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The paradigmatic examples of knowledge attributions found in the philosophical literature are sentences of the form 'a knows that p'. However, many of the sentences we use to express knowledge take a different form, with 'know' embedding a wh-clause (a question) as in (1) or a nominal (a 'concealed question') as in (2).

(1) Philip knows who denounced Catiline.

(2) Meno knows the way to Larissa.

Intuitively (1) and (2) are true iff Philip and Meno know the true answer to the direct questions (3) and (4) respectively:

(3) Who denounced Catiline?

(4) What is the way to Larissa?

But what is the meaning of (3) and (4)? And how does it precisely relate to the meaning of (1) and (2)? In this article I will present a uniform analysis of the meaning of direct questions, embedded questions and concealed questions along the lines of Groenendijk and Stokhof (1984), Aloni (2001, 2008) and Aloni and Roelofsen (2011) which captures our main intuitions with respect to (1) and (2), but can also be applied to explain more complex examples like (5) and (6):

(5) Alphonse, you don't know who you are: you are the rightful heir to the Albanian throne. (Boër and Lycan 1986)

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

Crucial to the explanation of the last examples is the assumption that (concealed) questions quantify over contextually determined domains of individual concepts rather than over individuals *simpliciter*.

We will conclude the article with a discussion on the contrast in use between the following two questions (Percus, 2003; Heller and Wolter, 2013):

(7) Who do you think John is?

(8) Who do you think is John?

A clarification of the logical forms of these locutions will hopefully lead us to a

deeper understanding of our way of talking about facts and individuals and our (lack of) knowledge about them.

1 Questions and knowledge

Interrogative sentences are ubiquitous in conversations, but what is the meaning of an interrogative? The classical answer 'meaning equals truth conditions' doesn't seem to apply here because interrogatives, as well as imperatives, do not appear to have truth conditions. The intuition behind the classical answer was that one understands the meaning of a (declarative) sentence only if one knows what should be the case for the sentence to be true. Similarly, we could say that to understand the meaning of an interrogative one needs to know what would count as an answer to the expressed question. These sort of considerations brought many scholars, along the lines of Hamblin (1958), to identify the meaning of interrogatives with their *answerhood conditions*.[1] Most semantic theories define the meaning of questions in terms of the meaning of their answers with different traditions taking different answer types as central. For example, analyses in the Hamblin/Kartunnen tradition (Hamblin, 1973; Karttunen, 1977) define question meanings in terms of their *positive* (true) answers; structured meaning approaches model questions as functions from *constituent* answers to propositions (von Stechow, 1991; Krifka, 2001); and the partition theory of Groenendijk and Stokhof (1984), which we will adopt here, defines the meaning of an interrogative in terms of their *exhaustive* answers (see Dekker *et al.*, 2007, for a comparison):

(9) Who called?

a.	John called	[positive answer]
b.	Only John called	[exhaustive answer]
c.	John	[constituent answer]
d.	#The sun is shining today	[not an answer]

In Groenendijk and Stokhof's theory, interrogative sentences are represented by formulae of predicate logic preceded by a question operator, ?, and a sequence $\vec{x}$ of k variables. The meaning (*intension*) of an interrogative is identified with the set of meanings of all its possible exhaustive answers, which determines a partition of the logical space. The denotation (*extension*) of an interrogative in a given world is the proposition expressing the true exhaustive answer to the question in that world.

For example, a polar question like (10), logically rendered as (10a), has two possible exhaustive answers, the proposition that Obama is a Republican and the proposition that Obama is not a Republican, which together constitute a partition of the logical space. Given a world w where Obama is not a Republican,

[1] A similar strategy can be followed in the case of imperative sentences. The meaning of an imperative can be stated in terms of, not truth or answerhood conditions, but in terms of compliance conditions. One knows the meaning of an imperative if one knows what has to be brought about in order to comply with the issued order.

the denotation of (10) in w will be its only true exhaustive answer in w, namely the proposition that Obama is not a Republican.

(10) Is Obama a Republican?
   a. Logical form: $?Ro$
   b. Intension: {that Obama is a Republican, that Obama is not a Republican}
   c. Extension in w: that Obama is not a Republican

A constituent question like (11) will have as many possible exhaustive answers as there are possible denotations of the relevant predicate. Suppose that John and Mary are the only individuals who called in w, then the proposition that only John and Mary called is the denotation of the question in w.

(11) Who called?
   a. Logical Form: $?x.\, Cx$
   b. Intension: {that nobody called, that only Mary called, ..., that everybody called}
   c. Extension in w: that only John and Mary called

Groenendijk and Stokhof propose the following analysis for knowledge where α can be a *wh*-clause or a *that*-clause:

(12) $K_x\alpha$ (read as x knows α) is true in w iff x's epistemic state in w, represented as a set of possible worlds, is a subset of the denotation of α in w.

If α is a *that*-clause, the denotation of α in a given world is the proposition expressed by the corresponding declarative sentence[2]. Thus 'John knows that Rome is the capital of Italy' is predicted to be true in a world w only if John's epistemic state is a subset of the proposition 'that Rome is the capital of Italy' in w. If α is a *wh*-clause, the denotation of α in a given world is the proposition expressing the true exhaustive answer to the question in that world. So 'John knows what the capital of Italy is' is predicted to be true in a world only if John knows the true exhaustive answer to the question 'What is the capital of Italy?' in that world. In a world in which Rome is the capital of Italy, the denoted proposition will be the proposition that Rome is the capital of Italy, as in the previous case. It is easy to check then that Groenendijk and Stokhof's analysis easily derives the entailment in (13):

(13) Rome is the capital of Italy & John knows what the capital of Italy is
   $\Rightarrow$ John knows that Rome is the capital of Italy

In addition, offering a uniform analysis of knowledge-*wh* and knowledge-*that* Groenendijk and Stokhof also nicely capture the coordination fact in (14):

[2]While declarative sentences denote truth values, *that*-clauses are assumed here to denote propositions as in Frege (1892).

(14) John knows what the capital of Italy is and that it is a very old town.

Why do we use knowledge-*wh* constructions, rather than always using knowledge-*that* constructions? Because sometimes we want to attribute to somebody some knowledge which we ourselves do not have. If you don't know whether it is raining, you'd better assert (15) rather than (16):

(15) John knows whether it is raining.

(16) John knows that it is raining.

Groenendijk and Stokhof's analysis although reducing knowledge-*wh* to the knowledge of a proposition maintains this essential difference between knowledge-*that* and knowledge-*wh* which can be further explicated by looking at the case of iterated knowledge ascriptions. While (18) entails that Mary also knows that it is raining, (17) only entails that Mary knows the following proposition: if it is raining, then John knows that it is raining and if it is not raining, then John knows that it is not raining. As it is easy to check, these are exactly the predictions of Groenendijk and Stokhof's partition theory.[3]

(17) Mary knows that John knows whether it is raining.

(18) Mary knows that John knows that it is raining.

2 Questions of identity

Suppose that in front of you lie two face-down cards. One is the Ace of Hearts, the other is the Ace of Spades, but you don't know which is which. You have to choose one card: if you choose the Ace of Hearts you win $10, if you choose the Ace of Spades you lose $10. Now consider the following sentence:

(19) You know which card is the winning card.

Is this sentence true or false in the given situation? On the one hand, the sentence is true: you know that the Ace of Hearts is the winning card. If someone interested in the rules of the game asked you *Which card is the winning card?*, you would be able to answer in an appropriate way. On the other hand, suppose someone interested in winning the game would ask you *Which card is the winning card?* In this case you would not be able to answer in the desired way: as far as you know, the winning card may be the card on the left, but it may just as well be the card on the right. Therefore you don't know which card is the winning card (similar 'yes and no' cases were discussed in Boër and Lycan 1978, p. 303).

We would like to propose the following explanation of these sort of cases. Intuitively, there are two ways in which the cards may be identified in this

[3] Another challenge to the view that knowledge-*wh* can be reduced to propositional knowledge is the problem of 'convergent knowledge' presented by Schaffer (2007). See Aloni and Égré (2010) and Aloni *et al.* (2013) for a discussion on how this problem can be circumvented within Groenendijk and Stokhof's approach.

situation: by their position (the card on the left, the card on the right) or by their suit (the Ace of Hearts, the Ace of Spades). Whether (19) is judged true or false seem to depend on which of these perspectives is adopted. If identification by suit is adopted, as in the first context discussed above, the sentence is judged true. But if identification by position is adopted, as in the second context, the sentence is judged false.

Identification methods can be formalized as conceptual covers (Aloni, 2001).

(20) A conceptual cover is a set of individual concepts (functions from worlds to individuals) which exclusively and exhaustively covers the domain of individuals: in a conceptual cover each individual is identified by at least one concept in each world (*existence* condition), but in no world is an individual counted more than once (*uniqueness* condition).

In a conceptual cover each individual is identified in a determined way, and different covers constitute different ways of conceiving one and the same domain.

For the sake of illustration consider again the card scenario described above. In that scenario there are at least three salient covers representing ways of identifying the cards: (21a) representing identification by ostension, (21b) representing identification by name, and (21c) representing identification by description. The set of concepts in (21d) is not an example of a conceptual cover because it does not satisfy the conditions formulated in our definition. Intuitively, (21d) does not represent a proper perspective over the relevant domain of individuals: as far as we know, the card on the left might be the Ace of Spades. If so: (i) one card (the Ace of Spades) would be counted twice; and (ii) another card (the Ace of Hearts) would not be identified at all.

(21) a. {on-the-left, on-the-right} [ostension]
b. {ace-of-spades, ace-of-hearts} [naming]
c. {the-winning-card, the-losing-card} [description]
d. #{on-the-left, ace-of-spades}

When we talk about concepts, we implicitly assume two different levels of 'objects': the individuals (in D) and the ways of referring to these individuals (in D^W). An essential feature of the intuitive relation between the two levels of the individuals and of their representations is that to one element of the first set correspond many elements of the second. The intuition behind it is that one individual can be identified in many different ways. What characterizes a set of representations of a certain domain is this cardinality mismatch, which expresses the possibility of considering an individual under different perspectives which may coincide in one world and not in another. Individuals, on the other hand, do not split or merge once we move from one world to the other. Now, since the elements of a cover also cannot merge or split (by uniqueness), they behave like individuals in this sense, rather than representations. On the other hand, a cover is not barely a set of individuals, but encodes information on how these individuals are specified. We thus can think of covers as sets of individuals each identified in one specific way. My proposal is that questions

and knowing-*wh* constructions involve quantification over precisely this kind of sets. By allowing different conceptual covers to constitute the domain of quantification on different occasions, we can account for the 'yes and no' cases discussed above, without failing to account for the intuition that questions and knowing-*wh* constructions involve quantification over genuine individuals, rather than over ways of specifying these individuals.

We propose to relativize the interpretation function to a contextual parameter which assigns conceptual covers to variables as their domain of quantification (see appendix for details). The evaluation of (22) in the resulting semantics will vary relative to the contextually selected conceptual cover.

(22) You know which card is the winning card.
$K_a(?z.\ z = \iota x.\textsc{winning-card}(x))$
a. False, if $z \mapsto$ {on-the-left, on-the-right}
b. True, if $z \mapsto$ {ace-of-spades, ace-of-hearts}
c. Trivial, if $z \mapsto$ {the-winning-card, the-losing-card}

It is easy to see that the proposed semantics also gives a ready account of the following sort of cases (Boër and Lycan 1986):

(23) Alphonse, you don't know who you are: you are the rightful heir to the Albanian throne.

These kind of examples were problematic for Groenendijk and Stokhof's original theory. Since the embedded question received the analysis in (24), example (23) was wrongly predicted to require for its truth that Alphonse failed to know a tautology:

(24) a. Who are you?
b. {that you are d_1, that you are d_2, ... }

On the present analysis, instead, where questions quantify over concepts in a cover rather than objects, the intended meaning of (23) can be easily captured by letting the *wh*-pronoun range over elements of a descriptive cover with the concept 'the rightful heir to the Albanian throne' as one of its elements:

(25) a. Who are you?
b. {that you are the rightful heir to the Albanian throne, ... }

It is however important to stress again that given the constraints we have put on conceptual covers, quantification under conceptual cover functions logically exactly the same as quantification over individuals (Aloni, 2005), an element of a conceptual cover is then better characterized not as a representation of an individual but as the individual itself only specified in a determined way.

The next section provides independent motivation for a conceptual cover analysis of questions looking at the case of concealed questions.

3 Concealed questions

A concealed question (henceforth CQ) is a noun phrase naturally read as an identity question. As an illustration, consider the italicized nouns in the following examples:[4]

(26) a. John knows *the price of milk*.
b. John knows what the price of milk is.

(27) a. Mary discovered *the murderer of Smith*.
b. Mary discovered who the murderer of Smith is.

(28) a. They revealed *the winner of the contest*.
b. They revealed who the winner of the contest was.

Concealed questions arise not only with definite determiner phrases, but also with indefinite and quantified ones, as illustrated in (29) and (30):

(29) John knows a doctor who could help you. (Frana 2006)

(30) John knows every phone number. (Heim 1979)

Heim (1979) further discussed structurally more involved cases like (31) and observed that such CQ-containing CQs (CCQs) are ambiguous between two readings, which are generally referred to in the literature as Reading A and Reading B:

(31) John knows the capital that Fred knows.
a. Reading A: There is exactly one country x such that Fred can name x's capital; and John can name x's capital as well.
b. Reading B: John knows which country x is such that Fred can name x's capital (although John may be unable to name x's capital himself).

Suppose Fred knows that the capital of Italy is Rome. Then on Reading A, (31) entails that also John knows that the capital of Italy is Rome. On Reading B, (31) lacks this entailment. It only follows that John knows that Fred can name

[4] It is well known that English *know* also allows acquaintance readings:

(i) Mary knows the capital of Italy.
a. Acquaintance reading: Mary is acquainted with Rome.
b. Concealed Question reading: Mary knows what the capital of Italy is.

In languages like Italian and Dutch, where epistemic *know* and acquaintance *know* are lexically distinct, the CQ reading can be forced by using the verb for epistemic know (*sapere* in Italian and *weten* in Dutch), as shown by (ii) for Italian, which does not allow acquaintance interpretations.

(ii) Maria sa la capitale dell'Italia.
Maria $\text{knows}_{\text{EPI}}$ the capital of-the-Italy
'Mary knows what the capital of Italy is'

the capital of Italy.

A clarification of the logical forms of these sentences turns out not to be a trivial task. Heim in her seminal article considered three possible logical analyses for the basic definite cases in (26)-(28) but none of these could be extended to a proper analysis of both A and B readings of CCQs. Recently concealed questions have received some new attention in the linguistic literature. In what follows I will focus on a conceptual cover analysis of concealed questions (Aloni, 2008) which provides a unified account of the interpretation of definite, indefinite, and quantified CQs and of CCQs using the analysis of identity questions introduced in the previous section[5].

The first question that arises when trying to figure out the logical form of CQs concerns their semantic type. Syntactically CQs behave like nominals, but what is their semantic contribution? Different theories have provided different answers to this question. Some have assumed that CQs denote individual concepts (e.g. Romero, 2005; Frana, 2010), others properties (e.g. Brogaard, 2008) or individuals (e.g. Heim, 1979). We will assume that a CQ behaves semantically as a question, i.e. it denotes a proposition (cf. Nathan, 2006).

Two main arguments can be given in favor of a question/proposition analysis of CQs. The first involves coordination. Concealed questions can be coordinated with full-fledged declarative and interrogative complement clauses, as in (32) and (33).

(32) They revealed the winner of the contest and that the President of the association would hand out the prize in person.

(33) I only knew the capital of Italy and who won the Worldcup in 1986.

If CQs are taken to denote question extensions in the sense of Groenendijk and Stokhof, i.e. propositions, then these coordination facts can be straightforwardly accounted for (see example (14)).

The second argument in favor a question analysis is one of parsimony. It would be preferable not to have to assume a special purpose lexical item know_{CQ}, beside the independently motivated, acquaintance *know* and epistemic *know* (see footnote 4). If CQs simply denote propositions, standard epistemic know defined as in (12) will be enough for our purposes.[6]

Let us have a closer look now at our proposal. The core idea is that although CQs are syntactically nominals, semantically they function like embedded identity questions. More formally, the interpretation of a CQ is assumed to involve a type-shifting operator $\uparrow_z$ which transforms an entity denoting expression α into the identity question $?z.\ z = \alpha$ (*which z is* α*?*), where z ranges over some contextually determined conceptual cover.

(34) $\quad \uparrow_z \alpha \ =_{def} \quad ?z.\ z = \alpha$

[5]See Aloni and Roelofsen (2011) for an extension of Aloni (2008) which explains predicational readings of quantification CQs and quantificational CCQs cases.

[6]Question analyses of CQs have been challenged by a brief remark attributed by Heim (1979) to Greenberg and therefore known as Greenberg's observation. See Aloni and Roelofsen (2011) for a reply to this objection.

Illustrations. First consider a 'plain' definite CQ:

(35) a. John knows the capital of Italy.
b. $K_j(\uparrow_z \iota x.Px)$ $(= K_j(?z.\ z = \iota x.Px)$

When a proposition embedding verb like *know* applies to an entity denoting expression like *the capital of Italy*, the type-shifting operator $\uparrow_z$ must apply to avoid a type mismatch. The resulting sentence is then interpreted according to the analysis of knowledge ascription given in the previous section. The intended reading is obtained if x and z are both taken to range over the *naming* cover:

(36) $x, z \rightarrow \{\text{Rome}, \dots\}$

Under this resolution the embedded question $?z.\ z = \iota x.Px$ denotes in w the proposition that Rome is the capital of Italy, if Rome is indeed the capital of Italy in w. Sentence (35) then is true in w iff John's epistemic state in w supports this proposition.

Example (37) illustrates our analysis of quantified CQs:

(37) a. John knows every European capital.
b. $\forall x.(\textsc{european-capital}(x) \rightarrow K_j(\uparrow_z\ x))$

The most natural cover resolution for x and z here is the following:

(38) a. $x \rightarrow \{\text{the capital of Germany, the capital of Italy}, \dots\}$
b. $z \rightarrow \{\text{Berlin, Rome}, \dots\}$

The sentence is then predicted to be true iff for each European country John can name the capital of that country. Notice that contrary to the previous example, the quantified case crucially requires that x and z range over two different covers, otherwise the question $?z.\ z = x$ would be trivialized (i.e., it would denote a tautology in every world, relative to any assignment function).

Finally, we turn to Heim's CCQ ambiguity. As we mentioned above, Heim (1979) observed that sentences like (39) have the two readings paraphrased in (40) and (41).

(39) John knows the capital that Fred knows.

(40) Reading A:
There is exactly one country x such that Fred can name x's capital; and John can name x's capital as well.

(41) Reading B:
John knows which country x is such that Fred can name x's capital (although John may be unable to name x's capital himself).

On the present account, Heim's ambiguity can be easily represented as a scope ambiguity:

(42) John knows the capital that Fred knows.

a. $\exists x.(x = \iota y.(\textsc{capital}(y) \wedge K_f(\uparrow_{z_1} y)) \wedge K_j(\uparrow_{z_2} x))$ [Reading A]
b. $K_j(\uparrow_{z_3} \iota y.(\textsc{capital}(y) \wedge K_f(\uparrow_{z_4} y)))$ [Reading B]

The intended readings are captured by assuming the following cover resolution for the relevant variables:

(43) a. $x, y, z_3 \rightarrow$ {the capital of Germany, the capital of Italy, ... }
b. $z_1, z_2, z_4 \rightarrow$ {Berlin, Rome, ... }

On this resolution, Reading A says that there is a unique capital which Fred can identify by name (the first conjunct in (42a)), and that John can identify that capital by name as well (the second conjunct in (42a)). On Reading B, John can identify 'the capital that Fred knows' with one of the individual concepts in the conceptual cover associated with z_3. That is, there is some country x such that 'the capital that Fred knows' and 'the capital of x' denote the same city in all worlds in John's epistemic state.

4 A puzzle of knowing who

On the present account, questions are context sensitive expressions, their logical representation involves variables whose domain of quantification needs to be pragmatically supplied. It is well known however that pragmatic accounts often run the risk of overgeneration. For example, if Ralph is like most of us, example (44) is false, but it is not hard to find a resolution for x which will make (44) true, namely one mapping x to any cover containing the concept 'the shortest spy' (Quine, 1956; Kaplan, 1969):

(44) Ralph knows who$_x$ is the shortest spy.

What this example shows is that the resolution process of cover indices needs to be suitably constrained. The following section discusses some factors that we take to play a role in this process, and then concludes with the presentation of a puzzle concerning the contrast between knowing who is somebody versus knowing who somebody is.

Constraints on pragmatic resolution We assume that there are certain default choices for the resolution of cover indices, from which however we can sometime deviate. Deviation from the default choices though is costly and only justified if needed in order to comply with Gricean principles of conversation. More precisely, we assume the following:

1. Variable by default range over a perceptually-based cover (if application criteria apply) or naming (if application criteria apply)
2. Resolution to a non-default salient cover is possible but licensed only if it is needed in order to avoid trivial, contradictory or irrelevant meanings, and only if the obtained content could not have been expressed by a more perspicuous/effective form.

A proper description of the application criteria for identification by ostension and naming is beyond the scope of this work, but roughly they seem to relate to the application criteria of demonstratives and proper names: identification by ostension requires the relevant individuals to be in the perceptual surroundings of the interlocutors, as proper uses of demonstratives do, while identification by naming requires the availability of *shared* names for these individuals. When talking to a stranger you don't refer to your son as 'John', but you refer to president of the US as 'Obama' because only the latter can be assumed to be a shared name. Similarly, only when shared names are available, naming can be adopted as identification method.

Illustrations At a party with many African leaders, identification by ostension is the predicted resolution for x in (45), but during an exam on African politics, naming would be the default choice, since the application criteria for ostension would not be satisfied:

(45) Who$_x$ is the president of Mali?

On the other hand, a proper interpretation of (46) requires a deviatioun from the default resolution, a descriptive cover must be selected here because both ostension and naming would lead to a trivial interpretation:

(46) Alphonse, you don't know who$_x$ you are: you are the rightful heir to the Albanian throne.

Deviation from a default resolution however is not licensed for (47), since, assuming a neutral context, the only salient non-default cover would be one which, if adopted for x, would trivialize the sentence. The sentence is then predicted to be false if Ralph is not able to identify the shortest spy by ostension or by name.

(47) Ralph knows who$_x$ is the shortest spy.

Consider now the following scenario from Percus (2003):

(48) Scenario: When we arrive at the piano trio concert, a friend of ours tells us that he is going to introduce us to a couple of the musicians. He brings over two men in tuxedos and introduces one as John (the one on the left), and the other (the one on the right) as Bill. At this point, we know that John is one of the musicians, but we don't know whether he is the cellist, violinist or pianist. Likewise for Bill.

Percus observes that the following question is felicitous in this scenario and only admits (49a) as a proper answer:

(49) Who do you think John is?
a. John is the violinist.
b. #John is the man on the left.

c. #John is John.

Our pragmatic theory has a ready account for these facts: a non-default resolution to the salient descriptive cover is correctly predicted here, since the default choices (ostension and naming) would have given rise to violations of Gricean principles of conversation. Percus, however, further observes that the following variant of (49) would be infelicitous here:[7]

(50) Who do you think is John?

Identity questions like (50) where *who* originates in subject, or pre-copular position (let us call them *subject* identity questions) seem to have a more restricted use than those like (49) in which *who* originates in object, or post-copular position (let us call these *object* identity questions), but our pragmatic theory, as it stands, has nothing to say about this contrast. This is the puzzle I want to address in the remaining part of the article. In what follows I will first present some more data concerning subject identity questions and then discuss and dismiss two previous attempts to explain these data. A direction towards a solution will be suggested at the end, but we will have to conclude that more work is needed to arrive at a proper understanding of the contrast between these two types of identity questions.

Subject identity questions A first puzzle concerns the range of possible answers subject identity question can have. A context in which such questions are felicitous is given in (51). In this scenario only (52a) seems to be a felicitous answer to (52):

(51) Scenario: At a piano trio concert, you know the names of the three musicians (one is John), but you don't know who plays what instrument and what the musicians look like. The musicians come now onstage without their instruments and you ask:

(52) Who do you think is John?
a. The man on the left.
b. #The violinist.

A related puzzle concerns the range of nominals which can appear in subject identity questions. Unlike names and descriptions like *the violinist*, descriptions like *the man on the left* sound odd in the post-copular position of an identity question:

(53) Who do you think is John/the violinist/# the man on the left?

In what follows we will discuss two possible analyses of these facts: first the one proposed by Heller and Wolter (2013) and then the one proposed by Percus

[7]The puzzle cannot be reconstructed for questions like *Who is John?* because the main auxiliary moves above the subject in English questions, and therefore for *Who is John?* we cannot determine whether *who* originates in subject or in object position.

(2003).

Heller and Wolter's proposal relies on the notion of a perceptually grounded expression, i.e. an expression whose interpretation depends on the information which is available to the conversational partners via their perception of the physical surroundings. They propose the following generalizations: (i) the answer to a question with a post-copular name must be perceptually grounded (example (52)); and (ii) perceptually grounded expressions cannot occur in the post-copular position in identity questions (example (53)). One of their main points is that the (in)felicity of identity questions and answers depends not on the descriptive content of the definite alone, but rather on the relationship between linguistic content and what the interlocutors can perceive in their physical surroundings, as soon as we modify context (51) assuming that when the musicians come onstage they are carrying their instruments, the status of *the violinist* changes, (54b) is now a felicitous answer to (54), while question (55) becomes infelicitous:

(54) Who do you think is John Smith?
  a. The man on the left
  b. The violinist

(55) #Who do you think is the violinist?

Heller and Wolter's analysis is then implemented as follows: in an identity statement the post-copular element is assumed to denote a sort (in the sense of Gupta (1980)) thus contributing a set of individual concepts, whereas the pre-copular element denotes an individual concept. The statement is true if the denotation of the pre-copular element is an element of the denotation of the post-copular element. On this account, proper names and common nouns are fundamentally different from demonstratives and other perceptually grounded expressions, only the former specify a sort in the sense of Gupta and therefore are according to the analysis felicitous in post-copular positions. Perceptually grounded expressions instead do not specify a sort and it is precisely this feature which allows them to function as answers to questions with post-copular names.

This analysis captures the cases discussed so far, and correctly recognizes the pragmatic nature of these puzzles. It does not seem however to be extendable to explain the following cases of subject questions with a description in post-copular position rather than a name:

(56) a. Who do you think is the best singer of all time and why? [Google]
  b. Luciano Pavarotti. I am basing this on the power, range, tone and control that he has with his voice. ...

(57) a. Who do you think is the most envied woman in the world? [Google]
  b. Angelina Jolie

According to Heller and Wolter, names must be able to specify a sort to be able to occur in post-nominal position, but then they are automatically predicted to be infelicitous as answers to questions like (56a) and (57a). Heller and Wolter

propose a two-way distinctions between expressions which introduce a sort, and therefore can only occur in post-copular position, and expressions which don't, and therefore can only occur in pre-copular position, while these last examples show that one and the same kind of expression can occur in both positions depending on the occasion.

We turn now to Percus' (2003) own account of examples (52) and (53). Percus' direction to explain these cases is to argue that a question like 'Who do you think is α?' determines as the set of its possible answers a set of propositions like (58) that vary with respect to an individual, rather than an individual concept:

(58) $\{\text{that } d_1 \text{ is } \alpha, \text{ that } d_2 \text{ is } \alpha, \dots\}$

A proper answer to such questions then should involve a term which rigidly refers to the same individual in all possible worlds in the conversationalist context set (in the sense of Stalnaker (1978)). Assuming that 'the man on the left', and pronouns are such terms while 'John' and 'the violinist' aren't, Percus can account for the the contrast in (52), and the infelicity of (53). (53) is predicted to be infelicitous because its answer set will contain only tautologies or contradictions. The contrast in (52) is explained because (59a) is contextually equivalent to one of the propositions in the answer set of the relevant question, while (59b) isn't.

(59) a. John is the man on the left.
b. John is the violinist.

While there is no privileged piece of information in virtue of which one knows who α is, there seem to be one in virtue of which one knows who is α, namely you should be able to identify α as one and the same individual in all worlds in your context set, or, at least, this seems to be what Percus proposes. While Heller and Wolter's analysis was not extendable to explain the cases of post-copular descriptions like (57), Percus can in principle account for all cases discussed so far by assuming that while perceptually grounded expressions like *the man on the left* always refer rigidly (to account for cases (52) and (53)), names are rigid only in certain contexts. But in which contexts? Even disregarding the difficulty of giving a principled answer to this question, the following example poses a serious problem for Percus approach:

(60) Scenario: Maria's son Lorenzo had a test at school this morning where he was asked to name the presidents of several countries. In the evening at home, Maria's husband asks Maria (61a). Knowing that her son knows everything about Nauru, Maria correctly answers (61b). Assume that neither Maria nor her husband recall who the president of Nauru actually is, it might be Baron Waqa or Marcus Stephen.

(61) a. Who do you think is the only president Lorenzo knew?
b. The president of Nauru.

To account for the felicity of (61b) Percus would have to model the description 'the president of Nauru' as a rigid designator within the relevant context set, but this is very counterintuitive because the same context set should also model that the interlocutors don't know who the president of Nauru is, while Lorenzo knows. The conceptual cover account presented in the previous sections has a ready account of these sort of examples (see the treatment of reading B of Heim example in (42)) but involves abandoning a two way distinction between rigid and non-rigid designators/methods of identification: the relevant individual can be identified here in three possible ways as Baron Waqa, as the president of Nauru, or as the president that Lorenzo knows, and all three identification methods play a crucial role in our interpretation of this example.

A different hypothesis can at least be formulated in the present framework which captures all four cases discussed above. Even though we have now enough evidence that wh-pronouns even in subject identity questions can range over all kinds of covers, including those formalizing descriptive methods of identification, there seems to be an inherent ordering of identification methods, to which identity statements appear to be sensitive:

(62) ostension > naming > description

The ranking in (62), which directly relates to the ranking of referential devices discussed in Gundel *et al.* (1993) and Aloni (2001), could be justified by salience, but also by economy considerations:[8] whenever available identification by ostension seems to be the most salient method of identification,[9] and whenever possible pointing and naming are less costly than full-fletched linguistic descriptions.

The preliminary observations in the previous paragraphs suggest the following generalization, which refers to the ranking in (62):

(63) HYPOTHESIS: In identity statements the identification method used to identify the subject (pre-copular element) should be higher in order than the identification method used to identify the object (post-copular element).

The following apparent counterexample to (63) isn't such because it is arguably an example of a specificational sentence rather than an identity one (Higgins, 1973, p. 133)

(64) The number of planets is nine.

Although more empirical investigation is needed to test the validity of this hypothesis, it is easy to see that (63) covers the four cases discussed above, and also explains the tendency to prefer descriptive answers to object identity

[8] In any case the preference for perceptually grounded methods of identification does not seem to have anything to do with an alleged epistemological advantage of perception versus other methods of knowledge acquisition.

[9] If salience is the most relevant criterion here, the relative ordering between naming and description might revert depending on context.

questions like (49). The question remains of why it is so.

5 Conclusion

Entities can be conceived from many different perspectives and what perspective is assumed in actual conversations can vary relative to various pragmatic factors. The present analysis was an attempt to give a precise formalization of this insight and to discuss its impact on our interpretations of questions, concealed questions and knowing who constructions. We concluded the article with a discussion of the contrast between subject and object identity questions. To arrive at a proper account of this contrast more data should be gathered and the internal structure of identity statements should be taken into more serious consideration. This however must be left to another occasion.

6 Appendix

Let L be a language of first-order logic enriched with a ι-operator, a question operator ?, and knowledge operator K_a. A model for L is a quintuple (W, D, I, E, C) where W is a set of possible worlds, D a set of individuals, I a world dependent interpretation function, E is a function mapping individual-world pairs (a, w) into subsets of W (intuitively representing the epistemic state of a in w), and C is a set of conceptual covers based on (W, D).

Definition 1 [Conceptual covers] Given a set of possible worlds W and a domain of individuals D, a *conceptual cover* CC based on (W, D) is a set of individual concepts [i.e. functions $W \rightarrow D$] such that:

$$\forall w \in W : \ \forall d \in D : \ \exists! c \in CC : c(w) = d$$

Sentences are evaluated relative to a model, a world in that model, and an assignment function $g_{\mathcal{R}}$, where R is a cover resolution function. Here are the definitions

Definition 2 [Cover resolution functions] Given a set of variables V and a model (W, D, I, C), a cover resolution function $\mathcal{R}$ is a function that maps every variable x in V to some conceptual cover in C.

Definition 3 [Assignment functions] Given a set of variables V, a model (W, D, I, C), and a cover resolution function $\mathcal{R}$, an assignment function $g_{\mathcal{R}}$ is a function that maps every variable x in V to some individual concept in $\mathcal{R}(x)$.

Definition 4 [The denotation of variables] $\quad [\![x]\!]_{M,w,g_{\mathcal{R}}} = g_{\mathcal{R}}(x)(w)$

Definition 5 [Quantification under conceptual cover]

- $[\![\exists x.\phi]\!]_{M,w,g_{\mathcal{R}}} = 1$ iff $\exists c \in \mathcal{R}(x) : [\![\phi]\!]_{M,w,g_{\mathcal{R}}[x/c]} = 1$

- $[\![\forall x.\phi]\!]_{M,w,g_{\mathcal{R}}} = 1$ iff $\forall c \in \mathcal{R}(x) : [\![\phi]\!]_{M,w,g_{\mathcal{R}}[x/c]} = 1$

Definition 6 [Questions under conceptual cover]

- $[\![?\vec{x}.\phi]\!]_{M,w,g_{\mathcal{R}}} = \{v \mid \forall \vec{c} \in \mathcal{R}(\vec{x}) : [\![\phi]\!]_{M,w,g_{\mathcal{R}}[\vec{x}/\vec{c}]} = [\![\phi]\!]_{M,v,g_{\mathcal{R}}[\vec{x}/\vec{c}]}\}$
  where $\vec{x}$ is the sequence $x_1, \ldots, x_n$, and $\mathcal{R}(\vec{x})$ is the product $\prod_{i \in n}(\mathcal{R}(x_i))$.

Definition 7 [The ι-operator]

- $[\![\iota x.\phi]\!]_{M,w,g_{\mathcal{R}}} = c(w)$, if there is a unique $c \in \mathcal{R}(x)$: $[\![\phi]\!]_{M,w,g_{\mathcal{R}}[x/c]} = 1$
- Undefined, otherwise

Definition 8 [Knowledge ascription]

- $[\![K_a\,\alpha]\!]_{M,w,g_{\mathcal{R}}} = 1$ iff $E(a,w) \subseteq [\![\alpha]\!]_{M,w,g_{\mathcal{R}}}$

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