Technical Appendix to "Know How and Gradability"

Carlotta Pavese

January 8, 2017

A Cross-linguistic Considerations

A.1 Interrogatives or Free Relatives?

In the main text I have been conforming to orthodoxy in taking the complement of a know how ascription to be an interrogative. *Contra* this standard linguistic assumption, some philosophers have suggested that the embedded phrase "how to ϕ" might not be an interrogative but rather a 'free relative'. Free relatives are constructions of the form "wh- ψ" that can occur in nominal position. For example, in (1), "believe" cannot take interrogatives as complements, so "what you said" cannot occur as an interrogative. Rather, it works as a quantifier in objectual position:

(1) Mary believed what you said.

So the idea of the free relative analysis would be that "how to ϕ" plays the same semantic function in ascriptions of know how that "what you said" plays in (1).

This free-relatives analysis is implausible in general. It is a well-known linguistic generalization that infinitival-'*wh*' constructions, such as "how to ϕ," simply cannot work as free relatives, as shown, among other problems, by the fact that a verb such as "believe" cannot

take them as complement:[1]

(2) a. # Mary believes what to believe.

b. Mary believes what she should believe.

c. # Mary believes who to believe.

d. Mary believes who she should believe.

Moreover, as observed in the main text (pp. 9-10), the phrase "the way to swim" can be taken as complements by verbs, such as "learn" and "tell," that do not allow other kinds of nominal complements, suggesting that the position occupied by that phrase is not referential:

(3) a. I learned the way to swim.

b. I learned the capital of Italy.

c. # I learned Rome.

(4) a. I told Mary the way to reach Dogenal.

b. I told Mary the capital of Italy.

c. # I told Mary Rome.

The free-relative analysis of know how ascriptions is often motivated on the basis of the seeming equivalence between ascriptions such as (5-a) and (5-b):

(5) a. Mary knows how to swim.

b. Mark knows the way to swim.

But in light of the considerations just mentioned above and in the main text (§4.1) about the inadmissibility of free relatives within "learn" reports, we should aim at explaining the seeming equivalence between (5-a)-(5-b) in some way that does not commit us to the free relative analysis. The simplest explanation (also rather standard among linguists) is that in a construction such as "S knows a way to F" and "Mary found out a way to F," the nominal "a way to F" is a *concealed* interrogative, so (5-b) is equivalent to:

[1] See Schaffer (2009) for an accessible review of the main reasons why infinitival '*wh*'-clauses cannot be free-relatives.

(6) Mark knows what way is a way to F.

which is in turn equivalent to (5-a).[2]

Bengson and Moffett (2011) speculate that know how ascriptions ascribe an acquaintance relation towards ways of doing things rather than towards answers to questions. The main motivation offered is linguistic — i.e., the equivalence between (5-a) and (5-b). But a reason to think that this analysis is implausible is that in languages employing different verbs for the acquaintance relation other than the propositional verb ('*connaitre*' in French and '*conoscere*' in Italian), the acquaintance verbs cannot be used to ascribe know how, which is, instead, exactly what we would expect if know how were *knowledge by acquaintance* of a way to do something:

(7) # Mary connait comment nager.
Mary knows-by-acquaintance how to swim.

(8) # Mary conosce come nuotare.
Mary knows-by-acquaintance how to swim.

Finally, the acquaintance view cannot explain the fact that ascriptions of know how in other languages, such as French and Italian, take bare infinitivals "to ϕ" as complements, which clearly do not refer to ways:

(9) Mary sa comportarsi in pubblico.
Mary sait se-conduire en public.
Mary knows to behave in public.

'Mary knows how to behave in public'

B Against the Ambiguity Hypothesis

A variety of philosophers (such as Rumfitt (2003), Ginzburg (1995), Michaelis (2011), Wiggins (2012), Abbott (2013), and Ditter (2016)) have used cross-linguistic considerations to motivate the hypothesis according to which English know how ascriptions are ambiguous

[2] See Baker (1969), Grimshaw (1979), and more recently Aloni (2008), Aloni and Roelofsen (2011) for defenses of such analysis.

between two different logical forms — one embedding the interrogative complement "How to ϕ" (= "S knows + (interrogative) how to ϕ") and one not embedding an interrogative at all. Call the hypothesis according to which English know how ascriptions are ambiguous between these two logical forms the *Ambiguity Hypothesis*. In this section, I review the main arguments on behalf of the *Ambiguity Hypothesis* and I argue that they fail. Lacking convincing arguments on behalf of the *Ambiguity Hypothesis*, I propose we adopt *The English Univocal Logical Form Assumption* — the assumption that English ascriptions of know how univocally have the logical form they superficially appear to have — i.e., "S knows + (interrogative) how to ϕ."

Rumfitt (2003)'s main argument for the *Ambiguity Hypothesis* goes as follows. It is often observed that in Romance languages such as French and Italian, know how can be ascribed by means of ascriptions that appear to take bare infinitivals "to ϕ" as complements, such as, for example, (16), (10-a), and (11-a):

(10) a. Marco sait nager.

b. Marco sait comment nager.

(11) a. Marco sa nuotare.

b. Marco sa come nuotare.

Rumfitt (2003) (p. 162) observes that the infinitival construction embedding "to ϕ" can differ in meaning from the corresponding ascription embedding the interrogative: (10-b) and (11-b) (but not (10-a) or (11-a), can be used to mean that Marco has solved the problem of how to swim. As Wiggins (2012) also observes, moreover, the infinitival construction is somewhat more tied to ability. In other words, while one can affirm the interrogative construction while at the same time denying that the subject possesses the relevant ability, it would be weird to affirm the infinitival construction and deny at the same time that the subject has the relevant ability:

(12) a. ??Marco sa nuotare ma non ne ha la capacita'.

b. Marco sa come nuotare ma non ne ha la capacita'.

These observations suggests to Rumfitt and to Wiggins that English ascriptions of know how may be ambiguous between the *savoir faire reading* (the genuinely practical reading, the one tied to ability) and the *savoir comment faire* reading (which may well be equivalent to propositional knowledge and does not quite have the same connection to ability). Both Rumfitt and to Wiggins speculates when when used to ascribe *savoir faire*, English ascriptions of know how have a different logical form — one not embedding interrogatives — than they do when used to ascribe *savoir comment faire*.

Now, Rumfitt seems to assume that the interrogative form in Italian cannot express genuinely practical know how, or *savoir faire*. Native speakers of Romance languages can check that Rumfitt's assumption is not correct. In particular, it is not true that, for example, in Italian, the interrogative construction cannot express the sort of genuinely practical know how (or *savoir faire*) that Italian tends to ascribe *via* ascriptions of the same form as (10-a) and (10-b) — embedding infinitivals. For example, in Italian, with *some embedded verbs*, the infinitival construction is infelicitous and only the interrogative construction is allowed:

(13) #Mary sa prendere suo padre.
Mary knows to-deal-with her father.
Mary sa come prendere suo padre.

'Mary knows how to treat her father'

(14) #Mary sa trattare i suoi colleghi.
Mary knows to-treat her colleagues.
Mary sa come prendere i suoi colleghi.

'Mary knows how to treat her colleagues'

(15) #Mary sait traiter son clients.
Mary knows to-treat her clients.
Mary sait comment traiter son clients.

Mary knows how to treat her clients.

In examples (13)-(15) above, the infinitival form is out: in order to ascribe Mary *savoir faire* vis a vis her relationship with one's father, one would not use the infinitival construction; one would use the interrogative construction. If the infinitival construction were used, it would

ascribe a different sort of know how from that ascribed by the corresponding interrogative form. For example, (13)-a would ascribe to Mary knowledge of how 'to grab' her father as opposed to knowledge of how to deal with him.

Moreover, if Rumfitt were correct in thinking that Romance languages could not express *savoir faire* through the interrogative form, then it would follow that no genuinely practical know how (no genuine *savoir faire*) is, or can be, ascribed in all of these cases. But this conclusion is implausible: especially because in these cases the interrogative form seems to replace the infinitival form for all intents and purposes. Hence, this evidence suggests that, in Latin languages too, the interrogative form can sometime express genuinely practical know how — or *savoir faire*. Hence this suggests that in Latin languages, the interrogative form can be used with a reading that is truth conditionally equivalent to that expressed in those languages through the infinitival form.[3]

Crucially, this interpretation of the data is compatible with the univocity of English know how ascriptions — with the claim that they univocally exhibit the interrogative form. After all, the fact that the bare infinitival form and the interrogative form can sometimes come apart in their truth values is not sufficient to motivate the claim that English know how ascriptions are ambiguous between those two logical forms. One would also have to show that there is no interpretation of the interrogative form on which it has the same truth conditions as the bare infinitival form. It might very well be that the interrogative form alone is susceptible of two different interpretations, one corresponding to *savoir faire*, another to *savoir comment faire*.

[3]A very plausible, and independently motivated, explanation for both the ungrammaticality of a sentence such as "Mary sa prendere duo padre" or "May sait traiter son clients" in French and Italian appeals to the argument/adjunct distinction. Typically, manner adverbials (such as '*how*') are not arguments but adjuncts, so they do not need to appear at surface form and can be preferentially omitted on account of its brevity (Hence the grammaticality of "Mary sa comportarsi in publico" or "Mary sait se conduire en public"). With some verbs, however manner adverbials can work as arguments: for example, '*prendere*' in Italian and '*traiter*' in French are ambiguous between a meaning that thematically select for manner ('*to treat somebody in some way*') as opposed to a meaning that does not ('*to take*' or '*to negotiate*'). So in know how ascriptions that embed those verbs in linguistic environments that only permit the former meaning, the '*wh*'-word '*how*' has to appear at surface form, barring a syntactic violation. More precisely, a violation of the *projection principle*. Observe that this explanation treats ascriptions in those languages of the form "S knows + to ϕ" as the elliptical variants of their more explicit form "S knows + how to ϕ." It is an interesting question why in English, the question word '*how*' cannot ever be omitted. I suspect the explanation has to do with the fact if it were omitted, the English construction "know+infinitive" would be susceptible of two different meanings: the deontic meaning that one knows that one should ϕ and the know how reading. By contrast, in French and Italian, the infinitival construction does not allow for the deontic meaning, so no ambiguity has to be avoided.

This sort of ambiguity would not be an ambiguity in the English logical form — between an interrogative form and some other non-interrogative form. Rather it would be an ambiguity in the interpretation of the interrogative form itself.

Now, the differences in truth conditions sometimes observable between the infinitival form and the interrogative form can be independently explained without having to posit an ambiguity between an interrogative and a non-interrogative logical forms of the English ascriptions. They can be traced to 1. the context-sensitivity of know how ascriptions and 2. to the (independently motivated) ambiguities in the interpretation of the subject of the infinitival complement and the modal expressed by the infinitival complement (ambiguities which are not ambiguities between two different logical forms — i.e., they are not ambiguities between the logical form "know + interrogative how to ϕ" and the logical form "know how + infinitival to ϕ").

Know how ascriptions are context-sensitive. As observed by Schaffer 2007, 396, in some context, one may count as knowing how to play the flute, in some sense, by coming to know Monty Python?s explanation of how to play the flute is as follows: "Well, you blow in one end and move your fingers up and down the outside." But knowing such an explanation does not give one know how, in the relevant practical sense. In "Know How and Gradability," we have seen that our source of context-sensitivity has to do with the selection of a mode of presentation that is practical (§. 4.3). This dimension of context-sensitivity is associated with the question word 'how'.

Know how ascriptions are ambiguous between a generic interpretation ("how to ϕ" = how one could ϕ) and a *de se* interpretation ("how to ϕ" = how oneself could ϕ). (A further ambiguity has to do with whether the infinitival expresses an ability modal ("how to ϕ" = how one could ϕ) or a deontic modal ("how to ϕ" = how one should ϕ).) It is quite plausible that in Italian, ascriptions embedding interrogatives can be used to express the English generic interpretation of the subject of the complement whereas the ascriptions embedding bare infinitival mandatorily express the English *de se* interpretation. That would explain why the infinitival form and the interrogative form can come apart in Italian, compatibly with the

claim that English ascriptions only allow for the interrogative form. Hence, the claim that there is a further ambiguity in English, between a logical form embedding interrogative and one non-embedding interrogative, is as of now quite unsupported. There are different possible explanations for this ambiguity — it might be due to the interpretation of the subject of the infinitival "to ϕ" or to the contribution of the practical mode of presentation, which introduces a *de se* component.[4] Only the *de se* reading is distinctively practical. For example, consider the ski instructor, who intuitively can count as knowing how to perform a ski stunt despite not having the ability to do so. They only know how one can perform a ski stunt, but not how to perform it themselves.

How does acknowledging the context-sensitivity of know how ascriptions as well as the ambiguity in the interpretation of the subject of the embedded infinitival help against the *Ambiguity Hypothesis*? It helps because it is quite plausible that in Italian, for example, ascriptions embedding interrogatives could be used to express both the English generic interpretation and the *de se* interpretation, whereas the ascriptions embedding bare infinitival mandatorily express the English *de se* interpretation. Similarly, it is quite plausible that in Italian, just like in English, ascriptions embedding interrogatives may select contextually a non-practical reading, whereas ascriptions embedding bare infinitival mandatorily select the practical reading. That would explain why in Italian the infinitival form and the interrogative form can come apart in their truth values at least in some of their uses (for the latter can also be used with a generic interpretation), compatibly with the claim that English ascriptions of know how only allow for the interrogative form. se. After all, ascriptions of the form "s knows + (infinitival) to ϕ" in French or Italian are only translatable in English by *de*

[4] For example, Stanley and Williamson (2001) argue that the subject of the infinitival "to ϕ" is *de se* and the infinitival contributes an ability modal, so the relevant proposition would be of the form that w is how one oneself could ϕ. I am sympathetic to this resolution of the phrase "how to ϕ" but I'd rather not to take a stance on this issue. The main argument for the *de se* interpretation of the subject of the infinitival is that the ascription "S knows how to tie his shoes himself" is well formed and hence the reflexive "himself" must have a close antecedent. But it is open to us to believe that the *de se* component that provides the antecedent is contributed by the practical mode of presentation rather than by the interpretation of the subject of the infinitival. Moreover, it seems to me that we do ordinarily ascribe propositional knowledge by using the phrase "how to ϕ." For example, it is totally standard to say that one knows that Phelp's is a great way to swim. That piece of knowledge is uncontroversially propositional: there is no need to argue for that by resolving the modality implicit in the locution "a way to swim." Because of this, I do not think that an intellectualist is forced to take a stance on what the best way is to resolve the modality implicit in the locution "a way to swim."

se ascriptions "s knows + (interrogative) how (*de se*) to ϕ." That suggests that the predicate "knowing how to perform the ski stunt" is true of the ski instructor only on generic reading of the subject of the embedded infinitival verb (= knowing how one can ϕ) but is not true on its *de se* reading (= knowing how to perform the ski stunt himself). Hence, we are on good grounds in claiming that only the *de se* reading is relevant for ascriptions of know how and only in their *de se* readings do ascriptions of the form "s knows how to ϕ" entail the relevant sort of ability. (Another possible strategy, suggested by my view of practical modes of presentation, is to say that the ski instructor knows an answer to the question "how to ϕ" but not under a practical mode of presentation. For a practical mode of presentation represents a task in terms of operations that a subject *can* perform. And the ski instructor cannot perform some parts of the ski stunt. And so she cannot represent the task under a practical mode of presentation. On this strategy, the *de se* aspect of know how is contributed by the practical mode of presentation rather than by the interpretation of the embedded infinitival.)

Hence, the fact that the bare infinitival form and the interrogative form can sometime come apart — differ in their truth conditions — is not sufficient to motivate the claim English know how ascriptions are ambiguous between those two logical forms. One would have to also show that there is no interpretation of the interrogative form on which it has the same truth conditions as the bare infinitival form. But as I have argued above, the interrogative form in Latin languages, for example, can sometimes receive the genuinely practical interpretation. Hence, there is no reason to think that that does not happen in English.

So here is a general picture explaining all the evidence available that is compatible with the claim that English know how ascriptions are not ambiguous. In Latin languages, the infinitival form is also truth conditionally equivalent to the *de se* reading of the English know how ascriptions; by contrast the interrogative form can sometimes be given the generic interpretation. Hence the discrepancy in truth conditions between some uses of the infinitival form and some uses of the interrogative form. This analysis explains the observable data, without positing an implausible ambiguity in the logical form of the English ascription, over and beyond the ambiguity having to do with the interpretation of the subject of the infinitival

complement. Given this observation, the claim that there is a further ambiguity in English, one between a logical form involving an interrogative and one not involving an interrogative, is left quite unsupported.

As Rumfitt already pointed out, Ditter (2016) mentions evidence from Russian, German, and Turkish to argue for the *Ambiguity Hypothesis*. As Ditter (2016) I will focus on Russian, for German and Turkish do not seem to raise special or additional difficulties.

As Ditter observes, In Russian, we have two kinds of constructions: one with the embedding verb '*umetj*' — which cannot take a '*that*'-clause nor an interrogative as complement — and the standard "know + how to ϕ" construction. Ditter claims that the "know + how to ϕ" construction must ascribe a different state from the '*umetj*' ascription because, in Russian, one can coherently use sentences of the following form:

(16) John znaet kak igrat' na pianino, no on ne umeyet igrat.
John knows how to play the piano, but he does not know to play the piano.
'John knows how to play the piano, but he doesn't know how to do it'

As Ditter acknowledges, the literal translation of (16) would be a straight contradiction in English. According to Ditter, this observation motivates the claim that the English construction "knowing how to ϕ" is ambiguous between an interrogative construction and some other constructions — not involving an interrogative and corresponding to Russian's *umetj*'s ascriptions — of which Ditter omits to give the details.

Ditter's argument for the ambiguity hypothesis is, like Rumfitt's, too quick. First, the availability of constructions such as (16) in Russian does *not* show that '*umetj*' ascriptions do not ascribe the same state that in Russian can also be ascribed by the construction "know + (interrogative) how to ϕ;" nor does it show that English "knowing how to ϕ" is ambiguous between an interrogative and a non-interrogative logical form. As Ditter goes on to acknowledge, a way to make (16) intelligible in English is to translate it as:

(17) One knows how one could play the piano but does not know how to play the piano

himself.

In English, (17) makes perfect sense. As Ditter (2016) notices, it also translates (16) perfectly well. So also the phenomenon Ditter observes fails to establish that there is an ambiguity in the English ascriptions of know how that cannot be traced back to the already noted ambiguity between *de se* and generic reading. For the same reason, Ditter (2016) fails to establish that in Russian, genuinely practical know how cannot ever be ascribed by means of the construction "know how to ϕ." The reason why (16) is acceptable in Russian is that, while the '*umetj*' ascription mandatorily requires a *de se* interpretation, in Russian the construction "know + how to ϕ" can also license the generic reading, which is made explicit in (17). It might be that, because the *de se* reading of the Russian "know + how to ϕ" would make (16) contradictory, the generic reading is selected instead.

Because of this, Ditter fails to establish that in Russian, genuinely practical know how is not ascribed by means of the construction "know how to ϕ;" he also fails to establish that there is an ambiguity in the English ascriptions of know how that cannot be traced back to the already noted ambiguity between *de se* and generic reading. For this reason, Ditter fails to give new motivations for the ambiguity claim. Lacking reasons to think that there is a special ambiguity in English ascriptions of know how that is not reducible to the independently motivated ambiguity between *de se* and generic reading, it is good practice to proceed as if know how ascriptions' logical form were univocal and exactly what it looks to be — i.e., know + (interrogative) how to ϕ.

In fact, there are several independent reasons to reject the *Ambiguity Hypothesis*. What logical forms would English know how ascriptions be ambiguous between? I have already argued against the objectualist analysis of "how to ϕ" — i.e., against taking "how to ϕ" to be equivalent to the phrase "a way to ϕ." What are the other options? The proponents of the *Ambiguity Hypothesis* have failed to provide a detailed analysis. But presumably, the two logical forms are the following:

(18) 'know + (interrogative) how to ϕ"

(18) "know + how + (infinitival) to ϕ."

Now, consider (18). What is the logical role played by "how"? Because it is not supposed to be a question word, presumably "how" is an adjunct modifying the infinitival "to ϕ." (It could not modify "know," for it cannot precede it:

(19) # S how knows to ϕ.

Hence, "how" must modify "to ϕ.") But this would be a quite unprecedented construction for an adverb modifying the embedded infinitival verb. Consider:

(20) a. Mary knows how to swim.
b. Mary knows to swim.
c. Mary knows quickly to swim;
d. Mary has come to know effortlessly to swim.

(21) a. Mary learned how to swim.
b. Mary learned to swim.
c. Mary learned quickly to swim.
d. Mary learned effortlessly to swim.

(20-c)-(20-d) and (23-a)-(23-b) only license the reading where the adverbial phrases modify the embedding verb "know" or "learn" stated in:

(22) a. Mary has quickly learned to swim.
b. Mary has effortlessly learned to swim.

In (20-c)-(20-d) and (23-a)-(23-b) ,"quickly", "effortlessly" and "willingly" cannot modify the infinitival phrase "swim" — they cannot have a reading equivalent to:

(23) a. Mary has learned to swim quickly.
b. Mary has learned to swim effortlessly.

This suggests that in English, adverbials such as "quickly," "effortlessly" in (23-a)-(23-b), which modifies an infinitival verb such as " to swim" in general cannot move up and land between the embedding verb and the infinitival. Hence, the present analysis, on which "how"

in (18) is not a question word, but an adverbial modifying the embedded infinitival, would posit a quite unprecedented syntactic construction.

If so, the main cross-linguistic argument for thinking that English ascriptions of know how must be ambiguous between two different logical forms — one corresponding to the infinitival form of Italian, French, Russian ascriptions and the other corresponding to the interrogative form of the ascriptions in those languages — is undermined.

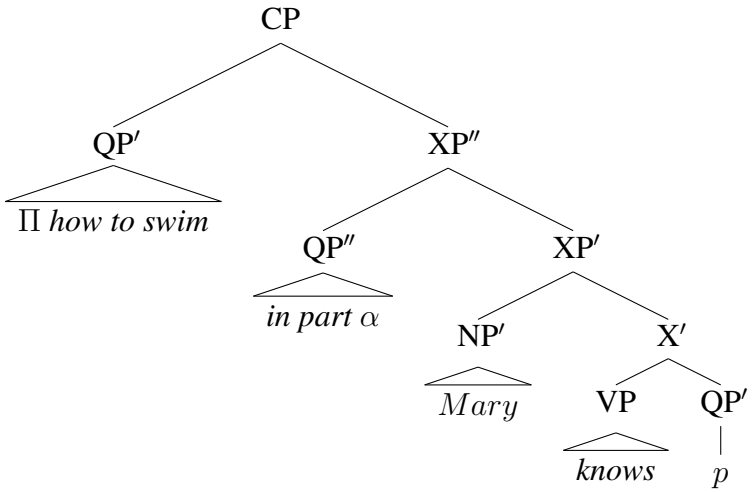
C Quantitative Gradability

I am following the standard practice of taking relative clauses and embedded interrogatives to arise from a common abstract '*Wh-* ϕ' (See George (2011) for discussion). The interrogative complement arises from the application of an interrogative feature 'Π' to that abstract. The interrogative feature 'Π' serves two purposes. First, it takes the abstract (in our case the predicate '*PRO to swim* w*-ly*') into a set of true answers (in our case, into a set of true answers to the question *How one could swim*); then it existentially generalizes over that set.

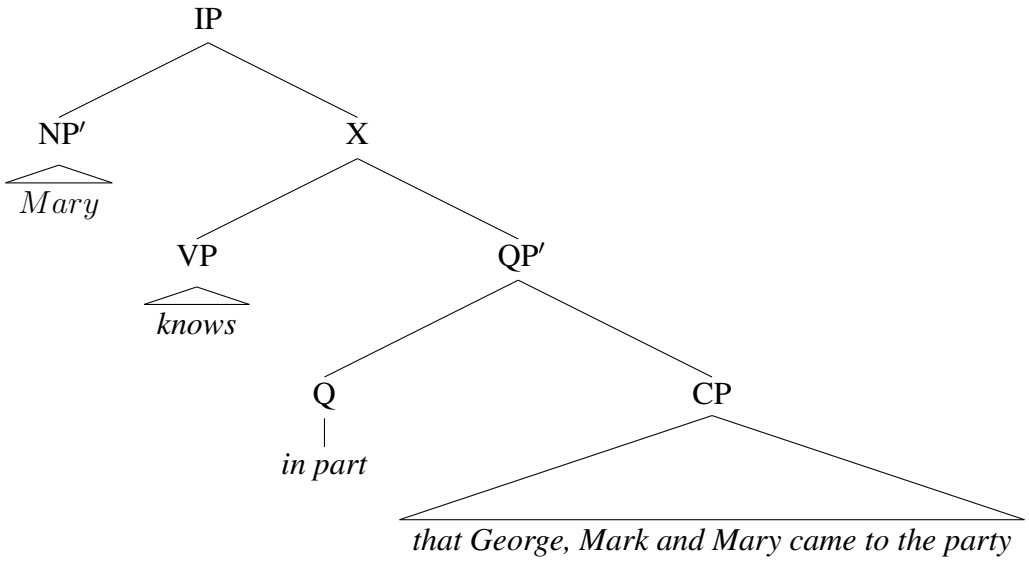
The logical form to be interpreted for knowledge-'*wh*' reports is reached through two standard quantifier movements. Consider the sentence '*Mary knows in part* Π *how to swim*'. We have two quantifier phrases, one embedded into the other: *1)* QP' = 'Π *how to swim*'; *2)* QP'' = '*in part* Π *how to swim*'. The embedding quantifier phrase QP'' moves up, this time because of a type mismatch with the verb '*know*' which takes propositions as arguments.[5] Because '*in part*' quantifies over propositions that are parts of an answer, by moving up, we expect the quantifier to leave behind a trace of the type of propositions ($\langle p \rangle = \langle s, t \rangle$). The embedded quantifier phrase QP' also moves up because of a type-mismatch with '*in part*': '*in part*' takes an answer as its argument whereas QP' existentially quantifies over answers. As a result of the movement, QP' leaves behind a trace of the type of answers. In particular, the type of an answer $\alpha = \langle p, \mathcal{Q} \rangle$, where $\langle p, \mathcal{Q} \rangle = \langle \langle s, t \rangle, \langle \langle s, t \rangle, t \rangle \rangle$. The resulting logical form to be interpreted is:

[5] I am following Heim and Kratzer (1998)'s analysis of lifted quantifiers.

Tree A



For know-'*that*' ascriptions, I will assume the following rather standard logical form:



How can practical modes of presentation be implemented into a compositional semantics? My analysis closely follows Kaplan (1968)'s analysis of *de re* belief reports and its semantic implementation in Yalcin (2015). The only differences have to do with the peculiarities of know how reports as compared to belief reports—that they embed interrogatives rather than *that*-clauses. Following Kaplan (1968), we can start by assuming that the Fregean truth conditions of a belief ascription such as (24) in its *de re* reading are given by (24-b):

(24) a. Mark believes somebody to be a spy.

b. $\exists x : \exists m$: M(m, x) & Mark B $\langle m \oplus$ is a spy$\rangle$.

M(m, x) iff m is a mode of presentation of x; B is the (Fregean) belief relation; $\ulcorner\oplus\urcorner$ (as

Yalcin (2015) calls it, 'the sense glue') combines m and the sense of '*is a spy*' into a Fregean proposition. Fregean propositions will be indicated by wide corner quotes '$\langle$, $\rangle$', whereas ordered pairs are indicated with smaller corner quotes '$<$, $>$'.

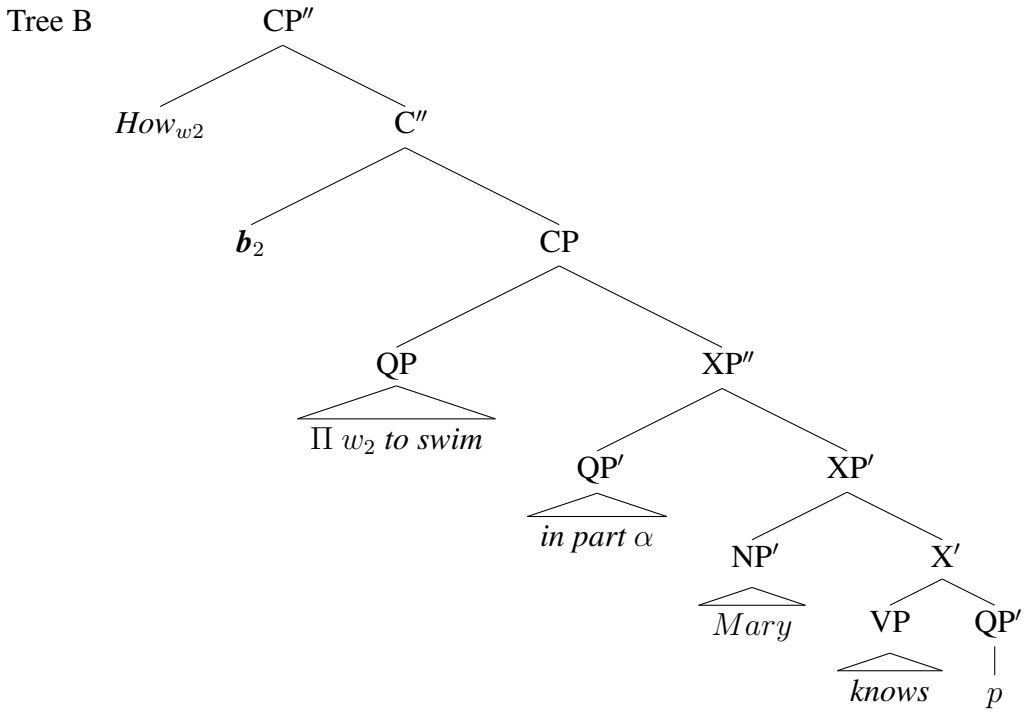
According to (24-b), for Mark to believe *de re* that somebody is a spy, there must be a mode m of presentation of some person x such that Mark believes the Fregean proposition $\langle m \oplus$ is a spy$\rangle$. By extending the same analysis to know how ascriptions, we can analyze the Fregean truth conditions of (25-a) as (25-b):

(25) a. Mark knows how to swim.

b. $\exists w : \exists \mathcal{P}$: M($\mathcal{P}$, w) & $\exists \alpha$: α = $<p^F$, *How one could swim*$>$, and $p^F = \langle \mathcal{P} \oplus$ IS HOW ONE COULD SWIM$\rangle$ and Mark knows every part of α.

According to (25-b), '*Mark knows how to swim*' is true just in case there is a way to swim and a practical mode of presentation for that way to swim, such that for some practical answer to the question *How one could swim*, Mark knows every part of that practical answer. Recall that a practical answer is an ordered pair. The first element of the ordered pair is a Fregean proposition p^F of the form $\langle \mathcal{P}$ *is how one could* $\phi\rangle$, where '$\mathcal{P}$' is a variable over practical senses that have as their referents ways w to ϕ [reference to published paper omitted for blind review]. The second element of the ordered pair is the practical question *How one could* ϕ. So according to (25), for Mark to know how to swim, there must be a contextually selected mode of presentation $\mathcal{P}$ of a way w to swim such that, for some complete answer to the question *How one could swim*, the first element of which is the Fregean proposition $\langle \mathcal{P} \oplus$IS HOW ONE COULD SWIM$\rangle$, Mark knows every part of that answer.

In order to trigger the kind of quantification over modes of presentation that Kaplan (1968) and Yalcin (2015) introduce for *de re* belief reports, we need the movement from Tree A to Tree B:



Following closely Yalcin (2015), we can describe this structure as generated by movement of the quantifier word '*how*', leaving behind a trace w_2; and before the quantifier lands at its new home at the top of the syntactic tree, it first adjoins to the tree a branching node dominating a numeral (call it a binder—b_2) which matches the numerical index on the trace. Semantically, the trace w_2 will be interpreted as a variable, and the binder b_2 will serve to trigger lambda abstraction over that variable. Once such a logical form is in place, its interpretation exploits the same kind of semantic rules postulated by Yalcin (2015) for Fregean *de re* belief ascriptions. We posit two kinds of semantic interpretations: one mapping expressions to their customary sense ($[\![\ldots]\!]^{g,s}$) and one mapping expressions to the referent determined by their senses ($[\![\ldots]\!]^{g,rs}$).

The existential quantifier $\ulcorner \text{How}_{w_2} \urcorner$ introduces an existential quantification over *modes of presentation of ways to* ϕ, through what Yalcin calls **Fregean Predicate Abstraction**:

> **Fregean Predicate Abstraction (FPA)** Let β be a branching node with daughters γ and δ, where γ dominates only a numerical index i. Then, for any variable assignment g,
>
> 1. $[\![\beta]\!]^{g,rs} = \lambda x\ [\![\delta]\!]^{g^{x/i},rs}$ if defined; else:

2. $[\![\beta]\!]^{g,rs} = \lambda x\ \exists m \in C\colon M(m, x)\ \&\ [\![\delta]\!]^{g^{m/i},rs}$.

(where C is some restriction on the domain of senses, supplied by context.)

Finally, we will need the two further semantic rules of **Sense composition** and **Functional Application**, which is appropriately revised to be sensitive to either the sense of an expression ($[\![\ldots]\!]^{g,s}$) or to its referent ($[\![\ldots]\!]^{g,rs}$):

> **Functional Application (FA)** If β is a branching node with γ and δ as daughters, then for any g: (a) If $[\![\delta]\!]^{g,rs}$ is in the domain of $[\![\gamma]\!]^{g,rs}$, then $[\![\beta]\!]^{g,rs} = [\![\gamma]\!]^{g,rs}([\![\delta]\!]^{g,rs})$; (b) If $[\![\delta]\!]^{g,rs}$ is in the domain of $[\![\gamma]\!]^{g,rs}$, then $[\![\beta]\!]^{g,rs} = [\![\gamma]\!]^{g,rs}([\![\delta]\!]^{g,s})$;
>
> **Sense Composition (SC)** If β is a branching node with γ and δ as daughters, and $[\![\gamma]\!]^{g,rs}$ or $[\![\gamma]\!]^{g,s}$ is in the domain of $[\![\delta]\!]^{g,rs}$, then for any g, $[\![\beta]\!]^{g,s} = [\![\gamma]\!]^{g,s} \oplus [\![\delta]\!]^{g,s}$.

In the lexicon, '*know*' expresses a property of propositions, so that the semantics is fully Intellectualist:

$[\![\textit{know}]\!]^{g,rs,C} = \lambda p\ \lambda x$ (know (p) (x)).

'*in part*' takes an answer α and a property P into the true just in case part of that answer has that property—in this particular case, the property of being known by Mary:

$[\![\textit{in part}]\!]^{g,rs,C}$ ($[\![\alpha]\!]^{g,rs,C}$, $[\![\gamma]\!]^{g,rs,C}$)= 1 iff some part of $g(\alpha) \in [\![\gamma]\!]^{g,rs,C}$.

The sense of the predicate in the interrogative abstract '*PRO to swim*' will be indicated by 'IS HOW ONE COULD SWIM':

$[\![\textit{PRO to swim}]\!]^{g,s,C}$ = IS HOW ONE COULD SWIM.

The interrogative feature 'Π' takes the abstract $[\![\beta_x]\!]^{g,rs,C}$ into a set of true practical answers of the form $\langle p^F, \mathcal{Q}\rangle$ and then existentially quantifies over them. The answer $\langle p^F, \mathcal{Q}\rangle$ has two components—i.e., a Fregean proposition p^F and a question $\mathcal{Q}$. A little more formally, here is the contribution of the interrogative feature 'Π':

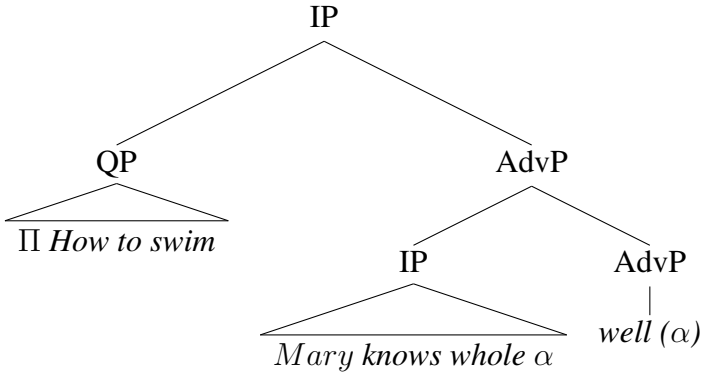
$[\![\Pi]\!]^{g,rs,C}$ ($[\![\beta_x]\!]^{g,rs,C}$, $[\![\gamma]\!]^{g,rs,C}$) = 1 iff $\exists\alpha$: $\alpha = \langle p^F, \mathcal{Q}\rangle$ (where $\mathcal{Q}$ = $\{p$: $\exists x$: p = λi ($x \in [\![\beta]\!]^{g,rs,C}$ at i)$\}$) & $p^F = \langle g(x) \oplus [\![\beta]\!]^{g,s,C}\rangle$ & $[\![\gamma]\!]^{g,rs,C}(\alpha) = 1$.

Finally, the composition proceeds as follows to reach the desired Fregean truth conditions for ungraded and graded know how ascriptions:

1. "Mark knows in part/entirely how to swim" is true in C iff
2. (BY DEFINITION OF TRUTH) $\forall g$ $[\![How\ b_2\ \Pi\ w_2$ ***PRO to swim in part/entirely*** α ***Mark knows*** $p]\!]^{g,rs,C}$ iff
3. (BY FA) $\forall g$ $[\![How]\!]^{g,rs,C}([\![b_2\ \Pi\ w_2$ ***PRO to swim in part/entirely*** α ***Mark knows*** $p]\!]^{g,rs,C})$ iff
4. (BY FPA) $\forall g$ $[\![How]\!]^{g,rs,C}(\lambda w\ \exists\mathcal{P}$: $M(\mathcal{P}, w)$ & $[\![\Pi\ w_2$ ***PRO to swim in part/entirely*** α ***Mark knows*** $p]\!]^{g^{\mathcal{P}/2},rs,C} = 1$) iff
5. (By meaning of Π, SC and simplification) $\forall g$ $[\![How]\!]^{g,rs,C}$ ($\lambda w\ \exists\mathcal{P}$: $M(\mathcal{P}, w)$ & $\exists\alpha$ ($\alpha = <p^F, \mathcal{Q}>$: $\mathcal{Q} = \{p$: $\exists x$: $p = \lambda i$ ($x \in [\![\beta]\!]^{g,rs,C}$ at i)$\}$ & $p^F = \langle g^{P/2}(w_2 \oplus [\![$***PRO to swim***$]\!]^{g,s,C}\rangle$ & for some part $p*$/every part $p*$ of α, $[\![$***Mark knows*** $p]\!]^{g^{p*/p},rs,C} = 1$)) iff
6. (By lexicon and simplification) $\forall g$ $[\![How]\!]^{g,rs,C}$ ($\exists\mathcal{P}$: $M(\mathcal{P}, w)$ & $\exists\alpha$ ($\alpha = \langle p^F,$ ***How one could swim***$\rangle$: $p^F = \langle\mathcal{P} \oplus$ IS HOW ONE COULD SWIM$\rangle$ & for some part $p*$/for every part $p*$ of α, Mark knows $p*$)) iff
7. (by FA, lexicon and simplification) There is a way to swim w and a practical mode of presentation $\mathcal{P}$ of w such that there is a practical answer $\alpha = \langle p^F,$ ***How one could swim***$\rangle$ where $p^F = \langle\mathcal{P} \oplus$ IS HOW ONE COULD SWIM$\rangle$ and Mark knows some part/every part of α.

D Qualitative Gradability

The logical form is to be represented thus:



For our purposes, here is the meaning of the adverb '*well*':

$[\![$*Well* (α)$]\!]^{g,rs,C}$ = 1 iff $[\![\alpha]\!]^{g,rs,C}$ is good relative to C.

The composition proceeds as follows:

1. '*Mark knows how to swim well*' is true in C iff

2. (BY DEFINITION OF TRUTH) $\forall g$ $[\![How_{w_2}\ b_2\ \Pi\ w_2$ ***PRO to swim entirely*** α ***Mark knows*** p ***well*** $\alpha]\!]^{g,rs,C}$ iff

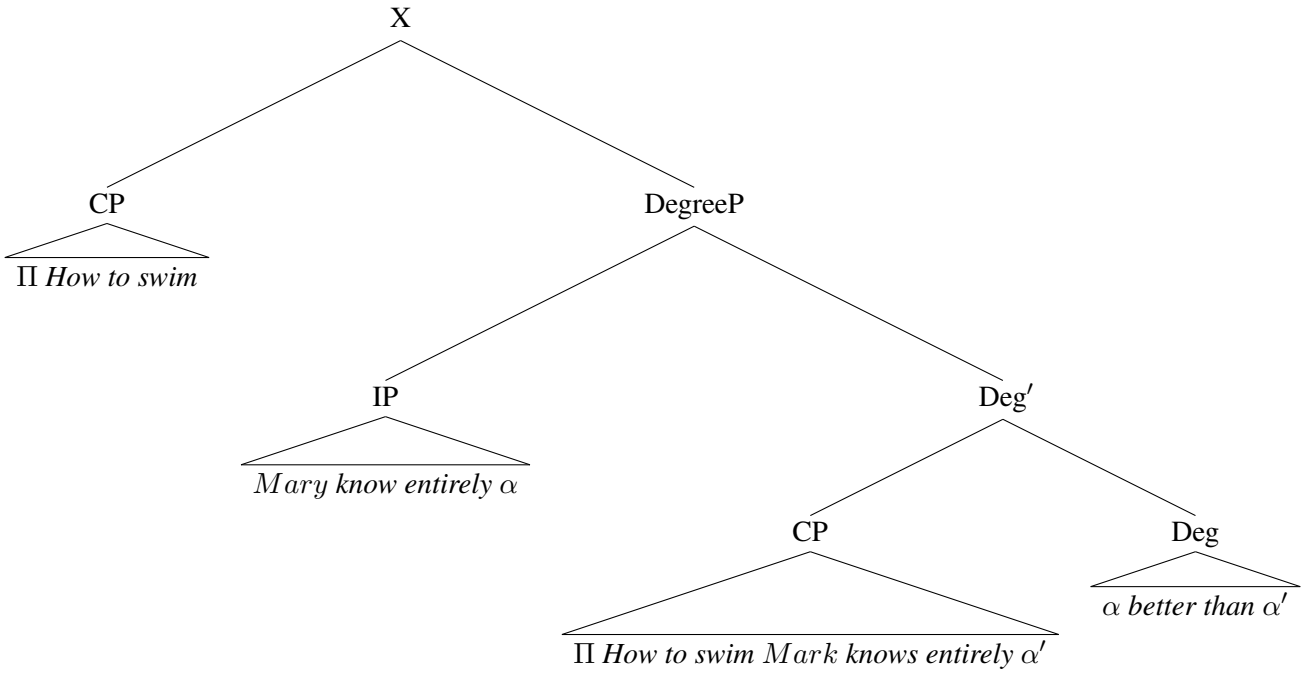
3. (As before, by FA, FPA, lexicon, SC and simplification) $\forall g$ $[\![How_{w_2}]\!]^{g,rs,C}$ ($\exists \mathcal{P}$: $M(\mathcal{P}$, $w)$ & $\exists \alpha$ (α = <p^F, ***How one could swim***>: $p^F = \langle \mathcal{P} \oplus [\![$***PRO to swim***$]\!]^{g,s,C} \rangle$ & for every part p of α, $[\![$***Mark knows*** $p]\!]^{g^{\mathcal{P}/w_2},C,rs}$ = 1 and $[\![$***well*** $(\alpha)]\!]^{g,C,rs}$ = 1) iff

4. (by lexicon and simplification) There is a way to swim w and a practical mode of presentation $\mathcal{P}$ of w such that for some practical answer α = <p^F, ***How one could swim***> where $p^F = \langle \mathcal{P} \oplus$ IS HOW ONE COULD SWIM$\rangle$, Mark knows every part of α and α is good relative to C.

What happens in a comparison, such as "Mariano Rivera knew how to close better than Trevor Hoffman knows how to close"? Recall that their logical form can be paragraphed as:

(26) There is a practical answer known by S to the question *How one could* ϕ better than *any practical answer known by* S *to the question* How one could ϕ.

And it can be represented by the following tree:



The meaning of '*better than*' arises from applying the comparative construction '*-er than*' to the meaning of '*well*'. I will spare the reader the details and will assume the following derived semantic value for '*better than*':[6]

> $[\![$*better than* (α) $(\alpha')]\!]^{g,rs,C}$ = 1 iff $[\![\alpha]\!]^{g,rs,C}$ is better (under the respects determined by C) than $[\![\alpha']\!]^{g,rs,C}$.

The composition proceeds as follows:

1. '*Mary knows how to swim better than Mark knows how to swim*' is true in C iff

2. (BY DEFINITION OF TRUTH) $\forall g$ $[\![\Pi$ *How PRO to swim entirely* α *Mary knows* p Π *How PRO to swim entirely* α' *Mark knows* p *better* $(\alpha, \alpha')]\!]^{g,rs,C}$ iff

3. (BY FA) $\forall g$ $[\![How_{w_2}]\!]^{g,rs,C}$ $([\![b_2$ Π w_2 ***PRO to swim entirely*** α ***Mary knows*** $p]\!]^{g,rs,C}$ = 1 & $[\![How_{w_3}]\!]^{g,rs,C}([\![b_3$ Π w_3 ***PRO to swim entirely*** α' ***Mark knows*** p ***better*** $(\alpha, \alpha')]\!]^{g,rs,C}$ = 1 iff

4. (BY FPA) For some way to swim w and a practical mode of presentation $\mathcal{P}$ of w, there is a practical answer $\alpha*$ = $<p^F$, *How one could swim*$>$ where p^F= $\langle \mathcal{P} \oplus$ IS HOW

[6] For more details on the compositional semantics, see Schwarzschild and Wilkinson (1990).

ONE COULD SWIM $\rangle$ such that Mary knows every part of $\alpha*$ and for every way w' to swim and practical mode of presentation $\mathcal{P}$ of w' such that there is a practical answer α** = $<q^F$, *How one could swim*$>$, Mark knows every part of α**: $[\![$*better* (α, $\alpha')]\!]^{g[\alpha*/\alpha,\alpha**/\alpha'],rs,C}$ = 1 iff

5. (By meaning of Π, lexicon, SC and simplification) For some practical answer α* to the question *How one could swim* known entirely by Mary, α* is better than any practical answer to the question *How one could swim* entirely known by Mark.

References

Abbott, B. (2013). Linguistic Solutions to Philosophical Problems: the Case of Knowing How. *Philosophical Perspectives*, 27(1):1–21.

Aloni, M. (2008). Concealed Questions under Cover. *Grazer Philosophische Studien*, 77:191–216.

Aloni, M. and Roelofsen, F. (2011). Interpreting Concealed Questions. *Linguistics and Philosophy*, 34(5):443–478.

Baker, C. L. (1969). *Indirect Questions in English*. PhD thesis, University of Illinois, Urbana.

Bengson, J. and Moffett, M. (2011). Non-Propositional Intellectualism. In Bengson, J. and Moffett, M., editors, *Knowing How: Essays on Knowledge, Mind, and Action*, pages 161–95. Oxford University Press, Oxford.

Ditter, A. (2016). Why Intellectualism still Fails. *The Philosophical Quarterly*, Online first advance access:1–15.

George, B. R. (2011). *Question Embedding and the Semantics of Answers*. PhD thesis, University of California Los Angeles.

Ginzburg, J. (1995). Resolving Questions, I. *Linguistics and Philosophy*, 18(5):459–527.

Grimshaw, J. (1979). Complement selection and the lexicon. *The Linguistic Inquiry*, 10(2):279–326.

Heim, I. and Kratzer, A. (1998). *Semantics in Generative Grammar*. Blackwell, Oxford.

Kaplan, D. (1968). Quantifying in. *Synthese*, 19:178–214.

Michaelis, L. A. (2011). Knowledge ascription by grammatical construction. In Bengson, J. and Moffett, M., editors, *Knowing how: Essays on Knowledge, Mind and Action*, pages 261–282. Oxford University Press, Oxford.

Rumfitt, I. (2003). Savoir Faire. *Journal of Philosophy*, 100:158–166.

Schaffer, J. (2007). Knowing The Answer. *Philosophy and Phenomenological Research*, 75(2):383–403.

Schaffer, J. (2009). Knowing the answer redux: Replies to Brogaard and Kappestrup. *Philosophy and Phenomenological Research*, LXXVIII:477–500.

Schwarzschild, R. and Wilkinson, K. (1990). Quantifiers in Comparatives: A Semantics of Degree Based on Intervals. *Natural Language Semantics*, 10:1–41.

Stanley, J. and Williamson, T. (2001). Knowing How. *Journal of Philosophy*, 98(8):411–444.

Wiggins, D. (2012). Practical Knowledge: Knowing How to and Knowing That. *Mind*, 121.481:97–130.

Yalcin, S. (2015). Quantifying in from a Fregean Perspective. *Philosophical Review*, 124(2):207–253.