Sortal versus relational nouns in concealed questions

Hana Möller Kalpak
University of Amsterdam, ILLC

1 Introduction

Concealed questions (CQ:s) are determiner phrases that read as embedded interrogatives (Baker 1968):[1]

(1) I know *the time*. ≈ I know *what time it is*.

Some determiner phrases make for better concealed questions than others. While the sentences in (2) involve the outlined concealed question readings, the sentences in (3) are difficult to make sense of at all, let alone as concealing questions.

(2) a. Kim knows *the capital of Italy*. (Heim 1979)
≈ Kim knows *what the capital of Italy is*.
b. Max found out *Sam's age*. (Barker 2016)
≈ Max found out *what Sam's age was*.
c. They revealed *the winner of the contest.* (Heim 1979)
≈ They revealed *who the winner of the contest was*.

(3) a. #Kim knows *the shoes*. (Frana 2006)
b. #Max found out *Sam's brick.* (Barker 2016)
c. #They revealed *the semanticist*. (Nathan 2006)

In these examples, the ability of a DP to read as a CQ correlates with the *type* of the DP's head noun. The sentences in (2) feature DP:s headed by *relational* nouns—*capital*, *age*, and *winner*—while the sentences in (3) feature DP:s headed by *sortal* nouns (*shoe, brick*, and *semanticist*). Data conforming to this contrast is often used to justify the claim that a definite DP *requires* a relational head noun, or at least noun *phrase*, to be interpretable as a CQ (Nathan 2006; Romero 2006; Caponigro & Heller 2007; Barker 2016; Frana 2017). The semantic analyses of CQ:s proposed by Nathan (2006), Barker (2016), and Frana (2017) all entail this claim, thereby predicting that definite DP:s headed by (unmodified) sortal nouns must lack CQ readings.

In this paper, I argue on the basis of examples like (4) for a semantics of concealed questions that makes more nuanced predictions about the distribution of CQ readings.

(4) I know your card. ≈ I know what (suit and rank) your card is.

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Card is a sortal noun, and the felicity of (4) thereby shows that it is not *necessary* for a DP to have a relational head noun in order to have a concealed question reading. Conversely, examples like (5) show that it is not *sufficient* for a definite DP to have a relational head noun in order to have a CQ reading, contrary to predictions made by previous accounts.

(5) #Alex guessed Sam's nose.

Frana (2006) noted in passing that even though examples like those in (3) and (5) lack concealed question readings *out of the blue*, they can receive CQ readings in exceptional contexts. The semantics (and pragmatics) of concealed questions proposed here will take this observation at face value. We will predict that CQ readings are available even for definite DP:s headed by unmodified sortal nouns, provided there is a salient *method of identification* of individuals in a suitable set of alternatives, including the individual(s) denoted by the DP.

The import of methods of identification for concealed question interpretation is the key insight underlying Aloni & Roelofsen (2011)'s semantic treatment of CQ:s. However, their account blurs the distinction between sortal and relational nouns, resulting in an undergeneration of CQ readings for quantified DP:s. We will see that adding an independently motivated treatment of the relational-sortal distinction to their account suffices to both avoid undergeneration, and yield the correct predictions regarding the availability of CQ readings of determiner phrases.

The paper is structured as follows. Section 2 details the main counterarguments to the explanation of CQ felicity in terms of noun type, and motivates an alternative explanation. Section 3 revises Aloni & Roelofsen (2011) in order to account for the problematic data, and Section 4 outlines the predictions made by the revised account. Section 5 concludes.

2 Background

Löbner (1981) is the earliest proponent of the view that the type of a determiner phrase's head noun determines the suitability of the phrase as a concealed question. Löbner suggests that concealed questions express questions of the actual value of a "functional concept" (approximately: *individual concept*). For instance, (6) would express that Robin knows what the value of the functional concept expressed by *the temperature of the water* is at the world-time index of utterance:

(6) Robin knows *the temperature of the water*.

To Löbner, functional concepts are expressed by DP:s built from *functional* head nouns, making such phrases interpretable as concealed questions.

Before proceeding, let us clarify the assumed noun type taxonomy. We follow the convention established in Partee (1983/1997) and take *sortal* nouns to be nouns denoting sets of individuals (type $\langle e, t\rangle$), such as *person, city, day, brick* and *number*. *Relational* nouns are nouns that denote relations over individuals (type $\langle e, \langle e, t\rangle\rangle$), such as *parent, capital, birthday, winner* and *age*. Intuitively, a parent is a person who stands in a particular *relation* to another person (their child). Likewise, a capital is a city that stands in a particular relation to a country, a birthday is a day that stands in a particular relation to an individual, and so forth.

Given this semantic distinction, it is common to treat sortal nouns as syntactically one-place, and relational nouns as syntactically two-place. Note however that the internal argument of a relational noun need not be overtly expressed, in parallel to the direct object of an optionally transitive verb like *eat*:

(7) a. The mother (of Kim) sat down.
    b. Kim ate (a sandwich).

Among relational nouns, we may further distinguish between *functional* and *non-functional* nouns (De Bruin & Scha 1988; Partee & Borschev 2012). Like the name suggests, a functional noun applies to a unique external argument for each internal argument. This includes Löbner's *temperature*, but excludes, for instance, *phone number* (since one may have more than one phone number). Functional nouns can be further divided into those expressing one-to-one functions, like *nose* (since no two individuals have the same nose) and those expressing functions that are merely *onto*, like *temperature* (since different objects may have the same temperature).

The literature contains many examples of CQ:s built from non-functional relational nouns, as in the oft-cited (8).

(8) John knows Bill's phone number. Heim (1979)
    $\approx$ John knows what Bill's phone number is.

Consequently, authors typically depart from Löbner (1981) and assume the ability of a DP to read as a concealed question correlates with *relationality*, rather than merely *functionality*, of the DP head noun.

This assumption has been motivated and semantically implemented in particular by Nathan (2006) and Barker (2016), though is adopted more widely (e.g., by Caponigro & Heller 2007; Romero 2006; Frana 2017). Nathan (2006) derives concealed question-meanings from determiner phrases through two type shifters: one that selects exclusively for relational nouns, and one that selects for sortal nouns modified by relative clauses or superlatives. This treatment predicts that unmodified sortals cannot head concealed questions, and that all DP:s formed from relational nouns can be concealed questions, since the type shifters apply indiscriminately to objects of the relevant sort.

The selection propoerties of Nathan's type shifters lack independent motivation: there is no clear reason as to why we may not stipulate a parallell type shifter for plain sortal nouns. Barker (2016) aims to provide such a reason. Barker argues that questions have *structured meanings*; that is, they express foreground-background pairs in the sense of Krifka (2001). On Barker's semantics, a DP can be type shifted into a question just in case its head noun (phrase) expresses a foreground/background structure. Relational nouns satisfy this condition: a noun like *birthday* can be gauged into a structure with a foreground corresponding to the property of being a *day*, and a background corresponding to the property of standing in the BORN-ON relation to some element of the foreground. In contrast, the meaning of an unmodified sortal noun, like *day*, is not divisible into distinct foreground/background properties.

While Nathan and Barker focus on definite determiner phrases, the possible concealed question readings of *quantified* determiner phrases has likewise been taken to be restricted by the type of the DP head noun. As Heim (1979) observed, quantified CQ:s headed by relational nouns tend to be ambiguous between a *set* reading and a *pair-list* reading:

(9) Kim knows every European capital.
Set reading: For every European capital x, Kim knows whether x is a capital.
Pair-list reading: For every European country x, Kim knows what the capital of x is.

On the basis of examples like (10), Frana assumes in Frana (2013) and Frana (2017), Chapter 4, that quantified DP:s headed by unmodified sortal nouns at most can have the set reading.

(10) Kim knows every European city.
Set reading: For every European city x, Kim knows whether x is a European city.
Pair-list reading: *

Frana proposes that the set/pair-list ambiguity of quantified concealed questions derive from the ambiguity in arity of (overtly) unsaturated relational nouns. On her semantics, then, determiner phrases headed by unmodified sortal nouns are unable to receive pair-list readings, since their head nouns are not optionally two-place.

2.1 Counterexamples to the noun type contrast

There are two perfectly general reasons to doubt any semantic analysis of concealed questions that predicts CQ readings to be restricted by the head noun type. We noted in the introduction that definite DP:s formed from relational nouns can still lack salient concealed question readings:

(11) a. #Ann found out the truck's carburetor. (Frana 2006)
b. #Alex guessed Kim's nose.
c. #They revealed Robin's mother.

This observation carries over to the case of quantified concealed questions. The below examples lack both straightforward set and pair-list readings:

(12) a. #Ann found out every carburetor.
b. #Alex guessed every nose.
c. #They revealed every mother.

This shows that relationality of the head noun, or noun phrase, is not sufficient to license the relevant CQ readings. While both Nathan (2006) and Barker (2016) observe this, neither offers a theory to explain it.

Conversely, there are clear-cut counterexamples to the claim that DP:s headed by unmodified sortal nouns must lack the relevant CQ readings. As already noted, possessive DP:s with an unmodified sortal head noun can have perfectly salient concealed question readings:

(13) I know your card. $\approx$ I know what (suit and rank) your card is.

Even plain definite DP:s built from sortal nouns can have immediate concealed question readings:

(14) Guess the song / movie / country / language!
$\approx$ Guess what the {song / movie / country / language} is!

Finally, quantified DP:s with sortal head nouns can have pair-list readings. (37) has an out of the blue reading on which it means, roughly, *Watch this magician guess, for each card in the deck, what (suit and rank) it is*.

(15) Watch this magician guess every card in the deck![2]

Thus, even without modification by a superlative or restrictive relative clause, a sortal noun can be the head noun of a determiner phrase reading as a CQ.

Frana (2006) observed that the ability of a DP to read as a concealed question is context dependent: in general, CQ readings can be brought forward by a sufficiently rich specification of utterance context. Frana exemplifies with the case of a quiz show, in which the contestants are challenged to visually memorize a number of items, with the goal of later being able to tell from pictures of parts of the same objects, which object each picture displays. If the set of objects includes a pair of shoes, a contestant may felicitously use (16) to mean that 'I only knew what the shoes were', in the sense of knowing only which picture portrayed part of the shoes.

(16) I only knew the shoes.

Analogous examples can be constructed for our other examples of definite DP:s lacking concealed question readings out of the blue, such as *Ann guessed the carburetor* and *They revealed the semanticist*: the former is facilitated in a context analogous the above, and the latter in any context licensing the unconcealed question *who the semanticist was*.

The two things that context may need to contribute to facilitate a CQ reading of are equally necessary for an utterance of the corresponding unconcealed question to be felicitous. First, we need a suitable set of *alternatives*, including the referent(s) for the DP. Second, we need a *method of identification* of these alternatives: otherwise, asking an identity question is decidedly odd. Frana's context provides precisely a set of alternatives (different objects), and a visual method of identifying these, as *the object depicted in picture one*, *the object depicted in picture two*, and so forth.[3] When the head noun of a definite DP describes individuals who have context independent methods of identification—such as *names*—they also have concealed question readings out of the blue, as indicated by the straightforward felicity of (14).

The dependency on salient methods of identification carries over to CQ readings of possessive and quantified DP:s. Clearly, an example like (17) is difficult to make sense of as it stands.

[2]This is the title of an ABC News clip from 2015, at the time of writing accessible at https://abcnews.go.com/Entertainment/video/watch-magician-guess-card-deck-38087975.

[3]M. Kaufmann draws essentially the same conclusion regarding Frana's observation in Schwager (2008).

(17) Kim guessed Sam's brick.

However, informants deem it acceptable when supplemented with a context featuring (i) a method of identifying the elements in the extension of the head noun (intuitively, this is a salient set of alternatives) and (ii) a specified *relation* between possessor and possessee. For instance, context may license a reading of (17) as *Kim guessed which of the bricks in front of her is owned by Sam.*

Pair-list readings of quantified CQ:s require a set of alternatives and *two* distinct methods of identifying these. (18) is the caption of a talkshow clip in which Nate is shown the silhouettes of various U.S. states, and correctly gives the name of the state for each silhouette.[4]

(18) Nate is only five years old, but he knows *every state* and where the capitals are.
Set reading: For every (U.S.) state x, Nate knows whether x is a state.
Pair-list reading: For every (U.S.) state x, Nate knows what the silhouette of x is.

Without this context, *every state* has only a set reading. With it, it has a pair-list reading along the above lines.

3 Proposal

We can capture the intuitions about the role of methods of identification in the interpretation of concealed questions by extending the treatment of concealed questions given in Aloni & Roelofsen (2011). On their account, concealed questions *denote* questions, derived from entity denoting expressions via a dedicated type-shifter.[5] Crucially for our purposes, Aloni & Roelofsen's semantics of concealed questions employs *conceptual covers*. Conceptual covers are formalizations of methods of identification, like identification by naming, ostension, or definite description (Aloni 2001). Formally:

Definition 1 (Conceptual covers) *Given a set of worlds W and a domain of individuals D, a conceptual cover CC based on (W, D) is a set of individual concepts, such that* $\forall w \in W : \forall d \in D : \exists! c \in CC : c(w) = d$.

To illustrate, consider a domain of two people; Kim and Sam. The set of the individual concepts expressed by the names *Kim* and *Sam* is a conceptual cover over this domain. In context, other methods of identification may be salient. If Kim and Sam are perceptually available, they may be identified ostensively, by individual concepts such as those expressed by *the person to the right, the person to the left*. The set of these concepts constitutes another, non-equivalent, conceptual cover over our two-person domain.

[4] At the time of writing, the clip with the given caption is available at https://www.facebook.com/ellentv/videos/10155496362772240/.

[5] For arguments in favor of assigning these constructions question denotations, see for instance Aloni & Roelofsen (2011), Section 2.

To capture the sensitivity of the interpretation of concealed questions to such methods of identification, we integrate conceptual covers into a standard language of first order logic, enriched with two operators 'ι' and '?'. A model M in this language will be a quadruple (W, D, I, C), where W is a set of possible worlds, D a set of individuals, I a (world-dependent) interpretation function, and C a set of conceptual covers based on (W, D). As usual, sentences are evaluated relative to a model, world, and assignment function. The twist is that variables now range *over conceptual covers*, and not directly over D. The range of a given variable is contextually determined: for a model M, we define a set of *cover resolution functions* R that map every variable to some conceptual cover in M.

Definition 2 (Cover resolution functions) *Given a model $M = (W, D, I, C)$ and a set V of variables, a cover resolution function R for M is a function that maps every $x \in V$ to elements $CC \in C$.*

The selection of a cover resolution function in a given context is governed by general pragmatic constraints. As discussed in detail by Aloni (2001), the function must map to covers that are *relevant*, *informative* and *consistent* relative to the common ground. Among these, the default cover resolution function is the one mapping variables to the contextually most salient covers, typically

1. ostensive covers, if the domain is perceptually available
2. naming covers, otherwise.

We will see more examples of these different types of covers in Section 4.

Assignment functions map variables to individual concepts, given a cover resolution function:

Definition 3 (Assignment functions) *Given a model $M = (W, D, I, C)$, a set V of variables, and a cover resolution function R, an assignment function g_R is a function mapping every variable $x \in V$ to some individual concept $c \in R(x)$.*

Thus, at a given world, variables still pick out individuals, though they do so *via individual concepts*:

Definition 4 (Variable denotations) $[\![x]\!]_{M,w,g_R} = g_R(x)(w)$

Both quantifiers and the ι-operator now range over conceptual covers, rather than over D directly:

Definition 5 (Quantifiers)

$$[\![\exists x.\varphi]\!]_{M,w,g_R} = 1 \textit{ iff } \exists c \in R(x) : [\![\varphi]\!]_{M,w,g_R[x/c]} = 1$$

$$[\![\forall x.\varphi]\!]_{M,w,g_R} = 1 \textit{ iff } \forall c \in R(x) : [\![\varphi]\!]_{M,w,g_R[x/c]} = 1$$

Definition 6 (The ι-operator) *If there is a unique $c \in R(x)$ such that $[\![\varphi]\!]_{M,w,g_R[x/c]} = 1$, then $[\![\iota x.\varphi]\!]_{M,w,g_R} = c(w)$. Otherwise, $[\![\iota x.\varphi]\!]_{M,w,g_R}$ is undefined.*

Following Groenendijk & Stokhof (1984), Aloni & Roelofsen (2011) analyze questions as having the form $?x.\varphi$, and as expressing, at a world w, the proposition corresponding to the true exhaustive answer to $?x.\varphi$ in w. Here, this proposition is determined relative to a particular cover resolution function:

Definition 7 (Questions)

$$[\![?z.\varphi]\!]_{M,w,g_R} = \{v \mid \forall c \in R(z) : [\![\varphi]\!]_{M,w,g_R[z/c]} = [\![\varphi]\!]_{M,v,g_R[z/c]}\}$$

At a world w, $?z.\varphi$ now denotes the set of worlds which agree with w on which individual concepts pick out individuals for which φ holds.

The formal framework outlined so far follows Aloni and Roelofsen's original proposal. Our additions to this setup are straightforward. We follow the common treatment of relational nouns as lexically two-place, with one-place readings being obtained by existential closure of the internal argument (Barker 2011). A type shifter for this purpose is defined below.

Definition 8 (Existential closure) $\textsc{Ex} := \lambda R_{\langle e,\langle e,t\rangle\rangle}\lambda x.\exists v R(v)(x)$

Sortal nouns receive the usual one-place treatment.

Following Partee (1983/1997), I assume that possessive constructions have distinct internal structures depending on the type of the head noun. While relational nouns feature an inherent relation linking possessor to possessee, sortal nouns do not. Formally, constructions like 'Sam's NP' or 'the NP of Sam('s)' have the logical form

- $\iota x.\text{NP}(s)(x)$ when NP is relational
- $\iota x.\text{NP}(x) \wedge \pi(s)(x)$ when NP is sortal

where π is a *free* relation variable, whose content needs to be pragmatically supplied. Typically, π is resolved to an *agentive* or a *control* relation, in the senses of Vikner & Jensen (2002).[6] Agentive relations hold between an object and an agent that has created or otherwise brought about the object. For instance, *Kim's painting* has a reading on which it describes a painting *created by* Kim. Control relations hold between an object and some animate being having the object "at her disposal", in the sense of being able to use or handle it. For instance, *Kim's card* can describe a card that is *owned by* or *held by* Kim. While such relations tend to be default, pragmatics can favor others, as in the interpretation of *John's team* as describing the team that John *is a fan of* (Partee 1983/1997).

3.1 Illustration

Before outlining the new predictions made by the account, we illustrate the general workings of the formalism by looking at an example for which our predictions coincide with those of Aloni & Roelofsen (2011).

[6] We depart from Vikner & Jensen in describing these relations as pragmatic defaults rather than as lexical, and in counting part-whole relations as 'inherent' relations, thus treating for instance *nose* as a relational noun, and the relation a nose has to its bearer as inherent.

(19) Kim knows the capital of Italy. $\rightsquigarrow K_k(\iota x.\textsc{capital}(i)(x))$

The translation of (19) is indicated to the right, where K is the epistemic operator defined in Definition 9.

Definition 9 (Knowledge) $[\![K_a\varphi]\!]_{M,w,g_R} = 1$ *iff* $E_a(w) \subseteq [\![\varphi]\!]_{M,w,g_R}$

K_a embeds proposition-denoting expressions, but the definite description *the capital of Italy* denotes an entity. To resolve the type mismatch, we use a version of Aloni & Roelofsen's *type shifter* $\uparrow_{z,P}$, which on our version distinguishes between sortal and relational head nouns.

Definition 10 (The type shifter $\uparrow_{z,P}$) $\uparrow_{z,P} \alpha := ?z.P(\alpha)$
where α is some entity-denoting expression, and P is some contextually salient property, per default

- *identity: $P \mapsto \lambda x.z = x$*
- *the property expressed by the (possibly internally saturated) head noun N of α:*
  - *If N is of type $\langle e, t\rangle$: $P \mapsto \lambda x.N(x)$,*
  - *If N is of type $\langle e, \langle e, t\rangle\rangle$: $P \mapsto \mathrm{Ex}(\lambda x\lambda y.N(y)(x))$ or $P \mapsto \lambda x.N(z)(x)$*

For a construction involving a possessive DP, the only resolution of P able to yield a non-trivial question denotation is identity:[7]

(20) $K_k(\uparrow_{z,P} \iota x.\textsc{capital}(i)(x)) \rightsquigarrow K_k(?z.z = \iota x.\textsc{capital}(i)(x))$

The natural default method of identifying capitals (or cities in general) is by name. We capture this reading by assuming the resolution function R mapping z, x to the naming cover over capitals:

$$R(z) = R(x) = \{\textit{Beijing, Washington DC, Berlin} \ldots\}$$

Given this, (19) is true at our world w^* just in case at w^*, Kim knows that the actual world is such that the individual picked out by the name *Rome* is the capital of Italy:

(21) $[\![K_k(?z.z = \iota x.\textsc{capital}(i)(x))]\!]_{M,w^*,g_R} = 1$ iff
$E_k(w^*) \subseteq \{v \mid \text{Rome is the capital of Italy at } v\}$

4 Predictions

This section outlines the predictions made by the account for definite and quantified concealed questions with different types of head noun.

[7] The alternative is (1), whose denotation is trivial regardless of selected range of z and x:

(1) $K_k(?z.\textsc{capital}(i)(\iota x.\textsc{capital}(i)(x)))$

4.1 Plain definite DP:s

Our general prediction, derived from the formal constraints on (concealed) question interpretation outlined above, is this: *A non-possessive, definite DP can have a CQ reading just in case the definite DP is defined, and there is a non-trivial method of identification of a set of alternatives including the referent of the DP*. By 'non-trivial method of identification' we mean that it yields a non-trivial question interpretation: it does not contain the individual concept which in each world picks out the referent of the DP.

For instance, we predict that (22) gets a concealed question reading whenever the context features (i) a unique maximally salient book, (ii) a non-trivial cover over a set of alternatives including this book. A context satisfying this is the context where Sam participates in a quiz, and is asked to name the book of which (23) is the first line.

(22) Sam knows the book. $\rightsquigarrow K_s(?z.z = \iota x.\text{BOOK}(x))$

(23) All happy families are alike; each unhappy family is unhappy in its own way.

This yields the interpretation of (22) on which it is true whenever Sam can name the book of which (23) is the first line.

(24) $[\![K_s(?z.z = \iota x.\text{BOOK}(x))]\!]_{M,w^*,g_R} = 1$ iff
$E_s(w^*) \subseteq \{v \mid$ *Anna Karenina* is the book whose first line is (23) at $v\}$

Constructions like (25) and (26) are predicted to be difficult to interpret: both *the capital* and *the shoes* require highly particular contexts in order to be defined. In contrast to capitals, shoe-individuals have no intuitive context independent methods of identification (such as names), further obstructing the availability of a CQ reading of (26).

(25) Max knows the capital.

(26) Kim knows the shoes.

4.2 Possessive DP:s

Our formal treatment reflects the following prediction: *A possessive DP can receive a concealed question reading whenever a suitable relation between possessor and possessee is salient, together with a domain of alternatives including the individual picked out by the DP (given the relation) and at least one non-trivial conceptual cover over this domain.* For the case of (19), these things were intuitively available *out of the blue*. A relation between countries and cities is inherent to the noun *capital*. The head noun extension—the set of cities—fulfills the requirements for being the alternative set, and its elements have a default, contextually independent method of identification; *naming*.

These conditions for the licensing of CQ readings of possessive DP:s do not demand a relational head noun. This allows us to explain when and why (27) is meaningful.

(27) Max knows Kim's card.

On the typical reading of *card* as *standard 52-deck playing card*, we have a default conceptual cover over a relevant set of alternatives including the DP: the cover consisting of the individual concepts expressed by the 52 possible combinations of suit and rank. Playing cards typically stand in a *control*-type relation to people—their purpose is to be featured in games, in which they are *held by, dealt to,* or *picked by* the game's participants. On this interpretation, (27) is true whenever Max knows the true answer to the question of which suit and rank the card Kim is controlling has, and false otherwise:

(28) Max knows Kim's card. $\rightsquigarrow K_m(?z.z = \iota x.\textsc{card}(x) \wedge \pi(k)(x))$
$\pi \mapsto$ CONTROLLED-BY
$R(z) = R(x) = \{$*the Ace of hearts, the Ace of spades, the Ace of clubs* $\ldots\}$

Certain constructions with sortal head nouns feature a good, contextually independent method of identifying the elements in the extension of the head noun (a generally salient set of alternatives), but lack a good candidate for relating possessor to possessee. (29) is a case in point: we typically identify days through *dates* or names of weekdays, but individuals cannot stand in control- or agentive relations to days.

(29) Alex guessed Charlie's day.

Our account correctly predicts that such constructions are infelicitous out of the blue, but that a contextualization providing a candidate for the missing relation licenses a CQ reading of (29), for instance as *Alex guessed which day is Charlie's day to do the dishes.*

Conversely, while DP:s headed by relational nouns feature an inherent relation, they still fail to have CQ readings in the absence of a method of identification of a set of alternatives. (30) is such an example.

(30) Alex knows Kim's nose.

It is difficult to think of a context in which *Kim's nose* is identifiable by something else than this very description, and in which a suitable set of alternatives is likewise contextually identifiable. Constructing a context similar to Frana's quiz show aids interpretation, but is crucially *required* in order to make sense of the sentence.

4.3 Quantified DP:s

Our analysis of (31) follows the analysis in Aloni & Roelofsen (2011), save the arity and existential closure of E-CAPITAL:

(31) Kim knows every European capital.
$\rightsquigarrow \forall x(\exists v.\textsc{e-capital}(v)(x) \rightarrow K_k(\uparrow_{z,P} x))$

The different readings of quantified concealed questions correlate with the different possible resolutions of P. We obtain the set reading by resolving P to the property of being a European capital, and the range of x to the naming cover over capitals.

(32) **Set reading:** For each European capital x, Kim knows whether x is a capital.
$\forall x(\exists v.\text{E-CAPITAL}(v)(x) \rightarrow K_k(?z.\exists v.\text{E-CAPITAL}(y)(x)))$
$P \mapsto \text{Ex}(\lambda x\lambda y.\text{E-CAPITAL}(y)(x))$
$R(x) \mapsto \{$*Rome, Amsterdam, Paris* $\ldots\}$

The resulting formula expresses that Kim knows of every European capital whether it is a European capital, as desired.

The pair-list reading results from resolving P to the property of being the capital of z, and the range of x to the naming cover over capitals:

(33) **Pair-list reading 1:** For each European country x, Kim knows what the capital of x is.
$\forall x(\exists v.\text{E-CAPITAL}(v)(x) \rightarrow K_k(?z.\text{E-CAPITAL}(z)(x)))$
$P \mapsto \lambda y.\text{E-CAPITAL}(z)(x)$
$R(x) \mapsto \{$*Rome, Amsterdam, Paris* $\ldots\}$

Resolving P to identity requires an additional conceptual cover over capitals to yield a defined, non-trivial interpretation. We obtain this by following Aloni & Roelofsen (2011) and allow cover resolution functions to map to *derived* conceptual covers. Derived conceptual covers are obtained by applying the intension of a salient one-to-one function (provided by an unsaturated functional noun, or the extralinguistic context) to a basic cover.[8] For the case at hand, we have a functional noun phrase *European capital*. This expresses a one-to-one function CAPITAL-OF defined for European countries, whose intension can be used to derive the cover $\{$*the capital of Italy, the capital of the Netherlands, the capital of France* $\ldots\}$ from the basic naming cover over European countries. We thus have the following possible resolution:

(34) **Pair-list reading 2:** For each European country x, Kim knows what the capital of x is.
$\forall x(\exists v.\text{E-CAPITAL}(v)(x) \rightarrow K_k(?z.z = x))$
$P \mapsto \text{Ex}(\lambda x\lambda y.\text{E-CAPITAL}(y)(x))$
$R(x) \mapsto \{$*Rome, Amsterdam, Paris* $\ldots\}$

Of course, when the relevant attitude verb is factive, like *know*, this second pair-list reading coincides with the first pair-list reading. The distinction gains relevance for constructions with non-factive attitude verbs, like (35).

(35) Kim guessed every European capital.
Pair-list reading 1: For every European capital x, Kim guessed of what country x is the capital.

[8]The condition that the function be *one-to-tone* guarantees that the resulting set of individual concepts satisfies *uniqueness*, and the condition that the function be derived from an *unsaturated* noun is motivated by the observation that a sentence like 'Sam knows the capital of Italy' does not make the cover $\{$*the capital of Italy, the capital of the Netherlands, the capital of France* $\ldots\}$ especially salient unless *Italy* is focal. The restriction further blocks spurious readings of such sentences, such as the *reading of the sentence as meaning that Sam knows whether *the capital of Italy* picks out the same individual as *the capital of France*.

Pair-list reading 2: For every European country x, Kim guessed what the capital of x is.

The restriction of derived covers to (one-to-one) functional nouns allows us to predict the absence of second pair-list readings for non-functional relational nouns, noted by Frana (2013):

(36) Joss knows three phone numbers (of people at the office).

a. **Pair-list reading 1:** For three phone numbers x (of people at the office), Joss knows whose number x is.

b. ***Pair-list reading 2:** For three people x at the office, Joss knows what the phone numbers of x are.

The first pair-list reading only requires one cover over the set of phone numbers (default: naming), and can therefore be derived through a resolution analogous to that of (33) above. On Aloni & Roelofsen's account, neither type of pair-list reading is predicted to be possible in the absence of a non-default cover.

As illustrated by the above examples, our predictions regarding the readings of quantified DP:s are the following. We predict that a *set reading* of a quantified DP requires at least *one* method of identification of a suitable set of alternatives including the head noun extension. A *pair-list* reading in contrast requires *two* methods of identification: either two over the set of alternatives, or, in the case of a relational noun, one over this set, and one over plausible candidates for the internal argument of the noun. Clearly, these conditions for the licensing of pair-list readings do not require that the head noun be relational. This allows us to explain when and why constructions like (37) can have immediate pair-list readings:

(37) Kim guessed every card.

The natural pair-list reading of (37) is given in (38).

(38) Kim knows every card. $\rightsquigarrow \forall x(\exists y.\text{CARD}(y)K_k(\uparrow_{z,P}\iota x.\text{CARD}(x)))$
Pair-list reading 2: $\forall x(\text{CARD}(x)K_k(?z.z = x))$
$R(x) \mapsto \{$the ace of hearts, the ace of spades, the ace of clubs $\ldots\}$
$R(z) = \{$the leftmost card, the second leftmost card $\ldots\}$
For every card x on the table, Kim knows what the suit and rank of x is.

By switching the ranges of x and z, we obtain an alternate, possible pair-list reading of 37 as *For every suit-rank combination x, Kim knows what the location of the card with x is.*

Thus, even a DP with a plain sortal noun like *card* may obtain a pair-list CQ reading, provided there are two salient, non-trivial methods of identification of the elements in its extension. Conversely, a quantified DP built from a relational noun may lack both a set and pair-list reading when interpreted out of the blue:

(39) They revealed every mother.

We predict that provided a good context, (39) may receive a set reading (for instance, as *For every mother in the room, they revealed whether she was a mother*) or a pair-list reading (for instance, as *For every person x in the room, they revealed who the mother of x was*).

4.4 Embedding, modification, and Greenberg's observation

Heim (1979) noted the ambiguity of (40) between (40a) and (40b).

(40) Max knows every European capital that Alex knows.

a. For every capital x such that Alex knows whether x is a European capital, Max knows whether x is a European capital.

b. For every capital x such that Alex knows whether x is a European capital, Max knows whether x is a European capital such that Alex knows whether x is a European capital.

One of the main contributions of Aloni & Roelofsen (2011) was to identify and derive four additional readings for such "complex" concealed questions, which involved pair-list readings (see especially their Section 4.2). While lack of space prevents this from being shown here, it should be noted that the additions to Aloni & Roelofsen's account do not interfere with the prediction that (40) is six-way ambiguous. Unlike Aloni & Roelofsen, however, we predict that the readings which require pair-list readings of the concealing DP:s are subject to the general constraints on pair-list readings outlined in the previous subsection.

Our version of Aloni & Roelofsen's account likewise retains their treatment of Greenberg's observation, and its exceptions (Aloni & Roelofsen 2011, Section 4.4). The resulting account further squares well with the common observation that concealed question readings are facilitated by noun modification: constructions like *Anne guessed the right number* are easier to understand as containing CQ:s than constructions like *Ann guessed the number* (Barker 2016). For definite DP:s, modification generally serves to both increase the set of contexts in which the uniqueness presupposition of the DP is satisfied, and to suggest a natural set of alternatives. In the unmodified case mentioned, the set of alternatives must include some implicitly salient set of individuals not being numbers; in the modified case, the set of alternatives is immediately taken to be a set of numbers, one uniquely distinguishable by being *right*. The latter effect of modification carries over to quantified DP:s, explaining patterns like that in (41).

(41) a. ?Alex knows every number. (Barker 2016)

b. Alex knows every prime number. (Aloni & Roelofsen 2011)

5 Conclusion

Contrary to the mainstream assumption, the availability of CQ readings of determiner phrases is not determined by the type (relational versus sortal) of the DP head noun. Concealed question readings of definite DP:s, and pair-list readings of quantified DP:s, can systematically be made available by contextual specification of a possessive relation (if needed) and one or more methods of identification of salient alternatives, including the individual picked out by the DP. Relationality of the head noun contributes only indirectly to felicity. Interpretation of a possessive DP always requires the salience of a relation between "possessor" and "possessee"; only when the head noun is relational is such a relation provided inherent to the DP. Inherent relationality of a noun typically makes available *individuation by internal* *argument* as a default method of identification of the elements in the denotation of the (internally saturated) noun. However, since both the relation and the method of identification can be supplied by context, relationality is not necessary for these readings to arise. Neither is it sufficient: at the end of the day, we need a good method of identifying the salient alternatives.

By adding an independently motivated treatment of the relational-sortal noun distinction to Aloni & Roelofsen (2011)'s semantics of concealed questions, we could account for the import of methods of identification for determining the availability of CQ readings. This addition further served to refine the treatment of quantified concealed questions.

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