The Partitive Constraint in Optimality Theory

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Abstract

This paper discusses a case of syntax/semantics interaction of a characteristically optimality-theoretic kind. Finnish partitive constructions exhibit a case alternation that is partly semantically, partly syntactically driven. The crucial semantic condition that plays a role in case selection is quantitative determinacy, which replaces the definiteness condition familiar from the Partitive Constraint. The crucial syntactic condition is the Case-OCP which prohibits the assignment of the same case to both the head and its sister. The syntactic and semantic constraints conflict which leads to various kinds of outcomes, including free variation and ambiguity, as well as preferences in expression and preferences in interpretation. We develop an optimality-theoretic analysis of these facts based on partially ordered optimality-theoretic grammars. In such grammars, conflicts among semantic and syntactic constraints are resolved in terms of ranking. Partial ordering is crucial in deriving preferences in expression as well as interpretation, including blocking effects.

1. Introduction

1.1. Preliminaries

Current work in Optimality Theoretic (OT) syntax and semantics has been concerned with two closely related questions.[1]

(1)
- OT SYNTAX. Given a semantic input, what is its optimal expression?
- OT SEMANTICS. Given a syntactic input, what is its optimal interpretation?

OT syntax takes the 'speaker's perspective': given a well-formed semantic input, the goal is to select the optimal syntactic expression for this input from among a set of competing candidate expressions (see e.g. Bresnan 1997, Aissen 1999, Bresnan to appear). OT semantics takes the 'hearer's perspective': given a well-formed syntactic input, the goal is to select the optimal semantic interpretation for this input from among a set of competing candidate interpretations (see e.g. de Hoop and de Swart 1999, Hendriks and de Hoop 1999). A third alternative is bidirectional optimization (Blutner 1999) where both types of optimization are carried out simultaneously.[2]

We first recognize that the question both OT-syntax and OT-semantics attempt to answer is essentially nondirectional and can be stated as in (2):

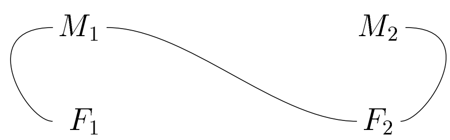
(2) What are the possible form/meaning relations?

Let us briefly consider the possible types of mappings between meanings and forms. In addition to one-to-one mappings (one-meaning-one-form), we find one-to-many mappings from meaning to form, which we call VARIATION, and one-to-many mappings from form to meaning, which we call AMBIGUITY. This is presented schematically in (3):

[1] The following abbreviations are used in the glosses: ELA: elative; INE: inessive; PAR: partitive; PL: plural; 1P: 1st person.

[2] Implicit in all these approaches is the assumption that the input to OT-syntax is a well-formed semantic representation and the input to OT-semantics is a well-formed syntactic representation. In other words, there are two levels of representation: a purely syntactic level that checks the well-formedness of syntactic representations and a purely semantic level that checks the well-formedness of semantic representations. The levels are independent of each other and come with their own well-formedness conditions, perhaps stated as optimality-theoretic grammars. In this paper, the terms 'OT-syntax' and 'OT-semantics' are construed narrowly as referring to theories of form/meaning correspondence.

(3) Variation and ambiguity



In this schematic example, the form F_1 is unambiguous whereas F_2 has multiple meanings (i.e. is ambiguous). Conversely, the meaning M_1 has multiple expressions (i.e. is variable), whereas M_2 is invariant.[3] At a more subtle level, we find the phenomenon of PREFERRED INTERPRETATIONS and PREFERRED EXPRESSIONS which can be viewed as weighted versions of ambiguity and variation, respectively. Such preferences obviously presuppose a quantitative treatment of some kind. In this paper, we will propose an approach that extends to all four types of effects.

Our goal is to explore a particular way of drawing nondirectional maps between forms and meanings. We will take the perspective of OT syntax as our point of departure and see how it extends to the following empirical phenomena that we take as the central problems of our inquiry:

(4) The phenomena to be accounted for:

- Variation, preferred forms
- Ambiguity, preferred readings, semantic blocking
- Uninterpretability: Forms that get no interpretation
- Ineffability: Meanings that cannot be expressed

Of course, any theory of syntax and semantics must account for form/meaning relations in some way and our simple diagram is intended to be theory-neutral. However, Optimality Theory makes one very general claim about the nature of the form/meaning relation that distinguishes it from most alternative theories, in particular compositional theories of semantics:

[3]The fact that optionality is just the flip side of ambiguity is also noted by Asudeh (1999).

(5) • The constraints governing the form/meaning relation are conflicting and violable.

• The actually attested form/meaning relations are optimal solutions to these constraint conflicts resolved by means of ranking.

Thus, if Optimality Theory is correct, we would expect to find evidence for constraint conflict and conflict resolution of a particular kind and it is precisely the existence of such evidence that we will set out to demonstrate in this paper.

1.2. The Partitive Constraint

The specific empirical issue that we will be concerned with is the well-known semantic generalization dubbed the PARTITIVE CONSTRAINT (Jackendoff 1977, Selkirk 1977, Barwise and Cooper 1981, Ladusaw 1982). The Partitive Constraint states that in partitive constructions such as *some of the cats*, the embedded NP must be definite.[4] This point is made by the following examples:

(6)	a.	some of the cats	b.	*some of most cats
		most of the cats		*most of some cats
		three of my cats		*three of cats

Despite its sound core, the Partitive Constraint is beset with a number of well-known empirical problems that have led many to question its status as a semantic constraint. Among such problems are the unexpected well-formedness of *half of a cookie*, *one third of all rental apartments* and *one of a number of applicants* where the embedded NPs are not definite.[5] Such examples have given rise to various responses. For example, Reed (1991) and

[4] In our discussion, we follow Jackendoff (1977), Selkirk (1977), Barwise and Cooper (1981), and Ladusaw (1982) in treating partitives as comprising an upstairs determiner and a downstairs/embedded NP. For example, in a construction like *most of the twenty liberal delegates*, the upstairs determiner is *most*, and the downstairs NP is *the twenty liberal delegates*. This is different from the approach taken by Keenan and Stavi (1986) and Chomsky (1970), who treat *most of the twenty* as a determiner.

[5] According to Barwise and Cooper (1981), definite NPs are those that have a non-empty generator set. Among other things, this excludes universally quantified NPs such as *all rental apartments* (see also de Hoop 1997).

Abbott (1996) conclude that the Partitive Constraint is a pragmatic constraint at best, whereas de Hoop (1997) maintains that there is a semantic generalization involved, but reformulates it as a kind of semantic agreement between the upstairs determiner and the downstairs NP: if the upstairs determiner quantifies over entities, the downstairs NP must denote an entity; if the upstairs determiner quantifies over a set of entities, the downstairs NP must denote a set of entities. Thus, for example, *half of a cookie* is correctly predicted to be well-formed given that *half (of)* quantifies over entities and *a cookie* denotes an entity. For a more detailed summary of the issues, see the articles in Hoeksema 1996, and also de Hoop 1998 and Barker 1998.

As this brief discussion has already shown, partitive constructions such as *some of the cats* present three closely related questions:

(7)
- What are the constraints on the downstairs NP (*the cats*)?
- What are the constraints on the upstairs determiner (*some*)?
- How are the two related?

In this paper, we will address these questions by bringing in new evidence from a language where partitivity is expressed in terms of overt morphological case marking. In Finnish, the part-whole relation can be expressed by means of two distinct morphological cases on the downstairs NP: partitive (PAR) and elative (ELA). This case alternation occurs with a class of determiners that roughly correspond to 'entity determiners' in de Hoop's (1997) sense, including *kilo* 'kilo' and *kolmasosa* 'one third'. There is another class of determiners, roughly de Hoop's (1997) 'set determiners', which include *muutama* 'some', *kaikki* 'all', and cardinal numbers. These determiners induce a different case alternation and will not be discussed here. The observation that de Hoop's semantic distinction between entity determiners versus set determiners roughly coincides with an overt morphosyntactic distinction in Finnish is striking, but cannot be pursued in this paper.[6]

[6] Syntactically, entity determiners head the partitive construction (Hakulinen and Karlsson 1979, Vainikka 1993). This is evident from the fact that when the entire phrase is assigned a case, this case is morphologically realized on the determiner, while the sister NP retains its partitive case marking, e.g. *kilo-ssa omen-i-a* kilo-INE apple-PL-PAR 'in a kilo of apples'. In this paper, we will assume that both partitive NPs and elative NPs are sisters of the head and we continue to refer to them as 'downstairs NPs'. For further discussion, see Vainikka 1993, and Hakulinen and Karlsson 1979.

At first blush, the difference between partitive and elative seems to be indeed (in)definiteness, as shown in (8) and (9).

(8) a. kilo voi-ta
kilo butter-PAR
'a kilo of butter'

b. kilo voi-sta
kilo butter-ELA
'a kilo of the butter'

(9) a. kilo munkke-j-a
kilo donut-PL-PAR
'a kilo of donuts'

b. kilo munke-i-sta
kilo donut-PL-ELA
'a kilo of the donuts'

It might thus seem that the partitive case would parallel the English PSEUDOPARTITIVES (Selkirk 1977) such as *a number of cats* and *a kilo of butter* which allow embedded bare plurals and mass nouns prohibited in true partitives, and that the elative case would parallel the true partitives that are subject to the Partitive Constraint. This seems to be more or less what has been assumed in earlier work. For example, Chesterman (1991) and Alho (1992) claim that the partitive is indefinite, and the elative definite. However, a corpus of actually occurring examples readily shows that the indefinite/definite distinction is a rather poor approximation of the facts.[7] Thus, we must first answer the simple descriptive question: what determines the choice of case in Finnish part-whole expressions? We make the following claims which will be discussed further in section 2.

[7] Most of our examples are based on the *Suomen Kuvalehti 1987* corpus which contains all the 1987 issues of this Finnish weekly magazine. The corpus is available at the University of Helsinki Language Corpus Server at `http://www.ling.helsinki.fi/uhlcs`. When the authentic corpus examples were too long for quotation in full, we have taken the liberty of shortening and modifying them as appropriate.

(10) A preview of the basic observations:

- The choice of case depends on multiple constraints, some semantic, some syntactic. The most important semantic constraint will be referred to as Quantitative Determinacy, which differs from the definiteness condition in the original Partitive Constraint. The most important syntactic constraint is the Case-OCP which bans adjacent identical morphological cases. These constraints interact in an optimality-theoretic fashion.
- The meaning of the elative case is lexically fixed, signalling quantitative determinacy. The meaning of the partitive case is flexible and assigned by constraint competition. In a Jakobsonian (1957) sense, elative is marked, partitive unmarked.
- The form/meaning relation is not always one-to-one; there is a substantial amount of ambiguity (one form, multiple meanings) and variation (one meaning, multiple forms), often with recognizable preferences.

To account for these observations, we construct an optimality-theoretic analysis that captures the Finnish pattern. These facts are theoretically important in several ways. First, they reveal the existence of conflicting and violable semantic and syntactic constraints whose interaction is amenable to ranking, thus providing evidence for Optimality Theory in the domain of semantics and syntax. Second, they reveal a Jakobsonian markedness opposition between the two cases, one marked (elative), the other unmarked (partitive), with the meaning of the unmarked case assigned by constraint competition. This confirms the status of the partitive as the unmarked case argued on completely independent grounds in the domain of the clause by Vainikka (1993) and Vainikka and Maling (1996). Finally, the Finnish facts show that patterns of ambiguity, preferred readings and semantic blocking lend themselves to an OT syntactic analysis, showing that this approach has the potential of providing answers to certain fundamental semantic questions.

2. The partitive/elative choice

2.1. The semantic facts

We will first examine the semantic conditions that play a role in the distribution of elative and partitive cases. Our goal is to show that the case distinction (elative/partitive) and the definiteness distinction are orthogonal. All four types of examples are found: indefinite partitives, definite partitives, indefinite elatives, definite elatives.

First, we observe that sometimes elative and partitive do not seem to differ in meaning at all. In examples (11) and (12), both partitive and elative may occur on a definite singular NP and the meaning difference is elusive. It seems to us that in contexts like (11) and (12), where the determiner *osa* 'part' is combined with a definite singular NP, the partitive and the elative are simply interchangeable with no obvious difference in meaning. This is an instance of FREE VARIATION.

(11) a. osa tä-tä kaupunki-a
part this-PAR city-PAR
'part of this city'

b. osa tä-stä kaupungi-sta
part this-ELA city-ELA
'part of this city'

(12) a. osa Eurooppa-a
part Europe-PAR
'part of Europe'

b. osa Euroopa-sta
part Europe-ELA
'part of Europe'

These examples are clearly problematic for the definiteness hypothesis. In addition, they also go against Leino's (1993) proposal that the partitive case denotes unlimited substance whereas the elative denotes a specific set/mass.

Second, (13) shows that the partitive sometimes yields two readings that can be translated as definite and indefinite. This is an instance of AMBIGUITY.

(13) litra viini-ä
liter wine-PAR
'a liter of wine' OR 'a liter of the wine'

The example in (13) is another demonstration that the partitive is perfectly compatible with both definite and indefinite readings. However, it must be duly noted that the default reading of (13) is indefinite ('a liter of wine') and this too requires an explanation. This is an instance of PREFERRED INTERPRETATION.[8]

Third, we also find that the elative case may occur on both definite and indefinite NPs, as shown in (14) and (15)[9], including universally quantified NPs like (16).

(14) osa Euroopa-sta
part Europe-ELA
'part of Europe'

(15) neljännes lehmä-n ruho-sta
fourth cow-GEN carcass-ELA
'one fourth of a cow's carcass'

(16) kolmannes kaiki-sta vuokra-asunno-i-sta
third all-ELA rental-apartment-PL-ELA
'one third of all rental apartments'

Partitive constructions where the downstairs NPs are not definite are among the well-known counterexamples to the definiteness hypothesis in English as well. For example, consider *half of a cookie* and *one third of all rental apartments* which are perfectly well-formed in English.

Finally, singular and plural NPs behave differently with respect to the choice of case. When the upstairs determiner is a fraction or a percentage and the downstairs NP is plural, elative is strongly preferred whereas the partitive is marginal and often ungrammatical, as shown in (17)–(19).

[8]Actual corpus examples of ambiguity are hard to find because the context often disambiguates. Our examples of ambiguity are constructed out of unambiguous corpus examples.

[9]The context of this example is unambiguous: 'On the pampa, the abundance of meat is such that if a piece as big as one fourth of a cow's carcass falls from a cartload of meat, no one pays any attention, least of all the driver.'

(17) Kolmasosa munke-i-sta/ ??munkke-j-a on italialaisia.
1/3 monk-PL-ELA/ ??monk-PL-PAR are Italians
'One third of the monks are Italians.'

(18) 63.4% suomalais-i-sta/ ??suomalais-i-a lomailee heinäkuussa.
63.4% Finn-PL-ELA/ ??Finn-PL-PAR make.holidays in.July
'63.4% of the Finns have their holidays in July.'

(19) Enemmistö suomalais-i-sta/ ??suomalais-i-a haluaa Koiviston jatkavan.
majority Finn-PL-ELA/ ??Finn-PL-PAR want Koivisto to.continue
'The majority of Finns want Koivisto to continue (as a president).'

While the stigmatized forms sound quite bad, the pattern does not seem totally ungrammatical. We have found a handful of authentic corpus examples, among them the following:

(20) Valtaosa-ssa valikoiv-i-a abortte-j-a on kysymys ...
majority-INE selective-PL-PAR abortion-PL-PAR is question ...
'In the majority of selective abortions, the question is ...'

Thus, partitive is at least marginally acceptable here. We take this to mean that both cases are allowed in this context, but elative is the better choice (for reasons to be discussed shortly), which is reflected in corpus frequencies. This is an instance of PREFERRED EXPRESSION. In sum, elative is preferred over partitive on plural NPs if the upstairs determiner is a fraction or a percentage.

In contrast, if the downstairs NP is singular, both partitive and elative become possible again, with no obvious difference in meaning. Again, notice that the partitive case gets a definite interpretation here.

(21) Kolmasosa kaupungi-sta ∼ kaupunki-a paloi.
1/3 city-ELA ∼ city-PAR burned
'One third of the city burned.'

(22) Suurin osa valastietoude-sta ∼ valastietout-ta tulee Kanadasta.
greatest part whale.knowledge-ELA ∼ whale.knowledge-PAR comes from.Canada
'Most of the knowledge concerning whales comes from Canada.'

(23) Napoleon valloitti puolet Euroopa-sta ~ Eurooppa-a.
Napoleon conquered half Europe-ELA ~ Europe-PAR
'Napoleon conquered half of Europe.'

The examples so far have shown that the case distinction (elative/partitive) and the definiteness distinction (definite/indefinite) are orthogonal. All four types of examples are found: indefinite partitives, definite partitives, indefinite elatives, definite elatives.

(24)

	INDEFINITE	DEFINITE
PARTITIVE	*kilo voi-ta* 'kilo of butter-PAR'	*osa Eurooppa-a* 'part of Europe-PAR'
ELATIVE	*neljännes lehmän ruho-sta* 'one fourth of a cow's carcass-ELA'	*osa Euroopa-sta* 'part of Europe-ELA

We thus conclude that the definiteness versus indefiniteness distinction corresponds to the elative versus partitive choice only approximately, if at all. Despite earlier claims to the contrary, partitives can be definite, elatives indefinite. In addition, both ambiguity and free variation are found. However, it is equally clear that the choice is not random either, but that there is some semantic notion, perhaps related to definiteness, that plays a role in case selection.

2.2. The semantic constraint

We now proceed to make our semantic proposal. First, we suggest that the semantic constraint relevant for case selection in the partitive construction is not definiteness, but QUANTITATIVE DETERMINACY.[10] Following a standard assumption in model-theoretic semantics, we assume that NPs denote families of sets (i.e. generalized quantifiers). We define a Q(uantitatively) D(eterminate) Noun Phrase as denoting a family of sets such that the intersection of each member of the family with the common noun denotation

[10]The term 'quantitatively indeterminate' NPs is used by Kiparsky (1998), who notes that the partitive case is assigned to quantitatively indeterminate NPs, for example, indefinite bare plurals and mass nouns. Kiparsky's discussion focuses on NPs that are arguments of the verb (see also Krifka 1992). In partitive constructions, however, our analysis below shows that the partitive case occurs with both quantitatively determinate and quantitatively indeterminate NPs.

is of a fixed size, that is, $\{X|X \subseteq E \wedge |[\![N]\!] \cap X| = n\}$. All other NPs are Q(uantitatively) I(ndeterminate).[11] Examples of QD NPs and QI NPs are given in (25):[12]

(25)	**NPs that are QD:**	**NPs that are QI:**
	exactly three cats	*cats*
	all cats	*some cats*
	a cat	*most cats*
	the cat	*wine*

In the examples discussed earlier, elative appears on NPs with interpretations like 'the butter', 'this city', 'a cow's carcass', 'all rental apartments', and 'the monks'. These NPs all fall within the class of QD NPs. On the other hand, partitive occurs on various types of NPs, definite (e.g. 'this city') as well as indefinite (e.g. 'wine'). Notice that while 'this city' is a QD NP, 'wine' is a QI NP. Based on the distribution of elative and partitive cases discussed above, we now make the following descriptive generalization:

(26) In Finnish partitive constructions, elative occurs on QD NPs whereas partitive occurs on both QD NPs and QI NPs.

Next, we note that determiners can also be partitioned into two groups using quantitative determinacy as a criterion: those that require QD downstairs NPs and those that do not. We make the standard assumption that determiners denote relations between sets of individuals. For example, *most*(A,B)

[11] Our definition of QD NPs looks similar to Verkuyl's (1993) notion of [+SQA] (Specified Quantity of A):

(i) $|A \cap B| = m$ (where $m \in \mathbf{N}$) $\Rightarrow$ [+SQA] (Verkuyl 1993:101)

For Verkuyl, [+SQA] picks out a class of NPs that give terminative aspect in aspectual composition. We note that this class of NPs does not coincide with the QD NPs in our list in (25). For example, NPs like *most cats* and *some cats* give terminative aspect readings (*Most cats died/Some cats came in* (*#for hours*)), and so are [+SQA]; however, by our definition, they are QI NPs. This is because Verkuyl makes the assumption that such NPs—which are conventionally defined in Generalized Quantifier Theory as having an 'open end'—must have a contextually finite denotation when they occur in sentences that get interpreted as 'expressing temporal structure' (see Verkuyl 1993:103). We make no assumptions of this sort here.

[12] As a reviewer points out, in the case of universally quantified NPs such as *all cats* we must assume that n is the cardinality of the common noun.

is true if and only if $|A \cap B| > |A - B|$. We define QD-determiners as those determiners D for which the truth of D(A,B) crucially refers to the size of the entire set A, not only to the size of $A \cap B$. All other determiners are QI-determiners. For example, in order to evaluate *One third of the cats are black* we need to compare the number of black cats to the total number of cats in the domain. This implies that the set of cats must have a fixed size; in other words, the downstairs NP ('the cat') must be a QD NP. The determiner 'some' is different: to interpret *Some cats are black* it is enough to check whether $|A \cap B| > 0$ and there is no need to know anything about the size of the set of cats. Thus, 'one third' is a QD-determiner whereas 'some' is a QI-determiner. More examples are given in (27).

(27) Types of determiners

Require QD NPs (D_{qd}):	**Do not require QD NPs** (D):
most	*some*
fractions (*one third*)	*plenty*
percentages (*30%*)	*kilo*
superlatives (*the tallest*)	*three*

Given that some determiners require a quantitatively determinate downstairs NP, and given that elative implies quantitative determinacy, we might expect to see a dependency between the upstairs determiner and the case of the downstairs NP in Finnish. In particular, a QD determiner, which requires a QD downstairs NP, should occur with elative downstairs NPs. (28) shows the choice of case (partitive vs. elative) with 14 determiners in a sample of 1,404 partitive constructions in the *Suomen Kuvalehti 1987* corpus.

(28) Upstairs determiner and downstairs case

			PAR%	ELA %	# OF TOKENS
(a)	gramma	'gram'	100	0	10
	hiukan	'a little'	100	0	10
	litra	'liter'	100	0	16
(b)	osa	'part'	41	59	337
	suuri osa	'great part'	15	85	84
(c)	suurin osa	'greatest part'	11	89	125
	pääosa	'main part'	7	93	14
	n:sosa	'nth part'	6	94	69
	valtaosa	'majority'	4	96	48
	puolet	'half'	2	98	187
	prosentti	'per cent'	1	99	418
	kolmannes	'one third'	0	100	56
	neljännes	'one fourth'	0	100	16
	viidennes	'one fifth'	0	100	14

Group (a) contains QI-determiners, group (c) QD-determiners. Group (b) contains the potentially ambiguous *osa* 'part' and *suuri osa* 'a great part'. While we will assume that they do not require a QD downstairs NP, it seems possible that these determiners have two readings: *osa* can mean either 'some' or 'proper part', and *suuri osa* either 'more than some great number' (the QI-reading) or 'more than half' (the QD-reading).[13]

The distribution of determiners and cases is surprisingly clear-cut. The determiners *gramma* 'gram', *hiukan* 'a little' and *litra* 'liter' are all QI-determiners. In the corpus, they occur with partitives only. At the other end of the scale, we find fractions which are QD-determiners. In the corpus, they occur with elatives only. While the raw numbers in (28) hide several potentially significant factors, they reveal that QI-determiners typically co-occur with the partitive and QD-determiners typically co-occur with the elative.[14] The numbers in (28) corroborate our expectation that QD-determiners should occur with elative downstairs NPs. It is evident that the

[13]See also Koptjevskaja-Tamm (forthcoming) who presents a similar cline of quantifiers that take elative and/or partitive case-marked NPs.

[14]The potentially interfering factors include for example whether the noun is mass or count, and if the latter, singular or plural. Recall that singular NPs may take partitive even under a QD-determiner, whereas plural NPs very rarely do.

choice of case is a function of the semantics of the determiner. An alternative would be to stipulate that determiners like fractions and percentages subcategorize for the elative case, but this would not explain the semantic generalization.

However, notice that the co-occurrence of QD determiners with elative NPs is only a strong tendency (see (17)–(20) and (21)–(23)). An interesting question also arises with the variable cases in (c): why do QD-determiners sometimes take partitive NPs? In what follows, we will see that the responsibility lies at least partly with a syntactic constraint that overrides the semantic constraint on quantitative determinacy.

2.3. The syntactic constraint

Up to this point, we have been pursuing a purely semantic explanation for the choice of case. We have proposed a semantic constraint that restricts the elative case to quantitatively determinate NPs. However, it turns out that this semantic constraint is violated under a particular syntactic condition stated in (29):

(29) Elative is blocked from the downstairs NP if the entire partitive construction bears the elative case. The same applies to partitive.

We now illustrate this syntactic constraint. Like many other languages, Finnish has verbs that assign special semantic cases to their arguments. For example, the verb *tulla* 'become' assigns elative to its subject.

(30) Sointu-sta tuli munkki.
Sointu-ELA became monk
'Sointu became a monk.'

Now, consider (31). Here, the entire partitive construction 'one third of the men' is assigned the elative case by the verb. Since this construction has a plural NP ('men') embedded under a QD-determiner ('one third'), we would expect the elative case to be strongly favored. Strikingly, the elative case is categorically blocked. If we change the verb to one that does not assign elative case, the expected elative emerges, as shown by (32).

(31) [Kolmasosa-sta [*mieh-i-stä/ mieh-i-ä]] tuli munkkeja.
One third-ELA *man-PL-ELA/ man-PL-PAR became monks
'One third of the men became monks.'

(32) [Kolmasosa [mieh-i-stä/ ??mieh-i-ä]] ryhtyi munkeiksi.
One third man-PL-ELA/ ??man-PL-PAR chose.to.be monks
'One third of the men chose to be monks.'

The same pattern arises with the partitive. The verb *rakastaa* 'love' takes a partitive object, as shown in (33).

(33) Anders rakastaa Helsinki-ä.
Anders loves Helsinki-PAR
'Anders loves Helsinki.'

In (34), the entire partitive construction 'this part of Helsinki' is assigned partitive case by the verb. Again, the partitive is blocked from occurring on the embedded NP 'Helsinki', even though it does emerge in free variation with the elative elsewhere, as shown by (35).

(34) Anders rakastaa [tä-tä osa-a [*Helsinki-ä/ Helsingi-stä]].
Anders loves this-PAR part-PAR *Helsinki-PAR/ Helsinki-ELA
'Anders loves this part of Helsinki.'

(35) [Tämä osa [Helsinki-ä ∼ Helsingi-stä]] rakennettiin 1800-luvulla.
This part Helsinki-PAR ∼ Helsinki-ELA was.built in.the.1800's
'This part of Helsinki was built in the 1800's.'

The determiners *kolmasosa* 'one third' and *osa* 'part' are syntactically heads of the construction (see footnote 6). We suggest that these blocking facts follow from a general syntactic constraint we will call CASE-OCP, following T. Mohanan (1994). The universal core of the OCP is the prohibition of adjacent identical elements. K.P. Mohanan (to appear) has proposed that the grammars of particular languages specify the participating elements and domains, yielding language-particular manifestations of this universal principle. We assume that in Finnish the language-particular manifestation of Case-OCP prohibits the same case from being assigned to both the head of an NP and its NP sister:

(36) Case-OCP (Mohanan 1994): $*\alpha\alpha$

For Finnish: $*[\mathrm{N}\ _{case\alpha}\ [\mathrm{NP}\ _{case\alpha}]]\ _{NP}$

We note that Case-OCP effects only emerge in certain syntactic configurations, but not others. As we have defined it, Case-OCP applies to a head and its phrasal sister, but crucially not to a head and its determiners and premodifiers, e.g. *tä-tä osa-a* 'this-PAR part-PAR' in (34) or *tä-ssä punaise-ssa talo-ssa* 'this-INE red-INE house-INE, in this red house', where the determiners and premodifiers agree in case with the noun.[15] In our corpus, the Case-OCP is responsible for several occurrences of the unexpected partitive under a QD-determiner. The upshot is that the syntactic constraint against adjacent identical cases is stronger than the tendency to select elative under a QD-determiner.

2.4. Summary

The semantic notion of quantitative determinacy is crucial in determining the elative/partitive choice in Finnish partitive constructions. We have proposed that the elative case only occurs on quantitatively determinate NPs whereas the partitive case may occur on both quantitatively determinate and indeterminate NPs. Determiners that require their downstairs NPs to be QD prefer elative (see group (c) in (28)), especially if the NP is plural (see (17–20)). However, this semantic generalization is overriden by Case-OCP, which is a syntactic constraint. In precisely this context, the partitive can fill in for the elative case (see (31)).

3. An OT analysis

We have now identified two core factors that influence the choice of case in Finnish part-whole expressions. The question remains how exactly these factors interact. The basic intuition is that the two factors are not equally important, but differ in strength. This can be described as the following informal algorithm:

[15] A reviewer notes analogous examples such as *Peter's sister's house* and *das Haus des Direktors des Instituts*. Whether Case-OCP effects are found in all languages, to what extent, and in what environments are questions beyond the scope of this paper.

(37) **Rule 1** Use either PARTITIVE or ELATIVE.
'1/3 of the cat (sg)' → *kolmasosa kissa-a~kissa-sta* (PAR~ELA)

Exception 1.1 ... unless ELATIVE is required (fraction + plural NP).
'1/3 of the cats (pl)' → *kolmasosa *kisso-j-a/kisso-i-sta* (*PL-PAR/PL-ELA)

Exception 1.1.1. ... unless ELATIVE is banned (the Case-OCP).
'out of 1/3 of the cats (pl)' → *kolmasosa-sta kisso-j-a/*kisso-i-sta* (PL-PAR/*PL-ELA)

This sort of generalization is very naturally expressible in Optimality Theory which is made for generalizations of the type 'Do X only if Y' or 'Do X except when Y' (Prince and Smolensky 1993). Put slightly differently, in OT it is easy to express regularities that are only approximately true provided that the violations arise from an attempt to satisfy a more important regularity, which itself may be only approximately true and violated under the pressure of an even more important regularity, and so on. This is precisely the notion of CONSTRAINT RANKING that lies at the heart of OT and this is what the informal algorithm in (37) is intended to express.

3.1. Input, output, constraints

To get the analysis off the ground, we need some INPUT and some OUTPUT. Following Bresnan (to appear), we will assume that the input is the language-independent content expressed in terms of features drawn from the universal space of possible grammatical and lexical contrasts, and the output consists of language-specific lexical items that carry with them their own interpretation of that content. The relationship between the two is regulated by ranked and violable constraints. Thus, for example, the input [BE PRES 2 SG] can be expressed in English by the lexical item <*art*:BE PRES 2 SG> which expresses the input perfectly faithfully. However, since this lexical item is not present in many speakers' lexicons, the next best match <*are*:BE PRES> fills in for it. This lexical item neutralizes number and person and for this reason is not perfectly faithful to the input. However, in most dialects, it is better than <*am*:BE PRES 1 SG>, another unfaithful candidate which does not realize input person and in addition introduces an unlicensed first person. In such dialects, we must rank our constraints in such a way that *are* will be selected over *am* as the optimal output.

In addition to input and output, we need CONSTRAINTS. In Optimality Theory, there are two types of constraints that are in inherent conflict: (i) FAITHFULNESS constraints that govern the input-output relation and strive to preserve all the input contrasts, and only those, in the output, and (ii) MARKEDNESS constraints that exert pressure towards unmarked output structures and tend to obliterate input contrasts. Based on the above discussion, we now propose the following constraints:

(38) Markedness constraints (hold of the output):

- CASE-OCP. The same case cannot be assigned to both the head N and its sister NP (*[N $_{case\alpha}$ [NP $_{case\alpha}$]] $_{NP}$).
- Q-AGR. A QD determiner must co-occur with a QD downstairs NP.
- *EXPRESS. Do not express input features.

(39) Faithfulness constraints (hold of the relation between input and output):

- MAX: Express input features.
- DEP: Do not express features not present in the input.

The two faithfulness constraints are in fact families of constraints. For our purposes, the important special cases will be the following:

(40)
- MAX(N) Express input number.
- MAX(Q) Express input quantitative determinacy.
- DEP(N) Do not express number not present in the input.
- DEP(Q) Do not express quantitative determinacy not present in the input.

We also need to specify the content of the lexical entries, in particular the case suffixes. This is done in (41).

(41) Lexical entries:

a.	ELA = [QD]		
b.	PAR = [ ]	Case variable. No semantic content.
c.	PL = [PL]		

In the lexicon, the elative suffix is assigned the feature [QD]; the partitive suffix is left unspecified. This is instrumental in accounting for the generalization that elative occurs with QD NPs, whereas partitive occurs with both QD NPs and QI NPs. In our analysis, partitive is the unmarked case whose meaning arises out of constraint interaction (for example, with reference to syntax). Consequently, partitive can fill in for the elative case under circumstances where the elative is for some reason blocked or dispreferred. What we see here is a classically Jakobsonian markedness opposition where the marked element 'signals A', and the unmarked element is a 'non-signal of A', but in neutralization contexts the unmarked element may also be compatible with 'signals A' (Jakobson 1957). Thus, the ultimately appropriate characterization of the partitive is as an unmarked (unspecified) category. Finally, the plural suffix is assigned the feature [PL]. Since Finnish has no overt singular morpheme, none will be assumed in the analysis.

3.2. Ranking

We now turn to four examples in order to figure out the relative ranking of the constraints. First, consider an example of free variation. Both *kolmasosa kissa-a* and *kolmasosa kissa-sta* mean 'one third of the cat (sg)' (e.g. 'One third of the cat is black').

(42) Free variation:

'one third of the cat (sg)'	→	*kolmasosa kissa-a* (PAR)
	→	*kolmasosa kissa-sta* (ELA)

In order to handle variation in OT, we will assume that optimality-theoretic grammars are not restricted to total orders, but may also be genuine PARTIAL ORDERS (Anttila 1997b). In other words, we will assume that ranking is an irreflexive, asymmetric, and transitive relation, but not necessarily connected. Now, consider the violations incurred by the two expressions in (42). In terms of markedness (*EXPRESS), partitive is always better than elative because it is simpler: it does not express any input features. However, in terms of faithfulness (MAX(Q)), elative is better than partitive if the input contains a feature QD that needs to be expressed, as is the case here. We can now capture the observed optionality by leaving the two constraints mutually unranked. This yields two totally ordered tableaux, shown in (43): partitive (*kolmasosa kissa-a*) wins under one ranking, elative (*kolmasosa kissa-sta*) under the other. In other words, the grammar predicts optionality.[16]

(43) 'one third of the cat'

		D_{qd} N[SG,QD]	MAX(Q)	*EXPR
a.		kolmasosa kissa-a[ ]	*!	
b.	⇒	kolmasosa kissa-sta[QD]		*
			*EXPR	MAX(Q)
a.	⇒	kolmasosa kissa-a[ ]		*
b.		kolmasosa kissa-sta[QD]	*!	

Note that *kolmasosa* 'one third' requires a QD downstairs NP and *kissa* 'cat' is a quantitatively determinate singular NP. The constraint Q-AGR will be satisfied in both cases and is thus irrelevant.

However, not all variation is completely free. The next example differs minimally from the previous one: the downstairs NP is plural instead of singular. In this case, both elative and partitive are found, but partitive is marginal. In our corpus, we have only found a handful of partitives in this environment, among them (20), showing that partitive is possible, but dispreferred. In contrast, elative is extremely common.

(44) Marginal variation, with a preferred expression:

'one third of the cats' → *??kolmasosa kisso-j-a* (PL,PAR)
→ *kolmasosa kisso-i-sta* (PL,ELA)

If we compare (42) and (44), the more marginal status of the partitive in (44) is evidently connected to the fact that the NP is plural. Recall that the determiner *kolmasosa* 'one third' requires a QD downstairs NP (Q-AGR). While the singular NP *kissa* 'cat' is by its very nature QD, this is not the case with the plural NP. The elative case contributes the feature [QD], making the plural NP quantitatively determinate. The question then arises: why is partitive plural allowed at all? It seems that Q-AGR gives rise to a strong tendency, but only a tendency. The solution is straightforward: we simply

[16]In all our tableaux below, we give only the serious contenders—the partitive and elative candidates—so as to demonstrate the relative ranking of the crucial constraints. We assume that all other possible candidates are ruled out by independent considerations. For example, a downstairs NP with no case marking would violate a high-ranking constraint that requires NPs to have case.

add the constraint Q-agr into the partial order which already contains two other constraints, Max(q) and *Express, but we still do not posit any rankings. This results in six totally ordered tableaux, shown in (45):

(45) 'one third of the cats'

		D_{qd} N[PL,QD]	Q-agr	Max(q)	*Expr
a.		kolmasosa kisso-j[pl]-a[ ]	*!	*	*
b.	⇒	kolmasosa kisso-i[pl]-sta[qd]			**

			Q-agr	*Expr	Max(q)
a.		kolmasosa kisso-j[pl]-a[ ]	*!	*	*
b.	⇒	kolmasosa kisso-i[pl]-sta[qd]		**	

			Max(q)	Q-agr	*Expr
a.		kolmasosa kisso-j[pl]-a[ ]	*!	*	*
b.	⇒	kolmasosa kisso-i[pl]-sta[qd]			**

			Max(q)	*Expr	Q-agr
a.		kolmasosa kisso-j[pl]-a[ ]	*!	*	*
b.	⇒	kolmasosa kisso-i[pl]-sta[qd]		**	

			*Expr	Q-agr	Max(q)
a.	⇒	kolmasosa kisso-j[pl]-a[ ]	*	*	*
b.		kolmasosa kisso-i[pl]-sta[qd]	**!		

			*Expr	Max(q)	Q-agr
a.	⇒	kolmasosa kisso-j[pl]-a[ ]	*	*	*
b.		kolmasosa kisso-i[pl]-sta[qd]	**!		

We assume the following quantitative interpretation for partially ordered OT grammars (Anttila 1997b):

(46) Quantitative interpretation (Variation):

(a) A candidate is predicted by the grammar iff it wins in some tableau in the partial order.

(b) If a candidate wins in n tableaux and t is the total number of tableaux in the partial order, then the candidate's probability of occurrence is n/t.

In this example, the grammar consists of three constraints, but so far no rankings. Thus, the total number of tableaux t is $3! = 6$. We find that ela wins in 4/6 (= 2/3) of the tableaux and par in 2/6 (= 1/3) of the tableaux.

The present grammar thus correctly predicts that elative is preferred over partitive if the upstairs determiner requires a QD downstairs NP and the NP is plural (contrast (43) and (45)).[17] Note that if some constraints were ranked with respect to some other constraints, as is often the case, t would be smaller than 6. If all constraints were ranked with respect to all other constraints, t would be 1. This is the familiar case where a grammar equals a single tableau (total order).

The third example (47) is different from the second in one respect: here the entire NP bears the elative case. Consequently, the preferences are drastically reversed. While in (44) partitive was strongly disfavored, in (47) it is the only possible option. This is our first example of an invariant pattern.

(47) Invariant pattern:

'out of one third of the cats'	→	*kolmasosa-sta* (ELA) *kisso-j-a* (PL,PAR)
	→	**kolmasosa-sta* (ELA) *kisso-i-sta* (PL,ELA)

This reversal in judgments is due to Case-OCP that strictly dominates the three constraints discussed so far, as shown in tableau (48). Since Q-AGR, MAX(Q) and *EXPR are mutually unranked, (48) actually corresponds to six tableaux. However, the ranking of these three constraints is irrelevant to the outcome: any of the six rankings will yield the same result because the higher-ranking Case-OCP will always pick (48a) as the winner.

(48) 'out of one third of the cats'

		D_{qd} N[PL,QD]	OCP	Q-AGR	MAX(Q)	*EXPR
a.	⇒	kolmasosa-sta_{ela} kisso-j[PL]-a$[\,]_{par}$		*	*	*
b.		*kolmasosa-sta_{ela} kisso-i[PL]-sta$[QD]_{ela}$	*!			**

This example demonstrates a simple point: not only *can* partitive occur under a QD-determiner on a plural NP; it *must* occur in this environment if

[17] Once all the constraints are in place, we will find that the predicted probabilities are 1/4 for the partitive and 3/4 for the elative in contexts where the OCP is irrelevant. A reviewer points out that this may still not be a strong enough bias given the heavily marked status of *??kolmasosa kisso-j-a* 'one third of cats'. This may well be so and more work is clearly needed. There are at least two ways to put such quantitative predictions to a serious empirical test: large naturally occurring corpora and controlled elicitation experiments. For precedents in phonology, see e.g. Anttila 1997a, Anttila and Cho 1998, Ringen and Heinämäki 1999, Hayes to appear and Boersma and Hayes 1999.

the alternative is a Case-OCP violation. In other words, the partitive case can fill in for the elative in syntactically adverse circumstances, revealing its unmarked nature.[18]

Our final example is again minimally different from the previous one. Recall that the Case-OCP not only applies to elatives (*ELA-ELA), but also to partitives (*PAR-PAR), as (49) shows:

(49) Anders rakastaa [tä-tä osa-a [*Helsinki-ä/ Helsingi-stä]].
Anders loves this-PAR part-PAR *Helsinki-PAR/ Helsinki-ELA
Anders loves this part of Helsinki.

(50) 'this part (par.) of Helsinki'

		D N[SG,QD]	OCP	Q-AGR	MAX(Q)	*EXPR
a.		*osa-a[ ]$_{par}$ Helsinki-ä[ ]$_{par}$	*!		*	
b.	⇒	osa-a[ ]$_{par}$ Helsingi-stä[QD]$_{ela}$				*

However, surface violations of the Case-OCP are found. Consider the following example:

(51) Etsi-n kilo-a [voi-ta/ *voi-sta].
search-1P kilo-PAR butter-PAR/ *butter-ELA
I'm looking for a kilo of butter.

In the context of OT, this immediately brings up the question: under what circumstances are such violations allowed? Put slightly differently, what is the higher-ranking constraint that forces such violations? We find that Case-OCP-violations are allowed precisely when the embedded NP is QI. This immediately reveals the solution: since the embedded NP is QI, using elative would express a meaning that is not present in the input, in violation of the constraint DEP(Q), which must thus rank above the Case-OCP (see (52)).

[18] Another possible way of satisfying Case-OCP would be to suppress the case of the head instead of the downstairs NP. We are here assuming a high-ranking faithfulness constraint that maintains the case of the head at the expense of its complement. The possibility of not having case at all is yet another way of satisfying Case-OCP. Again, we assume that this is ruled out by another high-ranking constraint requiring that NPs have case.

(52) ‘a kilo (par.) of butter’

		D N[QI]	Dep(q)	OCP	Q-agr	Max(q)	*Expr
a.	⇒	kilo-a[ ]$_{par}$ voi-ta[ ]$_{par}$		*		*	
b.		*kilo-a[ ]$_{par}$ voi-sta[QD]$_{ela}$	*!			*	*

The analysis correctly predicts that OCP-violations should only be found with the unmarked partitive for the following reason. An OCP-violation of type *ela-ela can be repaired by deleting one of the elatives: this is guaranteed by the ranking OCP ≫ Max(q). An OCP-violation of type *par-par cannot be repaired because this will necessarily involve inserting a marked elative which is categorically prohibited by the ranking Dep(q) ≫ OCP.

We conclude by summarizing the rankings for Finnish established so far.[19]

(53) Rankings for Finnish:

a. Dep(q) ≫ OCP
b. OCP ≫ Q-agr
c. OCP ≫ Max(q)
d. OCP ≫ *Expr
e. Max(n) ≫ *Expr

4. Consequences

4.1. Variation

So far, we have illustrated our analysis with four special cases. We will now explore its consequences in more general terms. The purpose of our analysis is to answer the question ‘Given a semantic input, what is its optimal expression?’ Our grammar is designed to answer this question by establishing the correct meaning/form relations. Assuming that grammars are partial orders, the following possible situations arise:[20]

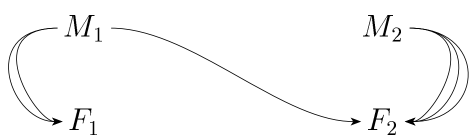
[19] We have not discussed the last ranking in the list: Max(n) ≫ *Expr. This ranking is needed to express the fact that, in general, number is not neutralized under markedness pressure. For example, ‘1/3 of the cats’ does not get realized as *kolmasosa kissa-sta* ‘1/3 cat-ela’, but *kolmasosa kisso-i-sta* ‘1/3 cat-pl-ela’, with an overt plural marker, even though the first realization is clearly better in terms of markedness.

[20] We will discuss ineffability in section 4.3.

(54)
- A given meaning has one expression (one meaning, one form).
- A given meaning has several expressions, possibly with quantitative preferences (variation, preferred expressions).
- A given meaning has no expression (ineffability).

The diagram in (55) is an example of a form/meaning map generated by a partially ordered grammar.

(55) Variation in a partially ordered grammar



Each individual tableau within the partial order is depicted as an arrow. For each M_i, the number of outbound arrows is constant; this is the total number t of tableaux in the partial order. If all t arrows point to one particular form, there is no variation. If the arrows are split among several different forms, there is variation. The number of arrows pointing at a given form is proportional to the form's probability of occurrence.

In order to see that the analysis really works, we must ensure that the grammar works correctly in all cases, no matter how the input is chosen (Richness of the Base). What we must do is find the optimal syntactic output for all semantically well-formed inputs. This means we must take the following steps:[21]

(56) For all semantically distinct NP-types
  for all semantically distinct determiner types
    for all total rankings subsumed by (53)
      generate the optimal expression(s).

Since the number of different NP-types, determiner types and total rankings is reasonably small, taking these steps is not too difficult. First, we

[21] In a complete analysis, we must also consider the OCP effect which adds another three-way choice: (i) The head noun is elative; (ii) the head noun is partitive; (iii) the head noun is neither of the two. We leave this step out to simplify exposition.

will consider the following five types of noun phrases to be semantically well-formed inputs:[22]

(57)

	Possible input NP	Example
	1. N[QI]	'milk', 'some milk'
	2. N[QD]	'the milk'
	3. N[SG,QD]	'a cat', 'the cat', 'this cat'
	4. N[PL,QI]	'cats', 'some cats', 'most cats'
	5. N[PL,QD]	'the cats', 'exactly three cats', 'all cats'

Second, we need to consider two types of determiners: those that require a QD downstairs NP and those that do not. We will not consider combinations of a QD-determiner and a QI downstairs NP, e.g. #*one third of water*, which we take to be semantically ill-formed. This leaves us with eight types of possible determiner-noun phrase combinations. Finally, we must check how these eight semantically well-formed inputs fare under all the total rankings subsumed by the ranked pairs in (53). There are 168 such rankings. This amounts to checking 1,344 tableaux in all.

The results are spelled out in (58). The main observation is that our partially ordered OT grammar predicts both categorical and quantitative patterns. Three types of outputs are predicted: (a) invariant partitive; (b) variation with a slight preference for the elative; (c) variation with strong preference for the elative.

(58) Predicted meaning/form mappings (OCP ignored):

	Input	Example	Output	Preferences
a.	D + N[QI]	'a liter of milk'	PAR	PAR categorical
	D + N[PL,QI]	'a kilo of apples'	PAR	PAR categorical
b.	D + N[QD]	'a liter of the milk'	PAR~ELA	5/12 ~ 7/12
	D + N[SG,QD]	'a part of a/the city'	PAR~ELA	5/12 ~ 7/12
	D + N[PL,QD]	'a kilo of the apples'	PAR~ELA	5/12 ~ 7/12
	D_{qd} + N[QD]	'one third of the milk'	PAR~ELA	5/12 ~ 7/12
	D_{qd} + N[SG,QD]	'one third of a/the cat'	PAR~ELA	5/12 ~ 7/12
c.	D_{qd} + N[PL,QD]	'one third of the cats'	(PAR~)ELA	1/4 ~ 3/4

[22]We will not consider *N[SG,QI] and *N[SG] well-formed, but instead assume that singularity implies quantitative determinacy. We also assume that NPs are exhaustively classified as either QD or QI, thus *N[PL] is not well-formed.

We make the following observations. First, 'a liter of milk' (D + N[QI]) and 'a kilo of apples' (D + N[PL,QI]) are predicted to exclusively take the partitive case, which is correct. Second, we predict that a plural noun under a QD-determiner (e.g. 'one third of the cats' (D_{qd} + N[PL,QD]) should strongly prefer elative, which is also correct. All other cases are predicted to fall somewhere in between: in such cases both elative and partitive are predicted to be possible, elative slightly preferred.

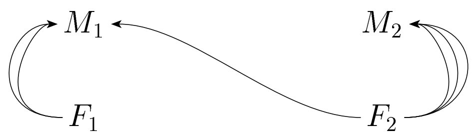
The obvious next step would be to match the quantitative predictions of the model with the actual corpus frequencies. However, this seems premature for the following reason: while the predicted statistical tendencies do emerge in the corpus, we know for a fact that there are lexical differences among the statistical patterning of individual determiners; yet as it stands, the model simply treats determiners as two distinct groups: those that require QD downstairs NPs and those that do not. However, *litra* 'liter', *gramma* 'gram' and *hiukan* 'a little' are strongly biased towards the partitive, whereas *suuri osa* 'great part' and *osa* 'part' are much less so. This is consistent with the observation of Koptjevskaja-Tamm (forthcoming) that Finnish determiners seem to form a continuum with respect to case selection. Before matching the predictions with the actual frequencies, we must incorporate these subtler determiner-specific distinctions in the model. The two obvious possibilities are: (i) to make the semantic/syntactic analysis more fine-grained by additional constraints; (ii) to assume that different determiners subscribe to slightly different grammars within the partial order. We will leave this for future work.

We have now answered the question 'Given a meaning, what is its optimal expression?' for all the possible inputs in our domain. The result was sometimes one-meaning-one-form, sometimes one-meaning-multiple-forms (i.e. variation), with certain quantitative preferences.

4.2. Ambiguity

We now turn to the OT-semantic question: 'Given an expression, what is its optimal interpretation?' If we are able to predict variation and preferences in expression, the obvious question is whether we are also able to predict ambiguity and preferences in interpretation. In terms of our diagram, the answer seems simple enough: all we need to do is reverse the direction of the arrows. Instead of taking the OT-semantics perspective (see section 1.1.), we simply retrace our steps through the OT-syntactic tableaux. Ambiguity is a situation where one form can be traced back to more than one semantic input.[23]

(59) Ambiguity in a partially ordered grammar



Again, in order to make sure that our grammar yields the correct semantic interpretation for all possible expressions, we must take the following steps:

(60) For all possible NP expressions
  for all possible determiner expressions
    for all total rankings subsumed by (53)
      retrieve the semantic input(s) for which the combined
      expression is the optimal output.

The total number of output expressions we need to consider is 16. This is the result of combining two cases (ELA vs. PAR), two numbers (PL vs. non-plural), two types of determiners (D_{qd} vs. D) and two types of nouns (mass vs. count). The results are spelled out in (61–63). We will ignore the Case-OCP for now.

(61) Ambiguity (2 expressions):

OUTPUT	EXAMPLE	INPUT	GLOSS
D + N_m-PAR	*litra maito-a*	D + N[QI]	'a liter of milk' ∼
		D + N[QD]	'a liter of the milk'
D + N_c-PL-PAR	*kilo omen-i-a*	D + N[PL,QI]	'a kilo of apples' ∼
		D + N[PL,QD]	'a kilo of the apples'

[23]Zeevat (1999) entertains a similar proposal, and suggests that optimality syntax is already a sound proposal for the architecture for optimal semantics. Later in his paper, Zeevat revokes this proposal in favor of Blutnerian bidirectionality (Blutner 1999).

(62) One form, one meaning (10 expressions):

OUTPUT	EXAMPLE	INPUT	GLOSS
D_{qd} + N_m-PAR	*kolmasosa maito-a*	D_{qd} + N[QD]	'1/3 of the milk'
D_{qd} + N_m-ELA	*kolmasosa maido-sta*	D_{qd} + N[QD]	'1/3 of the milk'
D_{qd} + N_c-PAR	*kolmasosa omena-a*	D_{qd} + N[SG,QD]	'1/3 of an/the apple'
D_{qd} + N_c-ELA	*kolmasosa omena-sta*	D_{qd} + N[SG,QD]	'1/3 of an/the apple'
D_{qd} + N_c-PL-PAR	*kolmasosa omen-i-a*	D_{qd} + N[PL,QD]	'1/3 of the apples'
D_{qd} + N_c-PL-ELA	*kolmasosa omen-i-sta*	D_{qd} + N[PL,QD]	'1/3 of the apples'
D + N_m-ELA	*litra maido-sta*	D + N[QD]	'a liter of the milk'
D + N_c-PAR	*hiukan omena-a*	D + N[SG,QD]	'a bit of an/the apple'
D + N_c-ELA	*hiukan omena-sta*	D + N[SG,QD]	'a bit of an/the apple'
D + N_c-PL-ELA	*kilo omen-i-sta*	D + N[PL,QD]	'a kilo of the apples'

(63) Meaningless syntax (4 expressions):

OUTPUT	EXAMPLE	INPUT	GLOSS
D_{qd} + N_m-PL-PAR	*kolmasosa maito-j-a*	–	(meaningless syntax)
D_{qd} + N_m-PL-ELA	*kolmasosa maido-i-sta*	–	(meaningless syntax)
D + N_m-PL-PAR	*litra maito-j-a*	–	(meaningless syntax)
D + N_m-PL-ELA	*litra maido-i-sta*	–	(meaningless syntax)

By taking the converse of the meaning/form relation we have now obtained all the possible interpretations for all the possible forms in our domain. In some cases, one form is predicted to have several meanings (ambiguity), in other cases we have one-form-one-meaning, and finally there are four expressions that are assigned no meaning at all (uninterpretability). This is because there is no input/ranking combination such that these forms would be selected as optimal. These expressions are indeed peculiar: they consist of mass nouns with number morphology. From the point of view of our analysis, they are just pieces of uninterpretable syntax.[24]

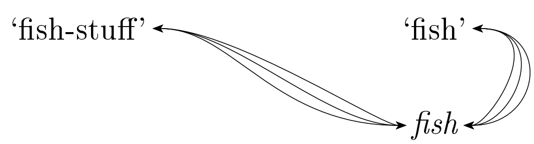
The final question is whether we can go beyond ambiguity and predict preferences in interpretation. In other words, in contexts where the OT-syntactic grammar predicts ambiguity, can we infer the preferred reading

[24]In fact, these strings do get an interpretation, but crucially one that implies an input where the mass noun has been converted to a count noun. Thus, the most natural interpretation of *kolmasosa maido-i-sta* is 'one third of the milk cartons', implying that the mass noun *maito* 'milk' is treated as a count noun. Similarly, the string *hiukan omena-a* 'a bit of an/the apple' gets an additional reading 'a bit of apple' implying that the count noun *omena* 'apple' is being treated as a mass noun.

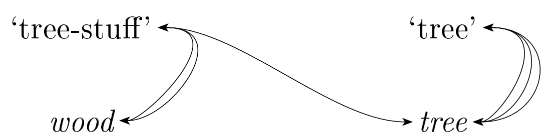
from a map like (59)? To take a concrete example, the fact that *litra viini-ä* is ambiguous and can mean either 'a liter of wine' or 'a liter of the wine' is predicted by our OT-syntactic grammar because this expression wins under two distinct semantic inputs. But can we also derive the rather strong preference for the interpretation 'a liter of wine'?

The fact that preferred interpretation may be influenced by the existence of alternative expressions for the same meaning is well known. Such effects are traditionally subsumed under the general notion of BLOCKING (see Aronoff 1976 and Kiparsky 1982b; for an OT-semantics perspective, see Blutner 1999). Blocking may be either partial or total (see for example Briscoe et al. 1995, Copestake and Briscoe 1995). A case in point is the well-known phenomenon of 'conceptual grinding' (see for example Pelletier and Schubert 1989) whereby a count noun acquires a mass noun reading, for example, *This is a fish* (count) versus *We had fish* (mass) *for dinner*. However, the existence of a specialized mass noun blocks the grinding mechanism, suppressing the potential mass noun interpretation of a count noun. Thus, for example, the oddity of *?This table is made of tree* is due to the existence of the lexical item *wood*.[25] We illustrate this situation in terms of the following hypothetical meaning/form maps:

(64) Ambiguity, no blocking



(65) Ambiguity, partial blocking



[25]From the Oxford English Dictionary (*OED2 on CDROM, version 1.11*), we find the following examples of *tree* used to denote '[T]he substance of the trunk and boughs of a tree', in other words, 'tree-stuff': c1440 Partonope 407 *A brygge of stone and not of tree.* 1896 Kipling 'Seven Seas, Sea-Wife iv', *To ride the horse of tree* [a ship].

The question now is how to capture such blocking facts, partial as well as total. Given the theory of variation outlined above, the obvious solution is to apply the quantitative interpretation of partially ordered grammars in (46) to ambiguity mutatis mutandis. This would imply something like the following definition:

(66) QUANTITATIVE INTERPRETATION (AMBIGUITY):

(a) A form F can be interpreted as M iff there is at least one arrow from F to M.

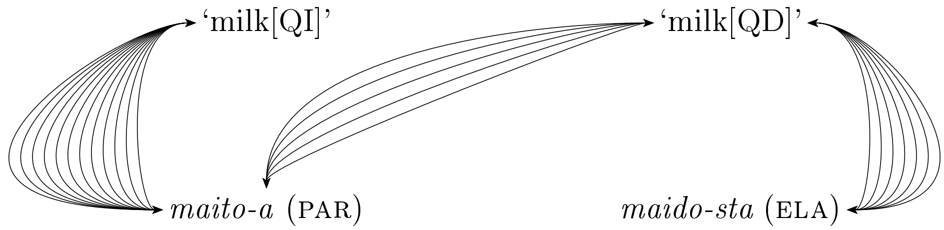
(b) If n is the number of arrows from F to M and t' is the total number of arrows out of F, then the probability that F is interpreted as M is n/t'.

This is a very simple theory of interpretational preferences. Essentially, it makes interpretational preferences a function of EXPRESSIBILITY: an interpretation with fewer alternative possibilities of expression is to be preferred over an interpretation with more alternative possibilities of expression. Returning to our example, the existence of *wood* as a possible expression for 'tree-stuff' necessarily reduces the probability of *tree* expressing this meaning. This is because the number of tableaux t is constant: adding an arrow from 'tree-stuff' to *wood* will subtract an arrow from 'tree-stuff' to *tree*. Thus, using *tree* for 'tree-stuff' means choosing the dispreferred interpretation of this form, hence the oddity of *?This table is made of tree*.[26]

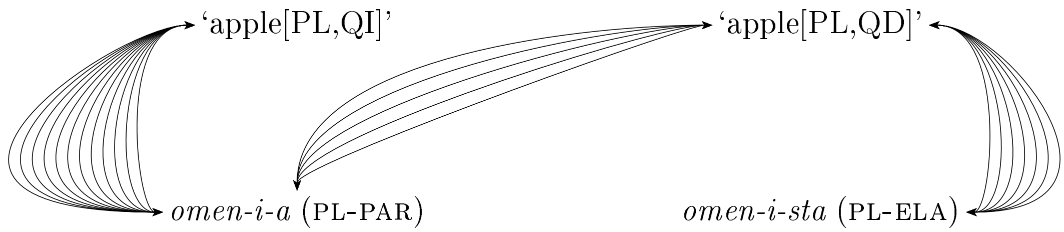
The interpretation in (66) gives the right results for Finnish. Our system predicts two cases of ambiguity: *litra maito-a*, meaning 'a liter of milk' or 'a liter of the milk', and *kilo omen-i-a*, meaning 'a kilo of apples' or 'a kilo of the apples'. The relevant maps derived from the partially ordered grammar are given below.

[26]There is another phenomenon also called blocking, exemplified by the pair *fury*/**furiosity*. Here the blocking is driven by a purely formal criterion: nonderived forms block derived forms (see e.g. Kiparsky 1982a). Thus, *fury* beats **furi+os+ity*. This can be seen as a reflex of a very general principle *STRUC 'Avoid structure' that has nothing to do with semantics per se; there is no sense in which *fury* is semantically more specialized than the putative **furiosity*, and there is no alternative meaning vying for the form **furiosity*. This kind of blocking is of a purely formal kind and has nothing to do with meaning/form mapping.

(67) Ambiguity of *litra maito-a* ‘a liter of (the) milk’:



(68) Ambiguity of *kilo omen-i-a* ‘a kilo of (the) apples’:



The prediction is that *litra maito-a* and *kilo omen-i-a* are preferably interpreted as ‘a liter of milk’ and ‘a kilo of apples’ ($p = 12/17 = .71$). The interpretations ‘a liter of the milk’ and ‘a kilo of the apples’ are possible, but dispreferred ($p = 5/17 = .29$). This is consistent with the intuitive speaker judgments.[27]

The analysis also correctly predicts that both ambiguity and interpretation preferences are context-sensitive. Consider what happens to ambiguity if we change the syntactic context.[28] We consider three different syntactic environments:

(69) Three different syntactic environments:

- Case-OCP is inactive (e.g. nominative subjects, accusative objects)

[27]There are at least two ways to put these predictions to a serious test: (i) collect a large number of preference judgments; (ii) examine how a particular form is interpreted in its various occurrences in a large corpus. This is left for future work.

[28]Nunberg and Zaenen (1992) discuss other contextual effects on interpretational preferences.

- Case-OCP against two elatives is activated (e.g. subject of *tulla* 'become')
- Case-OCP against two partitives is activated (e.g. object of *rakastaa* 'love', under negation)

In each case, the predictions about ambiguity and preferred interpretations are different. As discussed above, *litra maito-a* is preferably interpreted as 'a liter of milk', but it also has a dispreferred interpretation 'a liter of the milk', that is, a liter out of some specified quantity of milk. However, if the entire phrase is assigned the partitive case, we correctly predict that this interpretation disappears. An example is given in (70) where the entire partitive construction is assigned the partitive case under negation:

(70)

En	halua	litra-a	maito-a
I.don't	want	liter-PAR	milk-PAR

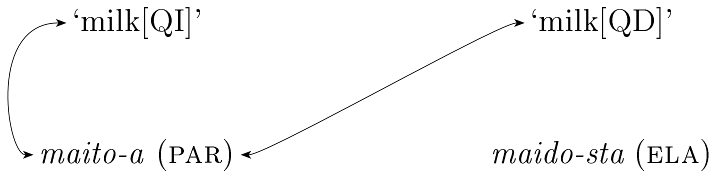
I don't want a liter of (*the) milk.

The ambiguity disappears because in this context the meaning 'milk[QD]' must be expressed with the elative; it can no longer be expressed with the partitive because that would trigger a Case-OCP violation. This renders *maito-a* unambiguous. On the other hand, the meaning 'milk[QI]' must still be expressed with the partitive because there is no better option available. Using the elative here would incur a fatal DEP(Q)-violation, as shown above in (52).

(71) Ambiguity disappears under the Case-OCP against *PAR-PAR:

The situation changes if the entire phrase is assigned the elative case. This time, the elative form becomes completely unusable. This means that the only way of expressing the meaning 'milk[QD]' is by means of the partitive case. This in turn implies that the form *maito-a* 'milk-PAR' becomes ambiguous. In fact, we further predict that neither meaning should be preferred over the other.

(72) Ambiguity reappears under the Case-OCP against *ELA-ELA:



An example of ambiguity is given in (73).

(73) Litra-sta maito-a tehtiin lettuja.
liter-ELA milk-PAR was.made pancakes
Pancakes were made with a liter of (the) milk.

In sum, our analysis predicts that syntactic and semantic constraints interact in terms of ranking to determine interpretation preferences, enhancing some interpretations while punishing—and even blocking—others, depending on the environment.

4.3. Residual problems

In this section, we point out issues that have not been dealt with and which will be left for future work.

- INEFFABILITY. In our system, an uninterpretable form is one that wins in no tableau. This is straightforward enough. In contrast, nothing has been said of ineffability, that is, meanings that for some reason cannot be expressed at all. As presently formulated, our grammar will assign some form to any (well-formed) semantic input. We leave open the question how the potential cases of ineffability are to be treated in Optimality Theory. For discussion, see for example Pesetsky 1997 and Smolensky and Wilson 2000.

- DETERMINER TYPOLOGY. In our analysis, we divided determiners into those that require QD downstairs NPs and those that do not. There is much more to say about the syntax and semantics of determiners. For example, *osa* ‘part’ seems half-way between QD-determiners and QI-determiners: while we have treated *osa* as a QI-determiner, it is much more likely to choose the elative than other QI-determiners and in addition seems statistically sensitive to the singular/plural distinction; both tendencies are characteristic of QD-determiners. This shows that individual determiners may differ in ways that we have not considered in this paper. For further discussion, see for example de Hoop 1997 and Doetjes 1997.

- Quantitative predictions. Hard empirical data (corpus evidence, experimental techniques) are needed to establish the preference claims, both in the direction of variation and ambiguity, and we have only begun our work in this area.

5. Conclusion

In this paper, we have examined a particular case alternation in Finnish that is partly semantically, partly syntactically driven. We derived the case alternation from an optimality-theoretic grammar where semantic and syntactic constraints interact in terms of ranking. More specifically, we proposed that the partitive/elative choice depends on three interacting factors: (i) the semantics of the upstairs determiner and the semantics of the downstairs NP (quantitative determinacy); (ii) syntax (Case-OCP), (iii) general faithfulness and markedness. We also argued that partitive is the unmarked case whose meaning is not lexically fixed, but arises through constraint interaction, for example with reference to syntax, whereas the meaning of elative is lexically given.

Following up on the consequences of OT-syntax, we were able to account for the following phenomena: (i) variation; (ii) preferred expressions; (iii) ambiguity; (iv) preferred interpretations; (v) uninterpretability. We made two crucial assumptions: (i) optimality-theoretic grammars are partial orders; (ii) partially ordered grammars can be interpreted quantitatively. Beyond these two assumptions, no additional apparatus was needed. Further, we argued that ambiguity, interpretational preferences and semantic blocking can be captured in the framework of OT-syntax. This provides a possible alternative to bidirectional optimization as developed by Blutner (1999) and Zeevat (1999).

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