WHAT CONCEALED QUESTIONS MIGHT CONCEAL*

ORIN PERCUS
University of Nantes / LLING EA 3827

Abstract

This birthday present for Irene is an attempt to get rid of an "Incomplete." It is a write-up of a SALT talk from a few years ago. I argue here that some "concealed question DPs" have questions as their semantic values, and that this comes about as a result of type-shifting operations; I sketch how this works. I suggest also that other "concealed question DPs" have a structure that embeds a question-denoting constituent, in which case these DPs literally do conceal questions. My overall hope is to provoke thoughts about the nature of type-shifting operations.

1 Introduction

1.1 Our protagonist

In concealed question constructions, a DP that on other occasions might serve as a referring expression appears in a context in which an interrogative clause could appear, and gives rise to a meaning that we could express using an interrogative clause in its place. A popular example is (1a), which admits a paraphrase as in (1b).

(1) a. John knows the price of milk.

*This is, with minor modifications, the text of a talk that I gave at SALT 20 in Vancouver in 2010. I gave an earlier version of it at the workshop Frequently Asked Concealed Questions in Göttingen in 2009. Given the extensive literature on the topic, it is probably safe to say that all of the facts I mention here have been observed before. As noted in the text, my discussion owes a huge debt to Lance Nathan's thesis; I also bring up some points raised in other studies, but mostly for space considerations I do not directly address those authors' points of view (I do cite some of the relevant works in the references). I would like to mention two studies in particular which I have not devoted enough consideration to, and which I feel could lead to a healthy re-evaluation of this material: Aloni and Roelofsen (2011) and Ginzburg and Sag (2001) (Section 8.3). The former brings up facts that go beyond those considered here in interesting ways; the latter could shed light on the selectional puzzles brought up at various points in this paper, and notably in the conclusion. Beyond this, work in progress by Chris Barker makes me want to rethink everything. Thanks to Uli Sauerland for helpful comments.

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b. John knows what the price of milk is.

Irene Heim earned these constructions a place in the semantics literature with a paper that she wrote in her early student years (Heim 1979), and there is now a large body of work that descends from that important reference. (In fact, as far as I am aware, attention to the price of milk started with that paper.) There is good reason for these constructions to catch the eye of compositional semanticists – at least semanticists who view functional application as the central mode of composition. It seems that they could lead us to the discovery of hidden aspects of syntactic or semantic combination. Consider the DP *the price of milk* and the interrogative clause *what the price of milk is*. On the basis of other contexts in which they appear, we would say that they are of different semantic types. But then they cannot both combine with the same verb and produce a meaning via functional application. So either there is more to the syntax than there seems to be and they actually do not both combine directly with the same verb, or there are aspects of the interpretive procedure that operate here that go beyond functional application.

But which is it? Are these constructions telling us something about syntax or semantics – or both? In what follows I will claim that most of the time they are telling us something about semantics, but that some of the time silent pieces of syntactic structure might also play a role. My approach as a whole is guided by the hunch that there is a very specific aspect of compositional semantics that concealed questions can help us to think about. I will explain that in the next subsection.

Readers acquainted with the literature may get the impression in what follows that they are reading Lance Nathan's 2006 thesis all over again. I am afraid this impression would not be far wrong: the talk that this paper is based on owed a lot to Nathan's thesis, and writing it up led to even more convergences. I now think that the best way to view this paper is as my own cut of scenes from that work, and that the surrounding narrative is the main contribution. As you read, please bear in mind this guilty admission.

1.2 Type shifting

Many of us assume a picture on which the atoms of syntactic structure are marshaled into semantic types, and on which composition rules are particular about the types of the composing items – and also systematic in producing the same output type given the same input types. Taken on its own, this places constraints on what constituents can combine in an interpretable way – and perhaps these constraints are stricter than we would like to predict. A variety of researchers have taken the position that in fact natural language is not quite so constrained, and that this is because there are additional operations we can make use of to change denotations given to us by the lexicon or derived by composition rules.

Once we imagine that the grammar includes type-shifting operations, questions arise, of course. What kinds of type-shifting operations can language make use of? What limits are there? Is it useful to imagine the type-shifting operations used in particular cases as being composed of more primitive operations? If so, what are the primitive operations, and what kinds of combination rules does language use for putting them together? And so forth. Questions of roughly the kind that arise in the theory of syntax once we admit the existence of transformations. My hunch is that concealed questions are relevant to the study of type-shifting operations, and while I won't suggest answers to any of these harder questions (much less address existing theories that do), I will try to

proceed in such a way as to trigger thoughts that relate to them. With this in mind, here is a brief introductory word about the typology of type-shifting.

I think it is appropriate to see the type-shifting operations that have been proposed as divided into two kinds. On the one hand, there are operations that we could call meaning-preserving. These essentially just reorganize meanings, and are therefore reversible – we can define an operation that recovers the original meaning from a shifted meaning. A simple example is Partee's *ident* operation, which essentially builds singleton sets and which I will call **S** here for "set." Schematically **S** works as in (2), and (3)–(4) illustrate with a potential application. (As shown in (2), **S** really produces a function, but I will often talk about functions as if they were the sets that they characterize.) The idea sketched in (3)–(4) is that we could appeal to **S** to account for the use of definite determiners with names in some languages, while imagining that names are intrinsically individual-denoting and that the definite determiner is intrinsically the iota operator. Maybe **S** shifts the denotation of the name, and then the denotation of the definite determiner applies to that ((4c)); or maybe it is the denotation of the definite determiner that undergoes a type-shifting operation, one that composes it with **S** ((4c′)). Since the iota operator is the inverse of **S**, the result will be as though we just left the definite determiner uninterpreted. (This illustration is purely for expository purposes; there are serious proposals about this phenomenon in the literature.)

(2) **S**:

a. officially: $x_\tau \rightarrow \lambda y_\tau$. y = x

b. viewed through "set glasses": x → { x }

(3) la Maria

(4) a. ⟦ la ⟧ = $\lambda f_{<e,t>}$: | f | = 1. the unique member of f

b. ⟦ Maria ⟧ = *m*

c. ⟦ (2) ⟧ = ⟦ la ⟧ (**S** (⟦Maria⟧)) = *m*

c′. ⟦ (2) ⟧ = ⟦ la ⟧°**S** (⟦Maria⟧) = *m*

Then there are also operations that make more substantial changes and are not reversible, and that we could call meaning-altering. Plausibly our linguistic competence places significant limits on these, as the conceivable possibilities are endless. The main meaning-altering operation that I will refer to in the discussion to follow is an operation that takes a function and recovers the set of its values – I will call it **V** for "value" ((5)). For example, as (6) shows, if we apply **V** to the property of being an ingredient of ice cream, we get a set of propositions that hold if one substance or another is an ingredient of ice cream. This set of propositions is just the kind of set that a Hamblin-style analysis of questions would posit as the denotation of *What is an ingredient of ice cream*?

(5) **V**:

a. officially: $f_{<\tau,\, \upsilon>} \rightarrow \lambda y_\upsilon$. for some x in dom(f), y = f(x)

b. with set glasses: f → { f(x) | x ∈ dom(f) }

(6) **V** (λx_e: x is a substance. λw_s. x is an ingredient of ice cream in w)
= { λw_s. sugar is an ingredient of ice cream in w,
λw_s. ice is an ingredient of ice cream in w,
λw_s. cream is an ingredient of ice cream in w, . . . }

1.3 To bear in mind in what follows

I will be assuming an analysis of questions of the kind I just brought up, where questions denote sets of propositions. More precisely, for most of what follows, I will be imagining declarative sentences as denoting functions from worlds to truth values, and questions as denoting sets of such functions. But this is a simplification that ignores temporal aspects of interpretation: a more refined analysis would deal in functions from more complex indices – like world-time pairs – to truth values. (This will come up briefly later.)

Also, I will sometimes use a shorthand and, to talk about a question denotation, I'll put a paraphrase in single quotes. So I'll write for example 'What member of S is an ingredient of ice cream?' to talk about the set of propositions { λw. x is an ingredient of ice cream in w | x $\in$ S }, or about the corresponding function λp. for some x in S, p = λw. x is an ingredient of ice cream in w. Similarly, I will sometimes write things like { 'What is an ingredient of y?' | y $\in$ T } to talk about a set of question denotations like the denotation of *What is an ingredient of ice cream?, What is an ingredient of yogurt?*, and so forth – or λQ. for some y in T, Q = 'What is an ingredient of y?' to talk about the corresponding function.

2 At least some "concealed question DPs" *are* questions.

2.1 Our protagonist: a second look

(7) below gives a little representative sample of English concealed question constructions.[1]

(7)

	"concealed question DP"	interrogative paraphrase
They established ...	... the time of Mary's flight	
John announced ...	... Mary's salary	
John forgot ...	... Mary's birthday	
John knows ...	... the password	
They concealed ...	... the solution to the housing crisis	... *what DP is/was*
John asked me ...	... the answer to that question	
They debated among	... the new interest rate	
themselves ...	... the price of milk	
... is of importance	... the capital of Italy	
	... the winner of the competition	
	... the murderer	... *who DP is/was*
	... the new appointee	

I described concealed question constructions as constructions where the use of a DP gives rise to a meaning that we could express using an interrogative clause in its place. Given this description, it is natural to imagine that the DP is contributing a question meaning. This apparently naïve direction is actually the one that I am going to pursue here: DPs like *Mary's birthday* or *the price of milk* can contribute question meanings, and they do in at least some of the cases above. In

[1] Not all combinations shown in this table work equally well. I have ordered the expressions in such a way that, by and large, the higher you are in the leftmost column, the lower you can go in the middle column and still have a natural concealed question construction (in my judgment). This variation in acceptability is curious and calls out for further investigation; it isn't the only place in this paper where selectional puzzles will raise their head.

a minute I will explain my motivation for this, and then the rest of the section will be for spelling out the details. It is worth noting at the outset that, once we take this view, there is a generalization that we can make about the kind of question meaning that the relevant DPs have: typically, we can describe the question meaning that the DP contributes in terms of other cases where we use the DP.[2] (8) expresses the idea, which we can illustrate with the DP *Mary's birthday*. On the basis of examples like *John thinks that Mary's birthday is in January*, we can think of a DP like *Mary's birthday* as associated in some way with a concept – a function that, in every world in which Mary has a birthday, yields Mary's birthday.[3] The question that the DP apparently contributes is the question of what value that concept yields – in the case of *Mary's birthday*, the meaning of *What is Mary's birthday*?

(8) Observation. Some verbs (or similar elements) that can combine with interrogative clauses can combine with DPs instead. In a variety of cases, when they combine with a definite DP from which we can "recover" a concept k, the resulting meaning is what we would expect if the verb combined with an element with the "question meaning"
{ λw: w $\in$ dom(k). x = k(w) | x = k(w') for some w' }.

Now, why say that DPs like *Mary's birthday* or *the price of milk* can contribute question meanings? This is a natural thing to say specifically in those cases where the DPs combine with a verb like *ask* (or *debate*). If we consider what we would say about the semantics of *ask* independently of the facts with DPs, it looks as though, to account for its behavior, we would say that it operates on question meanings and only on question meanings – we would come up with semantic values along the lines of those in (9). Looking at things from the side of the verb, then, the simplest thing to imagine is that, when *ask* combines with a DP like *the price of milk*, its semantics is just what we would otherwise say it is; and that suggests that, when this combination occurs, the DP is contributing a question meaning.

(9) a. $[\![\text{ask}]\!] = \lambda x_e.\ \lambda Q_{<st,t>}.\ \lambda y_e.\ \lambda w_s.$ in w, y asks x to convey to him the (strong exhaustive) answer to Q
b. $[\![\text{debate}]\!] = \lambda X_e.\ \lambda Q_{<st,t>}.\ \lambda w_s.$ in w, the members of X compare the likelihood of different conjunctions of propositions in Q

[2] That is: once we take a position on the way constructions with an interrogative phrase depend on the meaning of the interrogative phrase, we can determine what kind of question meaning we would say that a DP contributes in cases where we have a DP instead of an interrogative phrase; and typically we can describe this question meaning in terms of other cases where we use the DP.

[3] But what kind of concept is this exactly? What sort of object does this function yield? What sort of object is a birthday? I will pretty much look the other way in what follows and won't worry about how we should think of birthdays, salaries, prices, and so forth. In the case of words like *price*, things get even more complicated because of an apparent ambiguity in its simple intransitive use: looking at a "Milk $2/quart" sign, one person can say "Nobody will pay that price" to say that nobody will buy milk at $2/quart, while another person can say "I would only pay that price for beer" to say that he would only buy beer at $2/quart. I think these considerations are probably of relevance to recent discussions of so-called "pair-list readings of quantified concealed questions" in cases where non-functional nouns are involved (see Frana 2013); I won't touch on this phenomenon here.

Now, admittedly this is not a definitive argument, as verbs have been known to type-shift.[4, 5] At the same time, it seems to me that simplicity considerations support this position once we consider examples with quantified DPs like *John asked Mary one price* ((11)).

(10) John asked Mary the price of milk.

(11) John asked Mary one price.

Just as the sentence *John asked Mary the price of milk* ((10)) can be paraphrased as *John asked Mary the question 'What is the price of milk?'*, this new sentence can be roughly paraphrased as *John asked Mary one question among the following: 'What is the price of milk?', 'What is the price of cheese?', etc*. If John asked Mary what the price of milk was, for instance, but he didn't ask Mary what the price of any other thing was, then he (only) asked Mary one price. The relevance of this example is that it seems to me that a successful analysis will *have* to involve the type-shifting of *price* – even type-shifting the verb in such a way as to handle *John asked Mary the price of milk* would not get us out of this. But in that case an analysis where the verb doesn't change its meaning and all type-shifting occurs within the DP seems more appealing than an analysis where type-shifting occurs all over the place. And it is clear that we can *have* an analysis where the verb doesn't change its meaning and all type-shifting occurs within the DP. Just as in the case of (10) we would say that the price of milk comes to denote the question 'What is the price of milk?', in the case of (11) we would say that *price* comes to denote a predicate that holds of questions like 'What is the price of milk?', 'What is the price of cheese?' and so forth. In the subsections to follow, I will consider how this might happen.

Two brief notes on the above. First: I said here that it was natural to see DPs like *the price of milk* as contributing question meanings in cases where they combine with verbs that seem only to operate on question meanings. This position is equally natural in cases where they combine with expressions of a slightly more complicated nature, which sometimes do not operate on question meanings but which also clearly have a distinct analysis on which they do operate on question meanings. *Of importance* is one example. *Of importance* has an analysis on which it operates on propositions, and in this incarnation it has a semantic value roughly as in (12a). Consider for instance the sentence *That John showed up is of importance (to us)*: this presupposes that *John showed up* is true and says that the consequences of *John showed up* being true differ in important ways from what the consequences would have been if *John showed up* had not been true ((12a)). But now consider *Who showed up is of importance.* We would say this if we thought that the consequences of one group showing up differed in important ways from the consequences of a different group showing up – that is, if we thought that the consequences of one set of propositions in ⟦who showed up⟧ being true differed in important ways from the consequences of another set being true. It doesn't look as though we can arrive at this effect by saying that the proposition-selecting *of importance* in (12a) combines with a proposition; for these cases, it is reasonable to assume that *of importance* has an analysis as in (12b) that operates on a question. Importantly, when *of importance* combines with a DP like *Mary's salary*, it gives us the meaning that we would

[4] Indeed, the first important argument for type-shifting (Partee and Rooth 1983) involved type-shifting of verbs.

[5] Also, even if one accepts that *ask* is operating on a question meaning, one might wonder if the question meaning comes from the DP itself or rather from silent structure around it constituting an interrogative phrase – as Baker (1968) originally thought. Here too I think that consideration of examples like (11) alongside (10) pulls toward the type-shifting position, but see remarks in the Conclusion (Section 4).

get out of the question-selecting *of importance* combined with a question like *what Mary's salary is*. So here is another case where it is natural to see the DP as contributing a question meaning. Similar remarks apply to examples with the verb *conjecture*.

(12) a. $[\![\text{of importance}_{\text{prop}}]\!] = \lambda x_e.\ \lambda p_{<s,t>}.\ \lambda w_s$: p(w) = 1. w differs from the closest[6] worlds to w in which p is false in ways that x finds important in w

b. $[\![\text{of importance}_{Q}]\!] = \lambda x_e.\ \lambda Q_{<st,t>}\ \lambda w_s$. for two subsets Q' and Q" of Q, the closest worlds to w that make all and only the propositions in Q' true differ from the closest worlds to w that make all and only the propositions in Q" true in ways that x finds important in w

(13) a. $[\![\text{conjecture}_{\text{prop}}]\!] = \lambda p_{<s,t>}.\ \lambda x_e.\ \lambda w_s$: x has no evidence in w that p is true and entertains in w the possibility that p is false. x proposes in w that p is true

b. $[\![\text{conjecture}_{Q}]\!] = \lambda Q_{<st,t>}.\ \lambda x_e.\ \lambda w_s$. for some subset Q' of Q, x has no evidence in w that $\cap$Q' is true, entertains in w the possibility that $\cap$Q' is false, and proposes in w that $\cap$Q' is true

Second: I suggested above not only that *John asked Mary the price of milk* is analogous to *John asked Mary that question – the price of milk* denotes the question 'What is the price of milk?' – but also that *John asked Mary one price* is analogous to *John asked Mary one question – price* denotes here a predicate that holds of questions like 'What is the price of milk?'. *Price*, in other words, can contribute the meaning *price-question*:

(10′) a. John asked Mary the price of milk.

b. John asked Mary the question 'What is the price of milk?'
(cf. John asked Mary that question.)

(11′) a. John asked Mary one price.

b. John asked Mary one question "of the form 'What is the price of x?"'
(cf. John asked Mary one question.)

Once we recognize this, it is no surprise that we find ambiguity in examples like (14). The minute *price* is interpreted as *price-question*, we expect an ambiguity exactly parallel to the ambiguity in (14′). If nothing else special happens, (14) will communicate that there is a certain price-question that Fred asked Mary, and John asked Mary that question. On the other hand, if the whole DP *the price that Fred asked her* is treated as a "concealed question DP," (14) will communicate that John asked Mary the question *what the price-question that Fred asked her is*. We find parallel ambiguities in other examples with question-selecting verbs – see (15). And of course, we also find similar ambiguities in examples with different kinds of verbs: Irene Heim in her 1979 article famously discussed the very similar case in (16), which has been talked about in much this way, as referring to the answer to a price-question or to the answer to a question about price-questions.[7] (I will return to it later.)

[6]The precise content of "closest" here is determined by the context, I assume, and could be attributed to a parameter of semantic evaluation that I have left out.

[7]Nathan (2006, 63) specifically writes: "This can be thought of as Fred knowing the answer to a question (e.g. 'What is the price of milk?'), and John knowing either the answer to that question, or the answer to the meta-question 'Which question does Fred know the answer to?'" In her prior work, Maribel Romero extensively discussed these kinds of examples, and in roughly this way.

(14) John asked Mary the price that Fred asked her.

If we know that Fred asked Mary what the price of milk was:
Interpretation 1: John (like Fred) asked Mary what the price of milk was.
Interpretation 2: John asked Mary what the question that Fred asked her was.

a. John asked Mary the price-question that Fred asked her.
b. John asked Mary the price-question that Fred asked her. (concealed question)

(14′) John asked Mary the question that Fred asked her. (Two parallel interpretations.)

(15) a. The price of importance to Mary is of importance to us.
b. We conjectured the price that they conjectured.
c. We debated the risks that we would debate the next day.

(16) John knows the price that Fred knows. (Heim 1979)

If we know that Fred knows one price, the price of milk:
Interpretation 1: John (like Fred) knows the price of milk.
Interpretation 2: John knows that the price that Fred knows is the price of milk.

2.2 A step in the creation of question-related nouns

I just argued that, under question-selecting predicates, *the price of milk* can come to denote a question meaning and *price* can come to denote a set of questions. How does this happen? My claim here will be that both cases involve the same type shift that applies to relational nouns and enables them to deal in questions – in particular, in these examples, the relational noun *price*. The reason for saying that the same type shift is involved is the following. There are constraints on what relational nouns can appear in constructions of the kind we have looked at – *John asked Mary the price of milk* and *John asked Mary one price* – and I believe that the constraints are the same for the two constructions. This can be accounted for if the paths to the new denotations involve a common process that imposes these constraints: we can say that there are restrictions on the application of a specific type-shifting operation that relational nouns undergo in both cases. Below, I will discuss these constraints; then in the following subsection I will spell out the details of the type-shifting story.

The most salient constraint on the relational nouns that concern us here is this: at least at a first approximation, the relations that they denote must be functional. Take *price*. We typically don't imagine that an item can have two prices – and in any event, when we use a sentence like *John asked Mary the price of milk* or *John asked Mary one price*, we definitely don't imagine the products under consideration as having more than one price. It seems that only relational nouns that behave in this way can appear in these constructions. The best way of seeing that this constraint is in force is to consider what would result if it weren't. Consider sentences of the *John asked Mary one price* variety. In sentences of this kind, the noun plausibly starts out expressing a relation R (like the relation that holds between products and their prices) but then by hypothesis it ends up denoting a set of questions of the form 'What does x stand in the relation R to?' Now suppose that all we had were a type shift that effects changes of exactly this kind, with no additional strings attached. Consider what the prediction would be in cases where we have a noun that we clearly imagine *not* to express a functional relation, like *flavor* – ice cream can come in more than one flavor, after all. The prediction would be that I should be able to say *I asked Mary one flavor* to

mean that I asked her one question like 'What is a flavor of ice cream?', and I certainly can't do that:

(17) a. I asked Mary one price.
Possible paraphrase: "I asked one question of the form 'What is the price of x?"'
(e.g. I wanted to know what milk costs.)
b. I asked Mary one flavor.
Not a possible paraphrase: "I asked one question of the form 'What is a flavor of x?"'
(e.g. I wanted to know what flavors ice cream comes in.)

Another example that makes the same point is (18). As long as we are talking about problems with a single solution, we can say *One solution is of importance* to mean, for example, that it is of importance to us what the solution to Problem 1 is – if one solution turned out to be the right one, that would be a more useful result than if another one did. But if we talk about problems that really admit two solutions each, this sentence becomes odd, and it certainly doesn't express that, if one set of solutions to, say, Problem 1 turned out to be the correct one, that would be a more useful result than if another set of solutions did.

(18) One solution is of importance to us.
Paraphrase: "For one problem, it is of importance what the solution to that problem is."
Not a paraphrase: # "For one problem, it is of importance what the set of solutions is."

Then there are further constraints that relational nouns in our constructions are subject to. Not all functional relations work either. *Father* and *owner* are excluded, for example. I can't use *I asked Mary one father* to say that I asked her one question of the form 'Who is the father of x?', and it is odd to use *One father is of importance* to say that, in the case of one person, it is of importance who that person's father is. And analogous remarks go for *I asked Mary my father* and *My father is of importance*. I haven't been able to identify a further generalization here – this needs more attention – but it serves to drive home the point that the relational nouns that enter into our constructions are limited.

My conclusion from this, as I said, is that both constructions involve a specific type-shifting operation that applies to a relation and imposes restrictions on its input. My particular take on this operation is that, among other things, it actually *requires* its input to be a function. This means that we might not always be applying this operation to what we seem to be applying it to. Take *price* again. Even if we typically do not imagine such situations, it is compatible with the intrinsic meaning of *price* that one item can have two prices (this could happen due to carelessness for example), and on this basis one might conclude that *price* intrinsically does not denote a functional relation. My position in this case would be that the relation that shifts is actually not the original denotation of *price* but rather a "contextually restricted" version that only concerns items that have a single price. That is, we can further restrict denotations like that, and this further restricted relation is the relation that our picky type-shifting operation applies to – I will mark restricted denotations by putting a "C" on the element whose denotation is restricted, as in (19).[8] Similarly,

[8] A more serious investigation of the semantics of *price* might expose some simplifications in this discussion. For instance, it might be appropriate to see prices as relativized further, to pricing authorities and to transaction conditions. Maybe it is in fact correct to view items as having a single price relative to a single pair of these factors, and in cases where we say that an item has more than one price, it is due to existential quantification over one of them (cf. *Milk*

when it comes to *solution*, we apply the shift to a "contextually restricted" version of *solution* that only concerns problems with a single solution.

(19) $[\![\text{ price }]\!] = \lambda x{:}\ldots\lambda p{:}\ldots\lambda w.$ x has price p in w

$\downarrow$

$[\![{}^{C}\text{price }]\!] = \lambda x{:}\ldots\lambda p{:}\ldots\lambda w{:}$ x has only one price in w. x has price p in w

2.3 Some type shifts

Here now is a concrete proposal. It isn't so original: the type shifts that I will postulate here build on one formulated by Nathan (2006), and basically follow the pattern of his type shifts.

To begin with, we have a type shift that is common to the two constructions we have looked at, that can apply at the noun level and that I will call **T1**. **T1** operates on relations, and it is selective as to the relations it can operate on, as we have seen: it only likes relations that are functional, and even then it is not always happy. What this type shift consists in is just the composition of **V** with the relation to which it applies. As a result, when it applies to a relation R, it creates a function that, for a given argument x, produces the question 'What bears R to x?'. In the examples we have been looking at, it will apply to $[\![{}^{C}\text{price }]\!]$, and the result will be a function that, for a given argument x, produces the question 'What is the ^{C}price of x?' ((21)).

(20) **T1**: $R \rightarrow \mathbf{V} \circ R$
*Not all Rs can undergo **T1**. In particular: an R can only undergo **T1** if it is functional, i.e. for all x, a, b, w, if R(x)(a)(w) = 1 and R(x)(b)(w) = 1 then a = b.*

(21) **T1**($[\![{}^{C}\text{price }]\!]$)
$= \mathbf{V} \circ [\![{}^{C}\text{price }]\!]$
$= \lambda x{:}\ x \in \text{dom}([\![{}^{C}\text{price }]\!]).\ \mathbf{V}([\![{}^{C}\text{price }]\!](x))$
$= \lambda x{:}\ x \in \text{dom}([\![{}^{C}\text{price }]\!]).\ \{ [\![{}^{C}\text{price }]\!](x)(p) \mid p \in \text{dom}([\![{}^{C}\text{price }]\!](x)) \}$
$= \lambda x{:}\ x \in \text{dom}([\![{}^{C}\text{price }]\!]).\ \{ \lambda w{:}\ldots x \text{ has } {}^{C}\text{price p in w} \mid p \in \text{dom}([\![{}^{C}\text{price }]\!](x)) \}$
$= \lambda x{:}\ x \in \text{dom}([\![{}^{C}\text{price }]\!]).$ 'What is the ^{C}price of x?'

What happens next? In the case of *John asked Mary the price of milk*, nothing to speak of. There is a step of functional application as usual, in which the product of our type shift applies to *milk*, forming the question meaning 'What is the ^{C}price of milk?'. Then, I imagine that, in one way or another, *the* is rendered vacuous by virtue of the **S** shift – we saw earlier how this can happen – and the result is that the question meaning gets passed up as the contribution of *the price of milk*. In the case of *John asked Mary one price*, however, *price* undergoes another type shift, which is simply the **V** shift – I will give the name **T2** to this incarnation of the **V** shift that

has two prices, the legislated price and the market price; There are two prices of milk at this store, the standard price and the price for customers with a discount card). But the "contextual restriction" approach does seem valid to me for other cases, and it will play a substantive role in the discussion of "relationization" below.

applies to function-denoting nouns ((22)). Application of **T2** makes out of *price* a predicate that characterizes price-questions, one that we could paraphrase with the term *price-question*:[9]

(22) **T2**: F → **V** (F) (applies at the level of nouns)

(23) **T2** (λx: x ∈dom(⟦ ^{C}price ⟧). 'What is the ^{C}price of x?')
=**V** (λx: x ∈dom(⟦ ^{C}price ⟧). 'What is the ^{C}price of x?')
= { 'What is the ^{C}price of x?' | x ∈ dom(⟦ ^{C}price ⟧) }
= $\lambda Q_{<st,t>}$. Q is a price-question

And that's all. All? No. One detail still holds out. We have been concentrating here on constructions with relational nouns like *price* or *birthday*, and our story was designed specifically for them – the common type-shifting operation **T1** we posited applies specifically to relations. But it is well known that concealed question constructions don't have to contain relational nouns. (24) gives two examples with "intransitive" nouns, and to account for the second reading of our (14) (repeated below) we already noted that here we have a concealed question construction with the *price* that means *price-question*, which isn't relational. What is going on in cases like these?

(24) a. He asked me the year Mary was born.
b. She asked me the city I liked best.

(14) John asked Mary the price that Fred asked her
⋮
Interpretation 2: John asked Mary what the question that Fred asked her was
⋮
b. John asked Mary the price-question that Fred asked her (concealed question)

What is going on, I suggest (in the spirit of Nathan more than the letter), is that these constructions involve a further type shift that fits noun denotations into a format that enables our earlier rules to apply to them. Before anything else happens, the noun denotation undergoes a type shift that "relationizes" it, in such a way that it comes to select for a modifier of the kind we could get out of a relative clause. (25a) describes the meaning-preserving type shift **R** (for "relationize"), which applies to a property like the one we get out of the noun *city* and makes it into a relation.[10] (25b) shows precisely what happens there: in essence, **R** augments the noun's selectional features so that it needs to combine with a constituent that gets treated as a conjunct – note however that on my formulation here this constituent is not a "property" in exactly the same sense as the old

[9]Note that in order for the denotation of *one* to apply to this, *one* will need a cross-categorial treatment, allowing it to quantify over questions as well as individuals. Later, we will also want it to be able to quantify over propositions, and in fact we will want to give determiners this kind of flexibility quite generally. I mention this now to forestall confusion later.

[10]Uli Sauerland (pc) asked me whether "relationization" should be exploited in order to account for examples like those in (i) where *price of milk* seems to be modified restrictively; the idea would be that here, **R** applies to the constituent *price of milk*. I haven't made up my mind about examples like these (which in any event suggest to me that **T1** sometimes applies to constituents larger than a single noun).

(i) a. John asked Mary the price of milk at the local store.
b. John asked Mary the local price of milk.

city, since its individual and world arguments come in the opposite order. Since **R** as formulated cannot apply to the *price* that means *price-question* – it can only apply to constituents that take a world argument – I will imagine that there is also a minor variant of **R**, called **R'**, that can, and (26) shows **R'** in operation. (From here on, for ease of exposition I will pretend that, in places where *price* comes to mean *price-question*, we literally have the term *price-question*. I will also abbreviate the type of questions, <st,t>, as "q.").

(25) a. **R**: $P_{<X,st>} \rightarrow \lambda p_{<s,Xt>}.\ \lambda x_X.\ \lambda w_s.$ P(x)(w) = 1 and p(w)(x) = 1.

b. **R** (⟦ city ⟧) = **R** ($\lambda x_e.\ \lambda w_s.$ x is a city in w.)
= $\lambda p_{<s,et>}.\ \lambda x_e.\ \lambda w_s.$ x is a city in w and p(w)(x) = 1.

(26) a. **R'**: $f_{<X,t>} \rightarrow \lambda p_{<s,Xt>}.\ \lambda x_X.\ \lambda w_s.$ f(x) = 1 and p(w)(x) = 1.

b. **R'** (⟦ price-question ⟧) = R' ($\lambda Q_q.$ Q is a price-question.)
= $\lambda p_{<s,qt>}.\ \lambda x_q.\ \lambda w_s.$ x is a price-question and p(w)(x) = 1.

Once the "relationizing" gets done, everything happens as before. We restrict the relations to make them functional, and we apply **T1**, and basically this gives us the result we want, assuming we can insert a binder of world variables at the top of the relative clause. This is sketched in (27)–(29) below, where for short I write "O-N" for a noun whose denotation has undergone type-shifting via operation O.[11] Another possibility would be to apply **T2** after **T1**. This would create a new intransitive noun *price* that denotes a set of "meta-questions" specifically concerned with price-questions – questions like 'What is the price-question that Fred asked Mary?', 'What is John's favorite price-question?', and so forth. This kind of reading of *price* isn't very salient, but it has played a role in the literature, and I think *John asked one price* can indeed be understood as saying that John asked such a meta-question. Moreover, since in principle we can relationize any intransitive noun, then restrict and feed the result to **T1** – and then feed that to **T2** and start over again – we could go even further, relationizing *this* price and going off to higher and higher order meta-question readings. Such readings have been claimed to exist; if they do, one could take that as support for this approach.

(27) a. **T1** (⟦ ^{C} R - city ⟧)
= **T1**(λp:. . . λx:. . . λw: there is only one z such that z is a city in w and p(w)(z) = 1 . x is a city in w and p(w)(x) = 1)
= λp: . . . { λw: there is only one z such that z is a city in w and p(w)(z) = 1 . x is a city in w and p(w)(x) = 1 | . . . x . . . }
= λp: . . . 'What is the city with property p?'

b. **T1** (⟦ ^{C} R'- price-question ⟧)
= **T1**(λp:. . . λx:. . . λw: there is only one z such that z is a price-question and p(w)(z) = 1 . x is a price-question and p(w)(x) = 1)
= λp: . . . { λw: there is only one z such that z is a price-question and p(w)(z) = 1 . x is a price-question and p(w)(x) = 1 | . . . x . . . }
= λp: . . . 'What is the price-question with property p?'

(28) a. the city Mary is from

b. structure: [$_{NP}$ T1 - ^{C} R – city] [**3** [$_{CP}$ (OP) 2 **w$_3$** Mary is from t_2]]

[11] OP in (28)–(29) is a relative operator, in parentheses because it goes uninterpreted.

c. ⟦ (28b) ⟧ = λp:… 'What is the city with property p?' (λw. λx. Mary is from x in w)
= 'What is the city Mary is from?'

(29) a. the price Fred asked Mary

b. structure: [$_{NP}$ T1 - ^{C} R' – price-question] [**3** [$_{CP}$ (OP) 2 **w$_3$** Fred asked Mary t$_2$]]

c. ⟦ (29b) ⟧ = λp:… 'What is the price-question with property p?' (λw. λx. F. asked M. x in w)
= 'What is the price-question that Fred asked Mary?'

2.4 Some potential worries

I have claimed here that DPs like *the price of milk* can denote questions and that DPs like *a price* can quantify over questions of just these kinds. I have also proposed an account of how this happens, where type-shifting is responsible for the new denotations, and where the two phenomena involve a common type shift. There are many details that one could question. One worry that one might have, for example, is: were the precise type-shifting rules that I invoked the right ones?

For me, this is really an open issue. My intention in specifying the rules the way I did was to make maximal use of a single basic meaning-altering operation, **V**, but there are certainly other possibilities one could imagine.[12] I would like to call attention to one possibility that naturally comes to mind given the literature. First some background: in my discussion so far, I focused on DPs that appear under verbs like *ask*, which select for questions, but some of the same DPs also

[12]In fact, I assumed different type-shifting rules in the version of this work that I presented at SALT 20. The common type shift there was a rule that was a lot like **T1** except that the function it produced out of [[^{C}price]], instead of mapping milk to the question 'What is the price of milk?', mapped it to the singleton set {'What is the price of milk?'}. (That is, given R, it produced **S** ° (**V** ° R).). *The* then applied to this function in the normal way, yielding the question 'What is the price of milk?' The second type shift that converted this to the *price* that means "price-question" created the union of all of the function's values. It thus could be seen as the composition of another meaning-altering operation **U** with **V**, where **U** forms the union of a collection of sets.

I see this latter story as a more complicated story, hence my reluctance to include it in the text, but at the same time I think it has some things going for it. For one thing, it more clearly connects to other phenomena: **U** ° **V** is an "existential closure" operation, and, one could see it as the mechanism that underlies the detransitivization of relational expressions more generally. But also, importantly in my view, this different approach allows us to generate at no extra cost a meaning for constituents like *price of a dairy product* that characterizes the set { 'What is the price of milk?', 'What is the price of cheese?', … }. This meaning is like the meaning of *price* that corresponds to *price-question*, but the questions concerned are restricted to those involving dairy products, and I think we would like to be able to generate it. (Examples like *John knows every capital of a European country* have come up in the literature, and, as the next section will make clear, to capture the most salient reading of this sentence I would favor a treatment along these lines for *capital of a European country*.) With this different type-shifting story, using the *price* that results from the first type-shift – call it PRICE – we could generate a structure for *price of a dairy product* that yields this meaning and that is analogous to the structure of *father of a soldier* in *every father of a soldier*. Specifically, in Heim-and-Kratzer style, we could generate an uninterpreted PRO subject of PRICE, then QR *a dairy product* above that, and then raise the PRO subject above *that* ((i)). By contrast, with the type-shifting story in the text, something would have to be added, for example a type shift that creates PRICE by composing **S** with **T1**-^{C}price once we have gotten to that point.

(i) a. before movement: [PRO PRICE [a dairy product w$_1$]]

b. after movement: (PRO) 2 [[a dairy product w$_1$] [3 t$_2$ PRICE t$_3$]]

c. ⟦ (i b) ⟧ = λQ. For some x that is a dairy product in g(1), Q = 'What is the price of x?'

appear under verbs that select for concepts, as shown in (30)–(31).[13] On the basis of reasoning parallel to mine above, it is natural to think that these DPs therefore have analyses on which they denote concepts or quantifiers over concepts. Following this line of thought, *the price of milk* (for example) would sometimes have a semantic value like (32a) and *price* would sometimes have a semantic value like (32b) – and in fact Nathan has explicitly proposed type-shifting operations that would fit items like these into concept-selecting environments. (In (32) I have temporarily switched from world arguments to index arguments with time and world components since, once verbs like *change* enter the picture, we can no longer abstract away from temporal aspects of interpretation.[14]) Now, given this background, one might wonder if the way of arriving at question-related denotations is actually more circuitous than I made it out to be, and starts out with the concept-related denotations. Maybe, in a sentence like *John asked Mary the price of milk*, we first get out of *the price of milk* the concept in (32a) and then apply a type shift so as to derive a question about the concept's value. This idea has to its credit that it seems to open up an explanation for why we can only build question-related denotations out of nouns that describe functional relations. But I think it faces challenges too. Imagine that milk is the only product whose price went up yesterday, and with this in mind suppose also that John asked me what the price of milk was. In that case, this view seems to predict that I could use the sentence *John asked me the price that went up yesterday* to describe what happened, in the same way that I could use *John asked me the price of milk*. But I find it hard to understand the sentence that way.

(30) a. The price of milk changed / went up.
b. John hazarded / graphed / is an expert on the price of milk.

(31) a. One price changed / went up.
b. John hazarded / graphed / is an expert on one price.

(32) a. ⟦ the price of milk ⟧
= $\lambda \mathbf{I}$: milk has only one price at $\mathbf{I}^{T}$ in $\mathbf{I}^{W}$. the unique price of milk at $\mathbf{I}^{T}$ in $\mathbf{I}^{W}$
b. ⟦ price ⟧ = λk. there is some x such that, for all $\mathbf{I}$ in dom(k), k($\mathbf{I}$) = the unique price of x at $\mathbf{I}^{T}$ in $\mathbf{I}^{W}$.
(Notation: "$\mathbf{I}^{T/W}$" stands for "the time/world component of $\mathbf{I}$.")

A more serious worry concerns the overall claim that DPs like *the price of milk* can denote questions. One might object to this claim on the following grounds. One might think that, if these DPs can indeed denote questions, then any question-selecting verb that combines with DPs should be able to combine with these DPs, and that is not always what we find. Most prominently – as discussed in particular by Nathan riffing on an argument from Grimshaw (1979) – there are verbs like *wonder* and *inquire*, which combine with questions and with DPs but do not seem to combine with *these* kinds of DPs at all:

(33) a. *John wondered Mary's birthday.
b. John wondered the same thing.

[13] Note that sentences like *The price of milk went up* are not literally concealed question constructions, as an interrogative clause could not appear where *the price of milk* does.

[14] The semantic value for *change* would run along the following lines: ⟦ change ⟧ = λk. $\lambda \mathbf{I}$. k yields different values for two indices with world component $\mathbf{I}^{W}$, one whose temporal component immediately precedes $\mathbf{I}^{T}$ and one whose temporal component immediately follows $\mathbf{I}^{T}$.

(34) a. *John inquired Mary's birthday.
b. John inquired the same thing.

Then there are also verbs which combine with DPs but which, when they combine with *these* DPs, do not yield the meanings we would expect if these DPs had the kinds of question meanings we have imagined. *Tell* and *guess* are like that, at least in the judgments of some:[15] when *tell* combines with an interrogative clause, it does not imply that the subject communicated the true answer to the embedded question ((35a-36a), cf. Egré and Spector (2007)), but things look different when it combines with a "concealed question DP" ((35b-36b)). Arguably, though, there is nothing here that goes beyond what we have just seen – these verbs, which all describe acts of communication, combine with propositions as well, and arguably a verb like *tell* is ambiguous between a proposition-selecting *tell* and a non-veridical question-selecting *tell* of the same nature as *wonder* and *inquire*.[16]

(35) Background: I asked John to tell me where Mary was born. He didn't know so he made something up (/guessed). He told me /guessed) that Mary was born in Japan.
a. Did John tell me (/ guess) where Mary was born? On one reading, yes.
b. Did John tell me (/ guess) Mary's birthplace? No.

(36) a. John did tell me where Mary was born, as I asked him to. He was just wrong.
b. ?John did tell me (/guess) Mary's birthplace, as I asked him to. He was just wrong.

I am not swayed by this objection. This is because I can well imagine that the inability of these verbs to combine with question-denoting DPs like ours traces back to other ways in which they differ from the question-selecting verbs we looked at earlier. In particular (as also pointed out in passing by Nathan), when we turn our attention away from concealed question constructions and ask what other DPs these verbs combine with, we find that they are extremely selective. Verbs like *wonder* and *inquire* only like DPs containing the nominal head *thing* or a silent head – and they specifically do not like DPs containing nominal heads like *question* or *issue*, which are the kinds of DPs that sit happily together with *ask* or *of importance* or *debate* ((37)). While I don't claim to understand exactly why question-selecting verbs vary as to their taste in nominal heads – and I think it is important to find out[17] – it seems to me likely that, one way or another, the greater

[15] It seems to me that, generally speaking, the verbs in this class are verbs of communication that combine with propositions as well.

[16] The semantics of the non-veridical question-selecting tell might go roughly as follows: $[\![\text{tell}^{nv}{}_{Q}]\!] = \lambda Q_{<st,t>}.\ \lambda x_{e}.\ \lambda y_{e}.\ \lambda w_{s}.$ for some subset Q' of Q, while conversing with x, y asserts in w a sentence whose content is $\cap$Q'.

[17] An interesting direction to explore (some other time) might be that those question-selecting verbs that are happy with a DP "headed" by *question* (say) actually select for such a DP, and appear all the time with one though it might go unpronounced, e.g. *John asked Mary (the question) what the price of milk was*. The next section will in fact bring up related ideas. This kind of approach, on which the interrogative phrase would not itself be the argument of the verb, could perhaps help to get a grip on the intuition that different question-selecting verbs describe relations to different kinds of objects. Sentences like (i) are bizarre, for example; similarly, if on the one hand both John and Mary asked whether the death penalty was beneficial to society as a whole, and if on the other hand both my friends and yours debated whether the death penalty was beneficial to society as a whole, this could be reported by (ii a) and (ii b) but not so easily by (ii c). Pursuing this kind of approach would also lead one to ask whether "concealed question DPs" appearing with these verbs replace the interrogative phrase or rather constitute the whole direct object – in which case they would be syntactically more complicated than we have assumed until now.

selectivity of verbs like *wonder* and *inquire* leads them to reject question-denoting DPs of the kind we have posited.

(37) a. *I wondered that question / issue.
b. *I inquired that question / issue.
c. *I told Mary that question/ issue.

(37′) a. I asked that question.
b. That question/ issue is of importance
c. We debated that question/ issue.

3 But some "concealed question DPs" might actually have questions hidden within.

3.1 Proposition-selecting verbs

In the last section I claimed that DPs like *the price of milk* can denote questions and nouns like *price* can denote sets of questions. I motivated this idea by pointing out that it seems to be the simplest thing to say in cases where these DPs appear under verbs like *ask*, which select for questions. But concealed question constructions don't only involve verbs that are specifically keyed to questions, and when it comes to constructions involving other kinds of verbs, other analyses of these DPs would appear equally plausible. In this section, I will consider concealed question constructions with verbs like *know* that combine with propositions. I will take the position that these verbs inherently select for propositions – that *know* has a semantics as in (38), for instance.[18] Consistently with my general approach thus far, I will suggest that, in these cases of concealed question constructions, the verbs under discussion combine with proposition-denoting constituents. At the same time, the work we have done so far will play an important role.

(38) $[\![\text{ know }]\!] = \lambda p_{<s,t>}.\ \lambda x_e.\ \lambda w_s\text{: } p(w) = 1.$ For every doxastic alternative w' of x's in w, p(w') = 1...

When we considered question-selecting verbs, we noted (back in (8)) that there was a generalization about what kind of question meaning the verb seemed to combine with when it appeared with a "concealed question DP" like *the price of milk*. In the same way, when it comes to proposition-selecting verbs, there is a generalization about what kind of *proposition* the verb seems to combine with: thinking of the DPs as associated with concepts, the proposition is the proposition that the value of the "DP concept" is what it is in reality ((39)).[19] For example, a sentence like

(i) ??We debated, and they asked, the same thing.

(ii) a. John asked what Mary asked.
b. My friends debated what your friends debated.
c. John asked what your friends debated.

[18](38) obviously abstracts away from some details. The verb *know* also happens to have a use on which it means *be acquainted with*, but I will ignore this here (harmlessly, I think).

[19]I think one can maintain that, when a proposition-selecting verb combines with a "concealed question DP," it always behaves as though it combines with a proposition of this kind, and that apparent exceptions (*conjecture, of*

John knows the price of milk behaves as though *know* is combining with a complement whose semantic value is as in (40c); this sentence conveys that John situates himself in a world where the price is milk is just what its price happens in reality to be. I think there is a lesson to be learned from looking at (40c): our story about what happens under proposition-selecting verbs cannot be as simple as the story we told about what happens under question-selecting verbs. If indeed the sister of *know* comes to denote a proposition like (40c), then it is unlikely that this happens entirely as a result of type-shifting material in the DP. I say this because I see no natural way in which type shifting could yield something that, as far as its semantics goes, behaves like a constituent containing a world variable bound from outside. If indeed the sister of *know* comes to denote a proposition like that, then the variable must actually be present somewhere. My conclusion is thus that, when a proposition-selecting verb combines with a DP like *the price of milk*, it is combining with a complex constituent that has a complex structure.

(39) Observation. In a variety of cases where a verb that combines with propositions combines with a DP from which we can "recover" a concept k, a meaning results that is the meaning we would get if the verb combined with a *proposition* of the form λw. k(w) = k(w*) (where w* is the evaluation world of the verb).

(40) a. John knows the price of milk.
b. 1 [w_1 John knows α]
c. $[\![\alpha]\!]^g = \lambda$w. the price of milk in w is the price of milk in g(1)

But what kind of complex structure? Well, one that contains a question, I claim. The reason why we call these kinds of constructions "concealed question" constructions is precisely that we could have an interrogative clause in place of the DP, so there must be room somewhere in the verb's complement for a question-denoting constituent. I suggest that when a DP like *the price of milk* appears together with *know*, it is the question-denoting *the price of milk* that we have been concerned with all along, and that it fills the same spot that an interrogative clause would. Specifically, I would like to entertain the hypothesis that, in a sentence like *John knows the price of milk*, the complement of *know* has a structure that essentially spells out "the true answer to Q," where Q is the question contributed by *the price of milk*. Our earlier work on *the price of milk* thus remains relevant, and in the next subsection I will put some flesh on this idea and mention what I see as its merits.

3.2 A complex structure

(41) repeats the basic idea, which is that in a sentence like *John knows the price of milk*, *the price of milk* contributes the same question that it would contribute under a question-selecting verb, and then the material around it turns it into the proposition that truly answers that question. (42) adds some detail. There is a null head which I called *n* and which you can think of as "proposition" (hence interpreted vacuously as in (42)) but I will return to its contribution in a minute. Modifying the null head *n* is a relative clause whose main predicate is also an unpronounced item, *A*, which means "truly answering" – or more precisely, "is an element of the following question that is true

importance, ...) are due to the existence of a question-selecting twin. We seem to find this behavior in all cases where we are not forced to postulate a question-selecting meaning for the verb in order to account for the meaning that results when the verb combines with a syntactic question. (Note that *tell*, which I suggested realizes both a proposition-selecting verb and a question-selecting verb allergic to concealed questions, behaves in exactly this way.)

in my evaluation world." *A* applies to the question-denoting *the price of milk*. Finally, there is a *the* at the top of the verb's sister, which makes the whole thing come out as expressing "the proposition that truly answers the question 'What is the price of milk?' " Note that, the way I have put this structure together, there are actually *two* instances of *the*, the one at the top of the verb's sister and the one that constitutes part of the question-denoting *the price of milk*. Evidently only one of these instances of *the* is pronounced, and I will assume that it is the *higher* one, the one at the top of the verb's sister.[20]

(41) a. 1 [w_1 John $verb_{prop}$ [$_\alpha$ . . . [$_\beta$ the price of milk] . . .]]
b. $[\![\beta]\!]^g$ = 'What is the ^{C}price of milk?'
c. $[\![\alpha]\!]^g$ = the unique p in $[\![\beta]\!]^g$ such that p(g(1)) = 1

(42) a. 1 w_1 John knows [$_{DP}$ the *n* [(OP) 2 [$_{?P}$ w_1 t_2 *A* [$_{DP}$ the T1-^{C}price of milk]]]]
↓ "the" ↓ "price of milk"
b. $[\![n]\!] = \lambda p_{<s,t>}.\ 1$
c. $[\![A]\!] = \lambda Q_{<st,t>}.\ \lambda p_{<s,t>}.\ \lambda w_s.\ p(w) = 1$ and $Q(p) = 1$

Yes, this proposal is clunky and not terribly creative and in obvious need of fine-tuning.[21] But I think that there are two aspects to it that make it worth considering, at least as far as its basic format goes. First, the existence of the null head potentially fits this proposal together with other facts about the proposition-selecting verbs that combine with "concealed question DPs." These verbs are picky about what other proposition-denoting DPs they combine with: they only seem to like those whose NPs are headed by a noun like *fact*. For instance (cf. Vendler 1972), if we know that Mary's claim was that John was responsible, we can use *Bill believed Mary's claim* to express that Bill believed that John was responsible, but we *can't* use *Bill knew Mary's claim* to express that Bill knew that John was responsible or *Bill forgot Mary's claim* to express that Bill forgot that John was responsible. If we want to express these things by combining the verb with a DP, we have to say *Bill knew (forgot) the fact that John was responsible*. While this selectional behavior of verbs like *know* deserves an explanation, a proposal for concealed question constructions along the lines of ours is at least able to take it into account by saying that the null head is actually something like *fact* (in which case its semantics is more substantial than I assumed above). The second point in favor of the proposal is that it naturally extends to account for facts involving DPs that are not definite. In particular, if an unpronounced *a* can appear in the position where the unpronounced *the* appears, we can account for quantified sentences like (43), and in an intuitive way. The salient reading of *John knows every price* says that John knows every proposition truly answering some

[20] One might wonder why I have put the second determiner there at all, since, following the earlier discussion, it would be to all intents and purposes uninterpreted. There are two reasons: as we will see in a minute, I will suppose that *a* can occupy that position; I wish to leave open the possibility of the variant type-shift rules I mentioned in Note 12, and with these it would require an interpreted *the* to arrive at the question denotation of *the price of milk*.

[21] In particular, some more will have to be said about cases where full syntactic questions appear under *know*. Adopting this picture would lead us to say that the higher determiner can go unpronounced when a full syntactic question is embedded, and some explanation needs to be found for that. Also, this hypothesis will have to be supplemented to explain all the readings that instances of *know* with syntactic questions give rise to – for instance, to explain the fact that *John knows what is a flavor of ice cream* is naturally taken to express that John knows the exhaustive answer to the question "What is a flavor of ice cream?" (unlike *John knows a flavor of ice cream*, which will be discussed later).

price-question and this is just what we would read off a structure where the object of *know* is as in (43b): the word *price* here would be shifted to the *price-question* meaning by **T1** and **T2** in a familiar way (recall that for convenience I simply write *price-question* in cases where this has happened).[22, 23]

(43) John knows **every / most / one** price(s).

a. Reading: John knows **every / most / one** proposition(s) truly answering a price-question

b. Object of *know* before QR: [$_{DP}$ **every** *n* [(OP) 2 [$_{?P}$ w_1 t_2 *A* a price-question]]]

c. Object of *know* after QR: [$_{DP}$ **every** *n* [(OP) 2 [a price-question 3 [$_{?P}$ w_1 t_2 *A* t_3]]]]

By the way, we now have an analysis of Heim-ambiguity sentences like *John knows the price that Fred knows* that reflects exactly the way the ambiguity has been described – as an ambiguity between knowing the answer to a question and knowing the answer to a meta-question. (44) demonstrates first how we would see the ambiguity of a slightly simpler case, *John knows the price that Fred asked Mary*. There, off of one structure we will be able to read: "John knows the answer to" a certain price-question – namely, the price-question that Fred asked Mary. And off of the other structure we will be able to read: "John knows the answer to" a meta-question – the same one that we generated in *John asked Mary the price that Fred asked her*, generated in the same way. Then (45) presents the Heim ambiguity. To see how that example works after having gone through (44), all one needs to do is imagine replacing *asked Mary* by *knows the answer to*.

(44) John knows **the** price that Fred asked Mary.

Reading 1: John knows **the** proposition that truly answers the price-question that Fred asked Mary.

a. Sister of *A* in the object of *know* (which begins [**the** *n* [(OP) 2 [$_{?P}$ w_1 t_2 *A* [. . .]]]): [$_{\alpha}$ the price-question [$_{\beta}$ (OP) 3 [w_1 Fred asked Mary t_3]]]

b. $[\![\beta]\!]^g = \lambda Q$. Fred asked Mary Q in g(1)
$[\![\alpha]\!]^g$ = the unique price-question that Fred asked Mary in g(1)

Reading 2: John knows **the** proposition that truly answers the question 'What is the price-question that Fred asked Mary?'

a. Sister of *A* in the object of *know*: (cf. (29))
[$_{\alpha}$ the T1- ^{C} R'-price-question [$_{\beta}$ **4** [(OP) 3 $\mathbf{w_4}$ Fred asked Mary t_3]]]

b.[24] $[\![\beta]\!]^g = \lambda \mathbf{w}. \lambda Q$. Fred asked Mary Q in **w**
$[\![\alpha]\!]^g$ = 'What is the price-question that Fred asked Mary?'

[22]Once some creases are ironed out, parallel remarks should apply to a sentence like *John knows every (or one) price of a dairy product*, whose most salient reading expresses that John knows every (or one) true answer to a question of the form 'What is the price of x?' where x is a dairy product. (In which case we would also be able to generate the "pair-list" reading of *John knows every capital* assuming a silent indefinite.) See Note 12 for some words about the creases.

[23]Note that in the case of *most prices*, the plural marker realized on "price" would be associated not with a pluralizer on *price* itself, but rather with a pluralizer on the null head, presumably. More deserves to be said about this.

[24]Note that, consistently with what I said earlier, I assume that *the* behaves in these contexts as though it went uninterpreted, so $[\![\alpha]\!]^g$ is just as though *the* weren't there. Parallel remarks apply to the parallel example below and to (47).

(45) John knows **the** price that Fred knows.

Reading 1: John knows **the** proposition that truly answers the price-question that Fred knows the answer to.

a. Sister of *A* in the object of the higher *know*:
[the price-q. [$_\beta$ (OP) 3 [w_1 Fred knows the *n* [(OP) 4 w_1 t_4 *A* t_3]]]]

b. $[\![\beta]\!]^g = \lambda Q$. Fred knows in g(1) the proposition that truly answers Q in g(1)
$[\![\alpha]\!]^g$ = the unique Q such that Q is a price-question and Fred knows in g(1) the proposition that truly answers Q in g(1)

Reading 2: John knows **the** proposition that truly answers the question 'What is the price-question that Fred knows the answer to?'

a. Sister of *A* in the object of the higher *know*:
[$_\alpha$ the T1- ^{C} R'-price-q. [$_\beta$ **5** [(OP) 3 $\mathbf{w_5}$ Fred knows the *n* [(OP) 4 $\mathbf{w_5}$ t_4 *A* t_3]]]]

b. $[\![\beta]\!]^g = \lambda \mathbf{w}. \lambda Q$. Fred knows in **w** the proposition that truly answers Q in **w**
$[\![\alpha]\!]^g$ = 'What is the price-question that Fred knows the answer to?'

3.3 A discriminating type shift

If we adopt a picture of this kind, then it turns out that there is something that we need to add to it: interestingly, there seems to be a kind of type-shifting available with proposition-selecting verbs that is not available with question-selecting verbs. The approach I have been taking doesn't explain on its own why the type shift in question is discriminating in this way. However, to my mind, it is more a point in favor of the approach than against it that it gives us a clear way of talking about some important differences in behavior between verbs like *know* and verbs like *ask*.

Consider a sentence like *John knows every price of a dairy product*. This sentence has different readings,[25] but the one to focus on now is the following (in my judgment somewhat marginal) one: we can understand it as saying that John knows which figures function as dairy product prices – even while being ignorant, say, of what dairy product each figure is the price of. To put it another way, we can read the sentence as saying that John knows every true answer to a question of the form "What figure functions as the price of some dairy product?" However, with the resources that we have so far, we can't obtain this question, 'What is a dairy product price?', out of the material in *price of a dairy product*. To do so, what we need is a simple type shift that just applies **V** to the value we get out of this NP:

(46) **T3**: P $\rightarrow$ **V**(P) (applies at the level of NPs)

(47) John knows **every / one / the** price of a dairy product.

Marginal reading: John knows **every / one / the** one true answer to the question 'What figure functions as the price of some dairy product?'

a. Sister of *A* in the object of *know*:[26] [$_\alpha$ the T3-[$_\beta$ (PRO) 2 3 [a dairy product w_1] [4 w_3 t_2 price t_4]]

b. $[\![\beta]\!]^g = \lambda x$:... λw. for some y such that y is a dairy product in g(1), x is the price of y in w

[25] In Notes 12 and 22, I touched on the reading that I find most salient.

c. **T3** (⟦ β ⟧^{g}) = { λw. for some y such that y is a d.p. in g(1), x is the price of y in w | x . . . }

This same shift is arguably what results in the "set readings" that have been discussed in the literature (starting with the end of Heim (1979)), on which *John knows every phone number* can convey that John knows of every phone number that it is a phone number, without necessarily knowing whose phone number it is. *Phone number* would contribute the question 'What is a phone number?'

Apparently, we *can't* effect this kind of shifting under *ask*, for *John asked Mary the price of a dairy product* can't mean that he asked her 'What is a dairy product price?' Why there should be this difference is not clear, but the idea that *know* enables a kind of type-shifting that *ask* does not enable seems to be on the right track. I have argued that the restrictions on the kinds of nouns that appear under *ask* are due to constraints imposed by a relation-level type shift. If indeed *know* allows us to avoid using this type shift and to apply a different shift at the property level, then we would naturally expect relational nouns under *know* not to be constrained in the precise way they are under *ask*. And this expectation is indeed met. Under *know*, we find all kinds of relational nouns that can't appear under *ask*. Most strikingly, we find relational nouns that are not functional, like *flavor*: we find examples like *John knows every flavor of ice cream*. This example means that John knows every true answer to 'What is a flavor of ice cream?' which is what we expect if *flavor of ice cream* undergoes the property shift. Another example that could be seen similarly is *John knows one senator* (see Frana 2006, 2013 for examples like this one with indefinites), on the reading that expresses that John knows of a certain individual that he is a senator: this expresses that John knows one answer to the question 'Who is a senator?'[27] *Senator* here could be seen as quite analogous to *price of a dairy product*, with a silent indefinite argument – *senator of someplace*. Then, beyond this, there are functional relations that seem to be happy with proposition-selecting verbs even though they are not happy with *ask*, for example the kinship terms in (48). I can say *I forgot my own father* to say that I forgot that my actual father was my father, or *I announced my bride* to say that I announced that my actual bride was my bride, and, again, we can account for this with the property shift.[28] (This said, I am not convinced that this is the right analysis of such cases. Also, I do not get the impression that the same nouns can appear under all proposition-selecting verbs, as this approach would lead us to expect.)

(48) a. I forgot my own father! (cf. a'. # I asked him my own father!)
b. I announced my bride. (cf. b'. # I asked him my bride.)

[26]Here I have assumed Heim-and-Kratzer-style that we can generate a PRO subject for *price* and raise it, and I have imagined moreover that a binder of world variables (3) can be inserted. *The* will effectively go uninterpreted, as we have seen earlier.

[27]Interestingly, one could follow up on this sentence by saying *The one senator John knows has actually not done much to distinguish himself.* Here it seems that *senator John knows* can be used to express *person who John knows to be a senator*, and this does not seem to follow from anything I have said. Uses of this kind arguably make an appearance in Aloni and Roelofsen's very interesting recent discussion of "quantified concealed questions," which goes far beyond mine in its discussion of facts involving *know* (but which at least converges in its adoption of a type shift like mine above).

[28]In these cases, even the highest determiner of the verb's complement *(the n A T3-my bride)* would go unpronounced, but arguably that is what always happens in Saxon genitives.

4 Conclusion and doubts

In this paper, I started from the point that there are verbs that appear in concealed question constructions and that otherwise seem to operate only on question meanings. Given this fact, I concluded that "concealed question DPs" can denote question meanings, and the rest of the paper drew on this conclusion in one way or another. When we get to verbs that operate on propositions, there is no obvious reason to adopt the hypothesis that the DPs that appear with *these* denote questions, but I made a proposal for how to treat such cases that incorporates some of the conclusions I drew from cases involving question-selecting verbs. The overall picture that emerged was one on which type shifting starred and a few silent elements of syntax played a supporting role. In this final section, I will mention some problems for the specific approach that I took; these problems could make one wonder in particular whether I paid enough attention to syntax.

In my discussion of question-selecting verbs, I claimed that expressions like *the price of milk* could denote questions and expressions like *price* could denote sets of questions. But I went further than that: I made an explicit connection between expressions used in this way and expressions like *that question* and *question*. I even used this connection to dismiss the doubts that could be raised by the fact that verbs like *wonder* don't combine with "concealed question DPs": this is no surprise, I said, since they don't combine with *question* DPs. However, there are facts that suggest that, in making this connection, I went too far. It leads us to expect that where a *question*-expression can appear, a counterpart *price*-expression should be able to appear, and vice versa, and that is not what we find. One dramatic contrast involves the verb *answer*, which as shown in (49) permits *that question* as its object but not *the price of milk*; and as shown in (50) there is a sense in which proposition-selecting verbs like *know* pattern in the opposite way (given my proposal, facts like these would indicate that *A* works in the opposite way). Similar worries concern the connection that I made between *fact*-DPs and the "concealed question DPs" we find under proposition-selecting verbs: this leads us to expect "concealed question DPs" to appear where *fact*-DPs can appear, and, as (51) shows, that is not exactly what we find:

(49) a. ??John answered the price of milk.
b. John answered that question.

(50) a. John knows the price of milk.
b. #John knows that question. (≠ John knows the answer to that question.)

(51) a. ??John regretted Mary's birthday.
b. John regretted the fact that Mary's birthday fell on February 29.

What should we conclude from facts like these? At least in the case of (49) and (51), there is a diagnosis that suggests itself: the unacceptability of (49a) and (51a) is connected to the inability of *answer* and *regret* to combine with syntactic questions ((52)). Should we in fact see "concealed question DPs," then, as being reduced interrogative clauses – as their discoverer Baker (1968) originally thought? (What about *one price*?)

(52) a. ??John answered what the price of milk was.
b. ??John regretted what Mary's birthday was.

While I emphasized the importance of concealed questions for the study of type-shifting, the type-shifting system that I presented could also fuel suspicion. I made use of two main type

shifts, **V** and a "Geached" version of **V** that takes a function and composes **V** with it. The former applied in two specific cases – it operated on (already type-shifted) nouns that denoted functions to questions (in its **T2** incarnation), and it operated on NPs that denoted functions to propositions (in its **T3** incarnation). The latter applied in one case – it operated on nouns that denoted functional relations. But, as formulated, this is an awkward and stipulative distribution of contexts of application. We would really like to understand why things are that way. It is true that I could have formulated the type shifts themselves differently so as to make the overall system less awkward (having three different type shifts for the three different cases), but I'm not convinced that this would have been insightful; it might rather be a way of hiding the issue. Here also, one might think that it could help to think harder about the syntax. Are some of these type shifts associated with silent pieces of syntax? What elements are really combining in these cases?

In the end, concealed question constructions might be concealing more than I said.

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