging the verb *send* into either of these will give different results, since the thematic roles provided by each construction are different.

2　Classes of Dative Verbs

The above approaches to the dative alternation, couched in terms of different theories of argument structure, are all based on the Uniform Multiple Meaning Ap-

proach presented in (3). However, Rappaport Hovav & Levin (2007) present evidence that this approach cannot be correct; in particular, some verbs always encode caused possession, as they are infelicitous with non-possessor arguments regardless of the construction they occur in. One example is *give*:

(9)   *Possessor goal*:
        a.   John gave a package to Bill.
        b.   John gave Bill a package.

(10)   *Non-possessor goal*:
        a.   # John gave a package to London.
        b.   # John gave London a package.

Note the contrast between (10a) and (2a): *send* allows non-possessor goals in the PD construction, while *give* does not. Other dative verbs pattern with one or the other of these (Rappaport Hovav & Levin 2007):

(11)   a.   *Give*-type verbs:
            give, promise, offer, hand, feed, trade, tell, sell, owe, loan, . . .
        b.   *Send*-type verbs:
            send, pitch, email, toss, ship, forward, mail, fax, lob, throw, . . .

Further distinctions between verbs belonging to each subclass can be drawn, but they are not relevant to the dative alternation. Rappaport Hovav & Levin (2007) use these differences between verb classes to argue for a Verb-Sensitive Approach to the dative alteration, which can be summarized as follows:[1]

(12)   *The Verb-Sensitive Approach* (Rappaport Hovav & Levin 2007):

	PD construction	DO construction
Give-type verbs	Caused Possession	
Send-type verbs	Caused Motion/Possession	Caused Possession

3   Experiment 1

Experiment 1 tested the predictions of the Verb-Sensitive Approach in sentences with and without goal extraction to determine how dative verb class information affects acceptability. In simple sentences, replication of the judgements Rappaport Hovav & Levin present was predicted, as they are quite robust even in offline intuitive measures: *give*-type verbs with non-possessor goals are predicted to be unacceptable regardless of the construction they occur in; while *send*-type verbs should be acceptable with non-possessors in the PD construction only, as this is the only case when a caused motion reading is acceptable. If the Verb-Sensitive Approach is confirmed in this way, it provides support for an at least partially lexicalist approach

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[1]As an aside, note that Rappaport Hovav & Levin's approach allows for *send*-type verbs to receive a caused possession meaning in the PD construction. We could think of this as a different possible reading, or as an implicature arising when the location is also a potential possessor. The availability of this reading is irrelevant for my purposes here.

to argument structure, insofar as we must encode the verb-type differences somewhere. The question of where exactly these verb-type differences must be encoded is addressed in experiment 2.

Experiment 1 also tested dative sentences with goal extraction. Extraction is known to make semantic type coercion and integration of semantically anomalous material easier (Bredart & Modolo 1988; Ferreira *et al.* 2002; Ferreira & Patson 2007; Lowder & Gordon 2016; Sanford & Sturt 2002). Experiment 1 asked whether these kinds of effects would extend to the goal type/verb class mismatch.

3.1 Materials

Twenty octuplets of experimental sentences were constructed, crossing the factors VERB-TYPE (*give*-type, *send*-type), CONSTRUCTION (DO, PD), and GOAL EXTRACTION (goal extracted, goal not extracted). All goals were non-possessors, as this is where the crucial interaction between construction and verb-type occurs in the Verb-Sensitive Approach. VERB-TYPE and CONSTRUCTION were manipulated within subjects, and GOAL EXTRACTION was manipulated between subjects. A sample item is shown in (13).

(13)   a.   *Non-Extracted Goal*:

Jane $\left\{\begin{array}{c}\text{loaned}\\\text{threw}\end{array}\right\}\left\{\begin{array}{c}\text{the countertop some keys}\\\text{some keys to the countertop}\end{array}\right\}$.

    b.   *Extracted Goal*:

The countertop that Jane $\left\{\begin{array}{c}\text{loaned}\\\text{threw}\end{array}\right\}$ some keys $\left\{\begin{array}{c}-\\\text{to}\end{array}\right\}$ is all the way across the room.

The verbs used were those listed in (11), with each verb used twice, for a total of 10 *give*-type verbs and ten *send*-type verbs. There were also 68 filler items of various types, for a total of 88 sentences in the experiment.

3.2 Methods

Participants rated the experimental and filler sentences for plausibility on a scale ranging from 1 (completely implausible) to 7 (completely plausible). Items were run in a Latin Squares design, such that each participant saw an experimental item in only one of the eight conditions. Forty-eight self-reported native English speakers were recruited for experiment 1 on Amazon's Mechanical Turk platform; 24 ran the non-extracted goal experiment, and 24 ran the extracted goal experiment, with 6 participants in each list. Participants were paid $3.50 for the approximately 20 minute long experiment, and provided informed consent beforehand. The experiment was hosted on IbexFarm (Drummond 2011).

3.3 Results

Mean ratings for experiment 1 are shown in table 1. The key result was a three-way interaction between VERB-TYPE, CONSTRUCTION, and GOAL EXTRACTION, revealed in $2 \times 2 \times 2$ ANOVA both by subjects ($F_1(1, 46) = 7.62$, $p < 0.05$) and by items ($F_2(1, 19) = 6.44$, $p < 0.05$). Participants rated *send*-type verbs in the DO

non-extracted goal condition lower than *send*-type verbs in other conditions (indicated by the dashed rectangle). The Dative Illusion is the fact that goal extraction results in higher ratings for the DO, *send*-type, goal extracted sentences, putting them on a par with *send*-type, PD sentences (indicated by the solid rectangles)—despite the fact that DO, *send*-type sentences are rated low in non-goal-extracted contexts (due to their incompatibility with a caused motion reading).

Separate ANOVA run on only the non-extracted goal data revealed a CONSTRUCTION × VERB-TYPE interaction ($F_1(1, 23) = 27.21$, $p < 0.05$; $F_2(1, 19) = 24.96$, $p < 0.05$). In sentences without goal extraction, *give*-type verbs received lower ratings relative to *send*-type verbs in the PD construction compared to the DO construction.

	Goal Extracted		Goal Not Extracted	
	Give-type	*Send*-type	*Give*-type	*Send*-type
DO	2.60	4.25	1.68	2.57
PD	2.41	4.54	1.92	4.32

Table 1: Mean ratings per condition (Experiment 1)

3.4 Discussion
3.4.1 Models of Interpretive Illusions
The two-way interaction for sentences without goal extraction shows that *send*-type verbs get a bigger advantage in the PD condition relative to the DO condition than *give*-type verbs do—precisely when *send*-type verbs can license non-possessor goals, such as the ones used in the experimental sentences. This supports Rappaport Hovav & Levin's (2007) Verb-Sensitive Approach to the dative alternation.

For sentences with extracted goals, the illusory licensing of non-possessor goals with *send*-type verbs in the DO, goal extracted condition complicates the picture. What we see is that when goal extraction occurs, a non-possessor goal is licensed in a construction that disallows it when goal extraction does not occur—but only for *send*-type verbs. These results are hard to explain with depth of processing (Bredart & Modolo 1988; Erickson & Mattson 1981; Sanford & Sturt 2002) or good-enough processing (Ferreira *et al.* 2002; Ferreira & Patson 2007) approaches. In particular, these accounts have a hard time accounting for the verb-type differences: *send*-type verbs are subject to the Dative Illusion, while *give*-type verbs are not. This shows that fine-grained lexical semantic information is being processed at least deeply enough for the parser to distinguish between *give*- and *send*-type verbs. An attempt to save this kind of approach might assume that lexical information is always processed deeply, while syntactic information is not (though this is not standard).

An account treating the Dative Illusion as semantic coercion—along the lines of coercing *London* to mean *the people at the London office*—à la Lowder & Gordon (2016) would also fail to account for the verb-type difference. Coercion should be able to occur with both *give*- and *send*-type verbs, and we might have expected greater coercion with *give*-type verbs, since they always require possessor goals.

Another family of approaches that fares better is the noisy-channel model (Gib-

son *et al.* 2013; Levy 2008; Levy *et al.* 2009). These approaches treat interpretive illusions as arising from probabilistically modulated "corrections" that the parser makes to the linguistic input. In other words, the more likely an implausible sentence was the result of the corruption of a plausible sentence, the more likely it is comprehenders will interpret it as having the meaning of the plausible sentence.

This is particularly relevant for experiment 1's results, since it is reported that DO sentences with goal extraction are degraded for some speakers (e.g., Beckman 1996). It is plausible that participants were "correcting" these sentences to PD sentences, as it requires only one simple modification: inserting *to* after the theme:

(14)   The countertop that Jane threw some keys ⌐ was all the way across the room.
        The countertop that Jane threw some keys to was all the way across the room.

DO sentences without goal extraction are harder to correct this way, since doing so would require reversing the order of the arguments, making them less similar to a plausible PD sentence. Sentences with *give*-type verbs would have to be corrected by completely replacing the verb, which is an intuitively unlikely corruption.

3.4.2   The Locus of Thematic Roles

The difference between *give*- and *send*-type verbs, shown in both the analysis of the items without goal extraction and in their differential susceptibility to the Dative Illusion, supports the Verb-Sensitive Approach to the dative alternation. However, experiment 1's results could be made consistent with both lexicalist and neo-constructionist approaches to argument structure, assuming the noisy-channel model approach sketched above is on the right track. (I return to constructionist approaches in the general discussion.)

A lexicalist approach would explain the verb-type differences by assuming that *give*-type verbs always assign a recipient θ-role, while *send*-type verbs assign recipient in the DO construction, and may assign location in the PD construction. Presumably, goal extraction somehow interacts with how these roles are assigned in processing in a way that leads to the Dative Illusion.

A neo-constructionist approach could account for these data by having verbs select for θ-roles indirectly (cf. Pesetsky 1995, ch. 5). For instance, one could say that *give*-type verbs may select either of two functional heads: P_{HAVE} (in the DO construction) and to_{POSS}, a possessional variant of *to* (in the PD construction) (cf. Wechsler 1995). Each of these functional heads selects a recipient argument (though they would differ with regards to whether they combine with this argument first or second). In contrast, *send*-type verbs could select P_{HAVE} (in the DO construction) and to_{LOC} (in the PD construction). Thematic restrictions would be encoded by the verb only indirectly, mediated by the kinds of functional heads each can select. To account for the Dative Illusion, assume that comprehenders can only correct a sentence by reinserting a preposition licensed by the verb; the difference in which prepositions each verb can select leads to the verb-type differences, as only *send*-type verbs are compatible with reinsertion of the to_{LOC} necessary to license non-possessor goals. For *give*-type verbs, reinserting to_{HAVE} won't fix the θ-role mismatch; and to_{LOC} cannot be inserted, as they do not license it.

4 Experiment 2

Experiment 2 tested whether the noisy-channel model could account for the Dative Illusion, and whether the lexicalist or mediated neo-constructionist approach was more compatible with it. This was done by comparing Dative Illusion sentences (i.e., PD, goal extracted, *send*-type sentences) to sentences missing prepositions.

4.1 Materials

To test whether repair processes for Dative Illusion sentences and missing preposition sentences were different, half the participants saw a STRICT set of instructions, and half saw a LENIENT set of instructions. These told participants to rate sentences exactly as they appeared (strict), or to allow some leeway for typos and small omissions (lenient). If Dative Illusion sentences showed sensitivity to instruction type, while missing preposition sentences did not, or vice versa, it would show that Dative Illusion sentences are subject to different repair processes, arguing against a noisy-channel, preposition insertion approach.

Experiment 2 used the same items as experiment 1, but restricted to only *send*-type verbs, as these were the items displaying the crucial Dative Illusion effect. This left four conditions, crossing CONSTRUCTION (DO, PD) and GOAL EXTRACTION (goal extracted, goal not extracted). The Dative Illusion would appear as an interaction between CONSTRUCTION and GOAL EXTRACTION, with an interaction or lack thereof with INSTRUCTION TYPE indicating whether the Dative Illusion was a conscious or unconscious process. The prediction was that the Dative Illusion interaction would be found in at least the lenient instruction condition.

GOAL EXTRACTION was made a within subjects factor, unlike experiment 1, both to achieve greater power as well as to make a replication of the Dative Illusion more convincing by showing that it did not rely on participants being exposed to sentences with either only goal extraction or only without it.

A sample item for experiment 2 is shown in (15):

(15)   a.   *Non-extracted goal*:

Jane threw $\left\{ \begin{array}{l} \text{the countertop some keys} \\ \text{some keys to the countertop} \end{array} \right\}$.

   b.   *Extracted goal*:

The countertop that Jane threw some keys $\left\{ \begin{array}{l} - \\ \text{to} \end{array} \right\}$ was all the way across the room.

In addition, there were 52 (well-formed) fillers of various types. Thirty-two of these were coded as plausible or implausible (16 each), as a way to determine whether participants were using the scale to rate plausibility as intended.

Finally, there were 10 ill-formed control items, in a randomized block presented at the end of the experiment. Participants were given no indication that this block was any different from the rest of the experiment. Of the controls, 5 were sentences missing a preposition, and 5 had intuitively plausible typos. It was assumed that at least the typo items would be sensitive to the instruction type manipulation, as this error presumably does not affect the parser proper, this being specialized for spoken language. Sample control items are shown in (16):

(16)   a.   *Missing preposition*:
The train that Zack was waiting was delayed due to an accident.

(Missing *for* after *waiting*)

         b.   *Typo*:
The new care that Chuck got at the dealership had expensive lea-
ther upholstery.   (*car* → *care*)

4.2 Methods

Sentences were presented in two chunks that separated the subject and the predi-
cate. Reading times were measured for each chunk. Participants faced the same
plausibility rating task as in experiment 1. Sixty-four self-reported native English
speakers were recruited using Amazon's Mechanical Turk platform, 32 for each
instruction condition, and 8 per list in a Latin Squares design. They were paid
$3.50 for the approximately 20 minute experiment, and provided informed consent
beforehand. The experiment was hosted on IbexFarm (Drummond 2011).

4.3 Results
4.3.1 Experimental Items

Reading times will not be discussed, as no informative results appeared. Mean
ratings per condition for experimental items are shown in table 2. A $2 \times 2 \times 2$
ANOVA with factors INSTRUCTION TYPE, CONSTRUCTION, and GOAL EXTRAC-
TION revealed an interaction of CONSTRUCTION and GOAL EXTRACTION ($F_1(62)$
$= 60.26, p < 0.05; F_2(19) = 27.36, p < 0.05$). No interactions with instruction type
were found, though a main effect of instruction type was found by items ($F_1(62) =$
$1.16, p > 0.05; F_2(19) = 7.76, p < 0.05$).

	DO		PD	
	Extracted	Not Extracted	Extracted	Not Extracted
Strict Inst.	4.23	2.71	4.81	4.65
Lenient Inst.	4.46	2.73	5.20	4.74

Table 2: Mean ratings per condition (Experimental items, Exp. 2)

4.3.2 Plausible and Implausible Fillers

Mean ratings for plausible and implausible fillers are shown in table 3. An 2×2
ANOVA with factors INSTRUCTION TYPE and PLAUSIBILITY showed a main effect
of plausibility ($F_1(62) = 2239.84, p < 0.05; F_2(30) = 146.19, p < 0.05$). Instruction
type had no effect on fillers, either as a main effect or an interaction.

	Plausible	Implausible
Strict Inst.	6.03	2.09
Lenient Inst.	6.04	2.04

Table 3: Mean ratings per filler type (Fillers, Exp. 2)

4.3.3 Ill-formed Controls

Mean ratings for control items are shown in table 4. A 2×2 ANOVA with factors INSTRUCTION TYPE and ERROR TYPE revealed a main effect of instruction type ($F_1(1, 62) = 36.86$, $p < 0.05$; $F_2(1, 8) = 28.61$, $p < 0.05$). A main effect of error type was found only by subjects ($F_1(1, 62) = 18.89$, $p < 0.05$; $F_2(1, 8) = 0.65$, $p > 0.05$). Separate ANOVA were run on the missing preposition items alone, as these were the items crucial to evaluating the noisy-channel account of the Dative Illusion. These revealed a main effect of instruction type ($F_1(1, 62) = 17.99$, $p < 0.05$; $F_2(1, 4) = 35.74$, $p < 0.05$).

	Missing Prep.	Typo
Strict Inst.	4.47	4.94
Lenient Inst.	5.42	6.14

Table 4: Mean ratings per error type (Control items, Exp. 2)

4.4 Summary

Ratings of fillers did not show an effect of instruction type, but did show a main effect of plausibility; this shows that participants were using the scale to rate plausibility, and did not interpret lenient instructions as an invitation to rate implausible sentences as more plausible.

The interaction of CONSTRUCTION and GOAL EXTRACTION on experimental items replicates the Dative Illusion: participants rated sentences with goal extraction higher than sentences without goal extraction, despite the design changes between experiments 1 and 2.

Participants treated ill-formed controls, including missing preposition controls considered alone, differently depending on the instructions they saw, as shown by the main effect of instruction type on ratings. However, no interactions with instruction type appeared in the analysis of the experimental items or the fillers. This shows that participants were repairing Dative Illusion and missing preposition sentences differently; ratings for Dative Illusion sentences did not vary with instruction type, while ratings for missing preposition sentences did.

5 General Discussion
5.1 Models of Interpretive Illusions

Existing models of interpretive illusions are hard-pressed to explain the results of experiment 2. Depth-of-processing and good-enough processing approaches that would explain the results of experiment 1 as due to a failure to process a missing *to* would fail to account for the difference between experimental items and missing preposition controls; four of five of the missing preposition controls were missing a preposition in an object relative clause, the same environment where the Dative Illusion sentences were missing *to*. On such an account, we would expect no difference between the experimental object relative clauses and the missing preposition object relative clauses with regards to their sensitivity to the instruction type ma-

nipulation, given that the repair processes applying to these sentences would be the same. Such a difference was found, arguing against this approach.

Furthermore, experiment 2's results provide evidence against the noisy-channel approach to experiment 1's results. Missing preposition controls were as far from a plausible counterpart as the experimental items (i.e., one preposition was missing). Nevertheless, participants responded differently to these items than to the experimental items: instruction type affected responses to missing preposition controls, while there was no evidence of this for the experimental items. This suggests that the repair processes involved in each type of sentence are different.

A concern here has to do with order effects: control items were presented in a block at the end of the experiment. Seeing multiple ill-formed controls in a row may have changed the context of the experiment, and made participants treat the missing preposition items differently from the experimental items presented in a random order interspersed with filler items. To address this, an ANOVA on INSTRUCTION TYPE was run on the first missing preposition item seen by each subject. The effect of INSTRUCTION TYPE was significant by subjects ($F_1(1, 62) = 4.66$, $p < 0.05$), though not by items. Significance by items occured at the second missing preposition control seen ($F_2(1, 4) = 13.33$, $p < 0.05$). Presumably this is due to a lack of power by items when only considering one item. Note also that the first missing preposition control that subjects saw was either the first or second control item overall (if it was the second one seen, the first was a typo). This constitutes evidence that participants' ratings of missing preposition controls was dependent on instruction type from the first missing preposition control, despite no effect of instruction type on experimental items. This suggests that participants were processing the experimental items and controls differently from the first time they encountered them.

5.2   The Locus of Thematic Roles

As repair mechanisms for experimental items and missing preposition controls are different—shown by the difference in their sensitivity to the instruction type manipulation—we cannot assume that the Dative Illusion is the result of only being able to reinsert a preposition selected by particular types of verbs. There is, in fact, no evidence that participants were reinserting a preposition in Dative Illusion sentences. These results thus argue against the mediated neo-constructionist approach described in §3.4.2, and for a lexicalist approach to argument structure for dative verbs, in which argument roles are stated in the lexical semantics of the verb itself.

In addition, the results point to a model of sentence processing where argument structure is assessed together with the lexical semantics of the verb: the Dative Illusion can arise only if the dative verb in the sentence occurs with an alternative argument structure that would permit mapping the extracted goal to a plausible role. It does not occur for *give*-type verbs, for which such an alternative argument structure is not available. A visualization of the Dative Illusion in this view is presented in fig. 1 using HPSG as a formalism (cf. Wechsler 1995).

Under this view, illusory *send* blends the subcategorization properties of DO *send* with the thematic role selection properties of PD *send*. Allowing a non-lexically licensed mapping like this may be easier across clause boundaries, following the general pattern identified in Lowder & Gordon (2016). Unlike *send-*
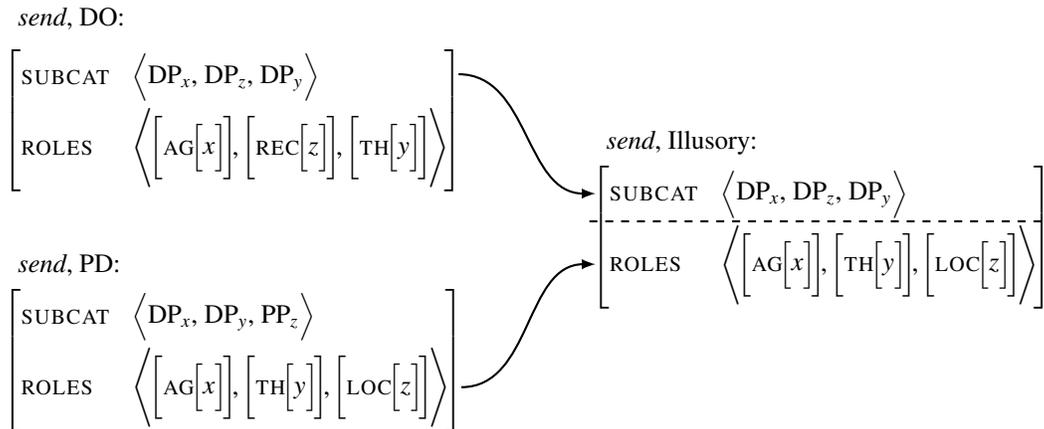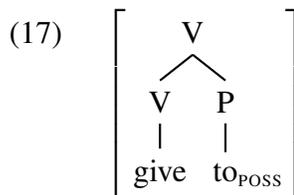
send, DO:

$$\begin{bmatrix} \text{SUBCAT} & \langle \text{DP}_x, \text{DP}_z, \text{DP}_y \rangle \\ \text{ROLES} & \left\langle \left[\text{AG}[x]\right], \left[\text{REC}[z]\right], \left[\text{TH}[y]\right] \right\rangle \end{bmatrix}$$

send, Illusory:

$$\begin{bmatrix} \text{SUBCAT} & \langle \text{DP}_x, \text{DP}_z, \text{DP}_y \rangle \\ \hdashline \text{ROLES} & \left\langle \left[\text{AG}[x]\right], \left[\text{TH}[y]\right], \left[\text{LOC}[z]\right] \right\rangle \end{bmatrix}$$

send, PD:

$$\begin{bmatrix} \text{SUBCAT} & \langle \text{DP}_x, \text{DP}_y, \text{PP}_z \rangle \\ \text{ROLES} & \left\langle \left[\text{AG}[x]\right], \left[\text{TH}[y]\right], \left[\text{LOC}[z]\right] \right\rangle \end{bmatrix}$$

Figure 1: An HPSG Derivation of Illusory *send*

type verbs, *give*-type verbs always require a recipient, so there is no source for a LOCATIVE GOAL role that could result in the illusory blend.

It should be noted that the use of HPSG here is intended as a notational convenience, as it makes it easy to visualize how the blend could come about in a lexicalist view of the argument structure of dative verbs. Approaches more in line with the kinds of approaches to syntax assumed in neo-constructionist accounts are possible as well. While the mediated neo-constructionist account with multiple *to*s detailed above wouldn't explain the difference between experimental items and missing preposition controls, another way of using a syntax more like that in (7) would be to say that rather than PD *give* selecting *to*$_{\text{POSS}}$, it "includes" it in a way that the missing preposition items didn't include the missing prepositions. The word *give*, then, would look like (17).

(17)
$$\begin{bmatrix} \begin{array}{ccc} & \text{V} & \\ & \diagup\diagdown & \\ \text{V} & & \text{P} \\ | & & | \\ \textit{give} & & \textit{to}_{\text{POSS}} \end{array} \end{bmatrix}$$

This is essentially a lexicalist approach, with a redefinition of what "word" means to include this sort of structure. We could also use a neo-constructionist-style syntax and say that the thematic role RECIPIENT is part of the denotation of *give*-type verbs. These approaches all end up being equivalent for my purposes: the key is that the thematic role is specified directly by whatever we mean by "the verb."

A constructionist approach has difficulty accounting for the verb-type differences found in experiment 1, much less the illusion. To account for the verb-type differences, assume that it is possible to derive a caused possession meaning from a caused motion construction, as seen with PD *give* sentences. This would be allowed by a metaphorical mapping between constructions, "transfer of ownership as physical transfer" (Goldberg 1995). We would then have to stipulate that this mapping always applies to *give*-type verbs, even when it seems like there could be a plausible caused motion reading, as in (18):

(18)   # John handed a book to the table.
      ≠ John caused a book to be on the table by placing it there with his hands.

We essentially have to stipulate that *give*-type verbs only allow possessor goals—which once again places the thematic role in the lexicon.

Even assuming this approach to the verb-type differences, accounting for the Dative Illusion would require going further, positing that participants could derive a caused motion (i.e., PD) reading from a caused possession construction (i.e., DO)—the opposite mapping from what is required to explain the verb-type differences. But again, this mapping could only be achieved for *send*-type verbs, as they are the only ones showing the illusion. The problem this raises is that this mapping is usually disallowed in sentences without goal extraction. Accounting for the illusion would require lexically restricting an illusory metaphorical mapping. This seems highly undesirable, as it requires us to put a processing fact into the grammar.

Together, then, experiments 1 & 2 provide evidence that the RECIPIENT role of *give*-type verbs is stated in their lexical entries—it is not mediated by a functional head nor introduced by the DO construction itself. This is an important result for theories of argument structure, as it shows that different theories allow for different patterns of processing effects. Evidence that superficially similar structures are processed differently pushes us toward theories that treat these structures as different.

These results also bear on models of interpretive illusions by showing that they can arise due to a failure to enforce the proper syntax/semantics mapping, beyond shallow processing of syntax or semantics alone. In fact, the results here show that embedded clause material was processed deeply both semantically and syntactically—semantically, because verb-class differences appeared in embedded clauses; syntactically, because participants noticed missing prepositions in controls in embedded clauses. Crucially, what goes wrong in the Dative Illusion lies in the mapping between syntax and semantics, while syntax and semantics alone are each processed correctly.

More research is needed to determine which properties of goal extraction sentences led to the failure to enforce the syntax/semantics mapping restrictions. But already these results provide justification for seeking a model of language that not only provides straightforward explanations of what happens when parsing goes right, but also of why parsing fails in the particular ways it does. Figuring out how and where an interpretive illusion can occur carries important implications for where thematic roles should reside in theories of argument structure.

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