FREE CHOICE AND EXHAUSTIFICATION: AN ACCOUNT OF SUBTRIGGING EFFECTS

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1 Introduction

Universal Free Choice (FC) items like Italian *qualsiasi/qualunque* or English FC *any*[1] (Dayal 1998, Quer 2000, Giannakidou 2001, Sæbø 2001) are felicitous in possibility statements, but need a post-nominal modifier to be felicitous in episodic sentences (licensing by a modifier is often called *subtrigging* since Dayal's (1998) revival of this term originally from LeGrand, 1975).

(1) a. #Qualsiasi/qualunque donna cadde.
'Any woman fell'
b. Qualsiasi/qualunque donna può cadere.
'Any woman may fall'
c. Qualsiasi/qualunque donna che provò a saltare cadde. (SUBTRIGGING)
'Any woman who tried to jump fell'

The goal of this article is to explain the distribution and meaning of *qualsiasi/qualunque* in the examples in (1). Universal FC items will be analysed as indefinites (*contra* Dayal, 1998). Following Aloni (2002, to appear) and Kratzer and Shimoyama (2002), I will assume that indefinites induce sets of propositional alternatives. The interpretation of FC items like *qualsiasi* will further crucially require the application of two covert operators over these sets: a universal propositional quantifier $[\forall]$ and an operator **exh** of exhaustification.

(2) $[\forall]$... **exh** (... FC ...)

The contrast between (1)-a and (1)-b will be explained by interactions between $[\forall]$, **exh** and the modal operator (Menéndez-Benito 2005). The interplay between exhaustification and the post-nominal modifier will play a crucial role in the explanation of the felicity and universal meaning of example (1)-c.

The article is structured as follows: The next section provides some background on Kratzer and Shimoyama's (2002) 'Hamblin' semantics and Menéndez-Benito's (2005) account of FC items in modal statements. Section 3 presents the main ingredients of our proposal: it defines an operation of exhaustification based on Zeevat (1994), and two standard type-shift rules (Partee and Rooth 1983, Partee 1987). Section 4 presents a first motivation for these mechanisms by applying them to the semantics of free relatives and wh-interrogatives (Jacobson 1995); and section 5, finally, discusses their main application to the phenomena of free choice. The article ends with a speculation on the status and origin of the $[\forall]$ and **exh** operators.

[1] English *any* also has a negative polarity use. For this reason in the article I focus on Italian that having different morphemes for negative polarity and free choice is a better mirror to these phenomena (Chierchia 2005).

2 Background and motivation

2.1 The variety of indefinites

Individual languages may possess a wealth of indefinite forms that relate to each other in complex ways (Haspelmath 1997). English, for example, has at least four different indefinite determiners: *a, some, any, one*. Italian has many more including *un(o), nessuno, qualche, (uno) qualsiasi/qualunque, qualsivoglia*. These various forms typically differ in distribution and interpretation, yet they do seem to have a common logical/semantic core.

In a number of recent articles (Aloni 2002, Aloni to appear, Kratzer and Shimoyama 2002) a formal analysis of indefinite meaning has been proposed with the potential to account for this variety. These studies identify the common meaning of various indefinite forms in their potential to give rise to sets of propositional alternatives, just like questions do (Hamblin 1973, Karttunen 1977, Groenendijk and Stokhof 1984).

(3) Someone/anyone/who/... fell $\mapsto$ ALT:

(only) d_1 fell	(only) d_2 fell	(only) d_3 fell	...

If I say that someone fell I suggest that I don't know who fell as much as if I ask who fell. Sets of propositional alternatives (e.g. (only) John fell, (only) Mary fell,...) are formal ways to represent this state of ignorance.

Sets of propositions can be bound by a variety of operators with different quantificational force. Examples of such operators are defined in (4) (where W is the logical space, i.e. the set of all possible words, and $A \subseteq Pow(W)$ is a set of propositions).

(4)
a. $[\exists](A) = \bigcup(A)$
b. $[\forall](A) = \bigcap(A)$
c. $[\text{Neg}](A) = W \setminus \bigcup(A)$
d. $[\text{Q}](A) = A$

The hypothesis is that different indefinite forms have emerged as an indication of necessary association with different matching operators[2]. Suppose *some* necessarily associates with $[\exists]$. This would explain its existential meaning and its distribution as 'positive polarity' item (Szabolcsi 2004). FC *any* might associate with $[\forall]$ explaining its universal meaning (Menéndez-Benito 2005). N-words in Negative Concord languages like Italian *nessuno* might associate with [Neg], interrogatives might associate with [Q] and so on.

(5)
a. $[\exists]$ (someone fell)
b. $[\forall]$ (anyone fell)
c. [Neg] (nessuno fell)
d. [Q] (who fell)
e. ...

f.

(only) d_1 fell	(only) d_2 fell	(only) d_3 fell	...

In (5), the expressions in parenthesis denote one and the same set of propositional alternatives, illustrated in (5)-f. The various propositional operators in (5)-a to (5)-e quantify over this set.

In the next section we have a closer look at Kratzer and Shimoyama's (2002) Hamblin semantics in which the analysis I defend in this article will be formalized.

[2] Association with an operator might occur either directly via syntactic agreement (Kratzer and Shimoyama 2002), or, indirectly, via lexically encoded pragmatic conditions (Aloni 2002, Aloni to appear).

2.2 Hamblin semantics for indeterminate pronouns

In a Hamblin semantics (Hamblin 1973, Kratzer and Shimoyama 2002) all expressions denote sets, mostly singleton sets of traditional denotations. E.g. the predicate *fell* of type $\langle e, \langle s,t \rangle\rangle$ will denote the singleton set containing the property FELL.

(6) $[\![\textbf{fell}]\!]_{w,g}= \{\lambda x \lambda v.\text{FELL}(x)(v)\}$

Indefinites, instead, denote multi-membered sets of individual alternatives. E.g. the denotation of *anyone*, *someone* or *who* in w is the set of humans in w.

(7) $[\![\textbf{anyone/someone/who}]\!]_{w,g} = \{x \mid \text{HUMAN}(x)(w)\}$

Via pointwise functional application, the latter set of individuals can be expanded into a set of Hamblin propositional alternatives, e.g. that Mary fell, that John fell, ...

(8) $[\![\textbf{fell}]\!]_{w,g}([\![\textbf{someone/anyone/who}]\!]_{w,g}) = \{\lambda v.\ \text{FELL}(x)(v) \mid \text{HUMAN}(x)(w)\}$

These alternatives keep growing until they reach an operator that selects them. As we saw in the previous section, differences between indefinite forms are captured by the assumption that each form can associate with a different operator. Following Menéndez-Benito (2005) I assume that universal FC items like Italian *qualsiasi* or English FC *any* associate with the universal propositional quantifier [∀], which, as we saw, when applied to a set A, yields the proposition which is true iff all propositions in A are true.

(9) $[\forall]([\![\textbf{fell}]\!]_{w,g}([\![\textbf{anyone}]\!]_{w,g}))= [\forall]$ ({that d_1 fell, that d_2 fell,...})= {that everyone fell}

Let us assume this analysis as a starting point and see what would be its predictions with respect to examples like those illustrated in (1). These predictions are summarized in (10). Assume that d_1 and d_2 are the only people who tried to jump.

(10) a. [∀](anyone fell)
b. [∀](anyone may fall)
c. [∀](anyone who tried to jump fell)

a′.

d_1 fell	d_2 fell	d_3 fell	...

b′.

$\Diamond d_1$ fall	$\Diamond d_2$ fall	$\Diamond d_3$ fall	...

c′.

d_1 fell	d_2 fell

Each sentence (10)a-c expresses universal quantification over the set of propositions (10)a′-c′ represented to its right. Therefore, (10)-a expresses the proposition that everybody fell; (10)-b the proposition that for each person x, x may fall, and (10)-c the proposition that everyone who tried to jump fell.

Although this analysis captures the universal meaning of the subtrigged case (10)-c, it does not explain its sharp contrast with (10)-a. Both sentences are predicted to be fine. Furthermore, as Menéndez-Benito (2005) observed, the meaning representation in (10)-b is not totally satisfactory, because it fails to capture the unrestricted freedom of choice expressed by the modal sentence. Consider the following scenario (Menéndez-Benito 2005, pp. 60–63):

(11) One of the rules of the card game Canasta is: when a player has two cards that match the top card of the discard pile, she has two options: (i) she can take all the cards in the discard pile or (ii) she can take no card from the discard pile (but take the top card of the regular pile instead).

In this scenario, (12) is judged false. An analysis along the lines of (10)-b, however, would predict (12) to be true.

(12) In Canasta, you can take any of the cards from the discard pile when you have two cards that match its top card.

To solve this problem, Menéndez-Benito (2005) assumes that the interpretation of universal free choice items (or maybe of all indefinites) involve the application of an exclusiveness operator which transforms Hamblin alternatives into sets of mutually exclusive propositions. Her predictions for our examples are summarized in (13).

(13) a. $[\forall]$(**Excl**(anyone fell)) a$'$. | only d_1 fell | only d_2 fell | only d_3 fell | ... |

b. $[\forall](\Diamond($**Excl**(anyone fall))) b$'$. | $\Diamond$ only d_1 fall | $\Diamond$ only d_2 fall | $\Diamond$ only d_3 fall | ... |

c. $[\forall]$(**Excl**(anyone who tried to jump fell)) c$'$. | only d_1 fell | only d_2 fell |

Menéndez-Benito's analysis brilliantly explains why unsubtrigged *any* is out in (13)-a, and gives a much more precise representation of the truth conditions of the modal sentence in (13)-b. Example (13)-a involves universal quantification over a set of mutually inconsistent propositions, therefore it cannot receive a consistent interpretation. The propositions universally quantified over in (13)-b, instead, are mutually consistent. Crucial is the fact that they have been expanded by the possibility operator. Therefore (13)-b is fine, and the unrestricted liberty of choice expressed by (1)-b or (12) receives an adequate representation. However, how it stands this analysis does not directly extend to explain the subtrigged cases. The most obvious representation (13)-c would receive an inconsistent denotation because, as in (13)-a, **Excl** occurs directly in the scope of the universal operator. By the introduction of **Excl**, or so it seems, we lose the intuitive analysis of subtrigged *any/qualsiasi* found in (10)-c. While the unsubtrigged and modal cases (a) and (b) seem to require sets of mutually exclusive propositions, the subtrigged case (c) doesn't. A question then arises: why **Excl** does not seem to play a role when a post-nominal modifier is present? My answer to this question will assume, rather than **Excl**, a much more general and independently motivated notion **exh** of exhaustification.

3 Proposal

Operations of exhaustification have been argued to be at work in the semantics of a large variety of constructions involving interrogative pronouns, e.g. wh-questions (Groenendijk and Stokhof 1984), free relatives (Jacobson 1995), correlatives (Dayal 1995) and so on. In this article I would like to propose that they play a role in the semantics of free choice indefinites as well. This would not be surprising since many languages employ wh-morphology to express free choice meanings, e.g. Italian *chi-unque/qual-unque*. On this issue see also (Giannakidou and Cheng 2006).

In its most general form, exhaustification is an operation that given a *domain A* and a *property P* returns a value. Here, the output will be a set of pairs (x, v) where, roughly, x is the maximal plural entity from A who satisfies P in v.

Following a number of authors, notably Jacobson (1995), I assume that the output of this operation of exhaustification can undergo two sorts of type-shift rules:

(i) SHIFT$_e$, yielding maximal plural entities (ordinary DP denotations);

(ii) SHIFT$_{\langle s,t \rangle}$, yielding sets of mutually exclusive propositions (in a Hamblin semantics, IP or Q denotations).

The core idea of my proposal is that, in the unsubtrigged and modal cases (14)-a and (14)-b, exhaustification is forced to produce sets of mutually exclusive propositions, because it must apply at the IP level.

(14) a. [$_{IP}$ Any woman fell]
b. [$_{IP}$ Any woman may fall]
c. [$_{DP}$ Any woman who tried to jump] fell.

In the subtrigged case (14)-c, instead, exhaustification can yield maximal sets of individuals because it can apply inside a DP boundary. These sets can then combine with the rest of the sentence to yield sets of mutually consistent propositions that can eventually be bound by [∀] without contradiction. The presence of the post nominal modifier 'who tried to jump' is crucial for the latter possibility because it supplies, inside the DP boundary, the second argument essential for the application of exhaustification. In the following sections, this proposal is worked out in details. The next section defines the notion **exh** of exhaustification. Section 3.2 introduces the two type shift rules SHIFT_e and $\text{SHIFT}_{\langle s,t\rangle}$. Section 3.3 shows what happen when these two rules apply to the output of exhaustification.

3.1 Exhaustification

When told *John and Mary called*, people normally conclude that nobody else called. In the linguistic literature, this is called an exhaustive interpretation of the sentence (Groenendijk and Stokhof 1984, von Stechow and Zimmermann 1984). Exhaustification is a very smart notion. When told *John can spend 150 euro*, people normally conclude that John cannot spend *more*. But when told *John can live on 150 euro*, they conclude that John cannot live on *less*. These exhaustivity inferences are normally taken to obtain by *pragmatic* reasoning (Spector 2003, Schulz and van Rooij 2006). However, exhaustive values (maximal/minimal values with respect to some order) have also been argued to play a crucial role in the *semantics* of a large number of constructions including free relatives (e.g. *What John earns is less than what John can live on* is normally interpreted as 'the *maximal* amount of money that John earns is less than the *minimal* amount of money that John can live on'), but also embedded questions, correlatives, plurals, comparatives, degree relatives and so on (Grosu and Landman 1998). In this article I defend the view that exhaustification plays a crucial role in our interpretation of free choice indefinites as well. In what follows we give a formal characterization of this notion.

In the formalization we assume a domain of plural individuals (Scha 1981, Link 1983, Landman 1989) that can be characterized, for example, as the power set $Pow(AT)$ of a given set of atoms AT. For simplicity, to refer to the elements of our domain, I will write a instead of $\{a\}$ and $a+b$ instead of $\{a,b\}$. And, following standard notation, I will write $\alpha \leq \beta$ for $\alpha \subseteq \beta$, and $AT(\alpha)$, if $|\alpha| = 1$. Note that for reasons that will become clear later the empty set, $\emptyset$, is included in our domain, as well as in the denotation of all predicates of the language.

To formally characterize exhaustification, we will build on Zeevat's (1994) notion of an exhaustive value defined in terms of entailment, although our analysis is also compatible with other proposals, notably Schulz and van Rooij (2006).[3] Zeevat's notion can be roughly characterized as follows.

[3]Schulz and van Rooij's (2006) definition of exhaustification improves on Groenendijk & Stokhof's (1984) classical definition in terms of predicate circumscription. Roughly, x exhaustively satisfies P (wrt A) in w iff (x is in A &) $P(x)$ is true in w, and for no v: $P(x)$ is true in v and $v <_P^{(A)} w$, where $v <_P^{(A)} w$ iff v and w agree on everything except the interpretation they assign to P, and it holds that $[P](v)(\cap A) \subset [P](w)(\cap A)$. A proper comparison between Zeevat's and this notion of exhaustivity is beyond the scope of this article.

(15) A value x exhaustively satisfies a property P wrt a domain A iff x is in A, $P(x)$ is true, and for all y in A: if $P(y)$ is true, then $P(x)$ entails $P(y)$.

Illustrations Normally exhaustive values are maximal plural entities. E.g.

(16) a. A: people $\{\emptyset, a, b, d, a+b, a+d, d+b, a+b+d\}$
b. P: falling $\{\emptyset, a, b, c, a+b, a+c, c+b, a+b+c\}$
c. x: the max collection of people that fall $a+b$

The plural entity $a+b$ exhaustively satisfies the property of falling as specified in (16)-b wrt the domain of people as specified in (16)-a because $a+b$ is the unique x in the domain such that (i) x falls and (ii) that x falls entails that y falls, for each other falling members y of the domain, i.e., in this case, $\emptyset$, a and b.

With scalar predication other exhaustification effects show up:

(17) a. A: amount of money $\{0, 50, 100, 150, ...\}$
b. P: λx[J can live on x] $\{100, 150, 200, ...\}$
c. x: the min amount of money that J can live on 100

(18) a. A: amount of money $\{0, 50, 100, 150, ...\}$
b. P: λx[J can spend x] $\{0, 50, 100, 150\}$
c. x: the max amount of money that J can spend 150

The exhaustive value in (18) is maximal because if you can spend 150 euro, then you can also spend 100 euro. In (17), instead, we have the opposite effect, because the entailment relation is reversed: if you can live on 100 euro, you can also live on 150 euro and not the other way around.

In our formalization, exhaustification **exh** is an operation that takes an expression α of type e (e.g. *who* or *anyone*), providing the domain A, and a predicate $\mathbf{P}$ of type $\langle e, \langle s, t \rangle \rangle$, providing the property P, and returns an expression $\mathbf{exh}[\alpha, \mathbf{P}]$ of type $\langle e, \langle s, t \rangle \rangle$ denoting the property of exhaustively satisfying P wrt A:

(19) a. $\alpha_e \mapsto A$
b. $\mathbf{P}_{\langle e, \langle s, t \rangle \rangle} \mapsto \{P\}$
c. $\mathbf{exh}[\alpha, \mathbf{P}]_{\langle e, \langle s, t \rangle \rangle} \mapsto \{\lambda x \lambda v[x \text{ exhaustively satisfies } P \text{ wrt } A \text{ in } v]\}$

The semantics of (19)-c is worked out in (20) using Zeevat's notion of exhaustive satisfaction, assuming, as in (19), that $[\![\alpha]\!]_{w,g} = A$, and $[\![\mathbf{P}]\!]_{w,g} = \{P\}$.

(20) $[\![\mathbf{exh}[\alpha, \mathbf{P}]]\!]_{w,g} = \{\lambda x \lambda v.\ x \in A \ \&\ P(x)(v) \ \&\ \forall y \in A : P(y)(v) \ \Rightarrow\ P(x) \subseteq P(y)\}$

$\mathbf{exh}[\alpha, \mathbf{P}]$ is an expression of type $\langle e, \langle s, t \rangle \rangle$. In the next section we discuss two standard operations to shift this predicative type into the individual and propositional types.

3.2 Type-shift principles

Since the seminal works of Partee and Rooth (1983) and Partee (1987) type-shift principles have entered the landscape of formal semantics. These principles apply when a category/type shift is required in order to combine meanings by available compositional rules. In this section I will present two type-shift principles mapping the property type $\langle e, \langle s, t \rangle \rangle$ to (i) the individual type e

and (ii) the propositional type $\langle s,t\rangle$. Section 4 will then motivate these principles by applying them to explain the semantics of free relatives and wh-questions (Jacobson 1995).

The first principle that I will call $\textsc{shift}_e$ is an intensional version of the well-known *iota*-rule mapping a property into the unique individual having that property in the world of evaluation w_0, if there is indeed just one, and undefined otherwise (Partee 1987).

(21) $\textsc{shift}_e : \langle e,\langle s,t\rangle\rangle \rightarrow e$ (from properties to **entities**)

a. $\mathbf{P} \rightarrow \iota x[\mathbf{P}(x)(w_0)]$

b. $\{P\} \rightarrow \{d\}$ if d is the unique P in w_0, undefined otherwise

$\textsc{Shift}_e$ maps an expression $\mathbf{P}$ of the predicative type $\langle e,\langle s,t\rangle\rangle$ into the expression $\iota x[\mathbf{P}(x)(w_0)]$ of the individual type e. As it is well-known, the iota-operator combines with an open sentence to give an entity-denoting expression, denoting the unique satisfier of that open sentence if there is just one, and failing to denote otherwise.

The second principle that I will call $\textsc{shift}_{\langle s,t\rangle}$ is a modified version of Kartunnen's (1977) 'Hamblin' question formation rule. $\textsc{Shift}_{\langle s,t\rangle}$ maps a property into a set of propositional alternatives expressing individual instantiations of that property. To define such a rule we need to extend the original Hamblin language with an operator $\hat{x}$ that combines with an open sentence $\phi(x)$ to give an expression $\hat{x}[\phi(x)]$ of the same type as x, denoting the set of alternative satisfiers of that open sentence. For example $\hat{x}[\mathbf{human}(x)(w)]$ is an expression of type e denoting the set $\{x \mid human(x)(w)\}$. As it is usual in a Hamblin semantics, the latter denotation should not be thought of as a property, but as a set of individual alternatives. The hat-operator is employed in our definition of the $\textsc{shift}_{\langle s,t\rangle}$ rule as follows.

(22) $\textsc{shift}_{\langle s,t\rangle}$: $\langle e,\langle s,t\rangle\rangle \rightarrow \langle s,t\rangle$ (from properties to **propositions**)

a. $\mathbf{P} \rightarrow \hat{p}\,[\exists x(\mathbf{P}(x) = p \wedge p \neq \emptyset)]$

b. $\{P\} \rightarrow \{d_1$ is P, d_2 is P, d_3 is P, ...$\}$

$\textsc{Shift}_{\langle s,t\rangle}$ maps an expression $\mathbf{P}$ of the predicative type $\langle e,\langle s,t\rangle\rangle$ into the expression $\hat{p}\,[\exists x[\mathbf{P}(x) = p \wedge p \neq \emptyset]]$ of the propositional type $\langle s,t\rangle$. The latter denotes the set of alternative satisfiers of the open sentence $\exists x[\mathbf{P}(x) = p \wedge p \neq \emptyset]$, i.e. the set of propositions {that d_1 is P, that d_2 is P, that d_3 is P, ...}.

3.3 Exhaustification and type-shift principles

In the previous two sections we have introduced an exhaustification operation **exh** yielding properties and two type-shift rules $\textsc{shift}_e$ and $\textsc{shift}_{\langle s,t\rangle}$ mapping properties to individuals and (alternative) propositions respectively. Observe now what happens when these two type-shift rules apply to the output of exhaustification.

$\textsc{Shift}_e$ applied to $\mathbf{exh}[\alpha,\mathbf{P}]$ is always defined and yields exhaustive values, i.e., usually, maximal plural entities.

(23) a. $\textsc{shift}_e(\mathbf{exh}[\alpha,\mathbf{P}])$

b. {the maximal plural entity from α satisfying P in the world of evaluation w_0}

$\textsc{Shift}_{\langle s,t\rangle}$ applied to $\mathbf{exh}[\alpha,\mathbf{P}]$ yields sets of mutually exclusive propositions. Since the emptyset is included in our domain, these sets form partitions of the logical space (Groenendijk and Stokhof 1984).

(24) a. $\text{SHIFT}_{\langle s,t \rangle}(\mathbf{exh}[\alpha, \mathbf{P}])$
b. {nobody is P, only d_1 is P, only d_2 is P, only d_1 & d_2 are P, ... }

In the following two sections we put these notions at work. Section 4 motivates these operations by applying them to explain the semantics of free relatives and wh-interrogatives. Section 5 discusses the main application to the modal and subtrigging effects of FC items.

4 Independent motivation: Free relatives and wh-interrogatives

Consider the following examples of a free relative and a wh-interrogative clause.

(25) a. **Free relative:** John helped [$_{DP}$ who fell]
b. **Wh-interrogative:** John knows [$_{Q}$ who fell]

Building on Cooper (1983) and Jacobson (1995) we assume that free relatives and wh-interrogatives like *who fell* in (26)-a and (26)-b are born with the same meaning, a predicative meaning, but type shift differently: free relatives type-shift into an entity-denoting expression, wh-interrogatives into a proposition-denoting one.

(26) a. who fell — type: $\langle e, \langle s,t \rangle \rangle$
b. (John helped) [$_{DP}$ who fell] — type: e
c. (John knows) [$_{Q}$ who fell] — type: $\langle s,t \rangle$

The common meaning (26)-a of (26)-b and c is an exhaustive property of type $\langle e, \langle s,t \rangle \rangle$[4] denoting the set of pairs (x, v) where x is the maximal collection of people who fell in v.

(27) who fell
a. **exh**[who, fell] — type: $\langle e, \langle s,t \rangle \rangle$
b. {$\lambda x \lambda v$. x is the maximal collection of people who fell in v}

In the case of free relatives, this property can type-shift into a DP denotation via the SHIFT_e rule. In the case of wh-interrogatives, it will type shift into a Q denotation via the $\text{SHIFT}_{\langle s,t \rangle}$ rule. Let us have a closer look.

Free relatives Since by definition of exhaustification λx. **exh**[who, fell]$(x)(v)$ is guaranteed to be at most a singleton set for each v, SHIFT_e can always apply in this case and yields an expression of type e denoting the maximal collection of people who fell in the world of evaluation w_0.

(28) (John helped) [$_{DP}$ who fell]
a. $\text{SHIFT}_e(\mathbf{exh}[\text{who, fell}])$ — type: e
b. {the maximal collection of people who fell in w_0}

Via point-wise functional application this denotation combines with the denotation of the rest of the sentence to yield the singleton set containing the proposition that John helped the people who fell. Eventually this set will be bound by [Q], the operator wh-pronouns necessarily associate

[4]Cf. the notion of an *abstract* in Groenendijk and Stokhof (1984), and the interpretation assigned to wh-interrogatives in the structured meaning approach (e.g. von Stechow 1991).

with. As we saw in (4), [Q] is the identity function. Therefore, as illustrated in (29), this analysis explains the definite reading that the free relative obtains in this sentence.

(29) a. John helped $[_{DP}$ who fell]
b. [Q] (**helped**(j)(SHIFT$_e$(**exh**[who, fell])))
c. {that John helped the people who fell in w_0}

Free relatives, however, sometimes also have a universal reading as illustrated by the following example from Grosu and Landman (1998).

(30) We will veto three-quarters of whatever proposals you make.
a. Of the proposals: three-quarters won't make it. (definite)
b. For each proposal: three-quarters of it will be vetoed. (universal)

On this account, the difference between (30)-a and b can be captured if we assume that the latter is further bound by a propositional universal quantifier.

(31) We will veto three-quarters of whatever proposals you make.
a. [Q](**P**(SHIFT$_e$(**exh**[whatever, **S**]))) (definite)
b. [∀]([Q](**P**(↓SHIFT$_e$(**exh**[whatever, **S**])))) (universal)

As we saw, (31)-a, that denotes a singleton set of propositions, immediately characterizes the definite reading of the sentence. To characterize the universal reading, we further apply [∀]. Universal quantification over a singleton set, however, is vacuous. To give content to this quantification, we need to assume a further operation ↓ that maps plural individuals back into their atomic elements.

(32) a. $[\![\downarrow \alpha_e]\!]_{w,g} = \{x \mid \exists y \in [\![\alpha]\!]_{w,g} \;\&\; x \leq y \;\&\; AT(x)\}$

(33) Illustration:
a. $[\![\alpha]\!]_{w,g} = \{a+b\}$ a singleton set of plural entities
b. $[\![\downarrow \alpha]\!]_{w,g} = \{a,b\}$ a multi-membered set of atomic alternatives

This operation is triggered in this approach by the presence of the universal quantifier, i.e. it applies only when it can serve to avoid vacuous universal quantification.[5] We turn now to the case of wh-questions.

Wh-interrogatives In the case of wh-interrogatives, exhaustive properties type-shift into a Q denotation of type $\langle s,t\rangle$ via applications of the SHIFT$_{\langle s,t\rangle}$ rule. As we saw, when applied to the output of **exh**, SHIFT$_{\langle s,t\rangle}$ yields partitions of the logical space.

(34) (John knows) $[_Q$ who fell]
a. SHIFT$_{\langle s,t\rangle}$(**exh**[who, fell]) type: $\langle s,t\rangle$
b. {nobody fell, only d_1 fell, only d_2 fell, only d_1 & d_2 fell, ... }

[5] We need to assume that ↓ cannot apply unless triggered by [∀], otherwise we would wrongly predict the availability of a third existential reading for sentences like (30) given by [∃]([Q](**P**(↓SHIFT$_e$(**exh**[whatever, **S**])))). This and other issues, e.g. the role played by *ever* in these constructions, deserve further investigation, but unfortunately must be left to another occasion.

Questions and assertions have the same type in this account as it is standard in a Hamblin semantics, namely the propositional type $\langle s,t \rangle$. Both denote sets of propositions (*contra*, e.g. Groenendijk and Stokhof 1984). Their difference is that while assertions denote singleton sets, questions, typically denote multi-membered sets, explaining, for example why the latter cannot be assigned a truth value. Our account, however, depart from the original Hamblin's proposal in that we have assumed that questions denote partitions, like in Groenendijk and Stokhof's theory.[6] In what follows I would like to show that this framework that assumes Groenendijk and Stokhof partitions in a Hamblin semantics offers us an original way of accounting for question and proposition embedding verbs like *know*, *believe* and *wonder*.

It is well known that *know, believe* and *wonder* differ with respect to their embedding potential. As illustrated in (35), *believe* can embed only propositions, *wonder* only questions, and *know* can embed both questions and propositions.

(35) a. John believes that Mary fell/# who fell.
b. John wonders who fell/# that Mary fell.
c. John knows who fell/that Mary fell.

In this framework we can capture this contrast as follows.

Let $\text{Bel}_x(A)$ be interpreted as standard in terms of truth in all worlds compatible with what x believes. We propose to account for the difference between *know, believe* and *wonder* in terms of Bel_x, the common core of these verbs, in combination with different propositional quantifiers. Let us start with *believe*. We propose to analyze *believe* in terms of Bel_x in combination with the existential quantifier $[\exists]$ as illustrated in (36).

(36) a. x believes A
b. $\text{Bel}_x[\exists](A)$

(36)-b expresses the proposition that x believes that there is at least one true proposition in A. If A has a unique member p, as it is the case when *believe* embeds an indicative sentence, (36)-b says that x believes that p. If A, instead, denotes a partition of the logical space, the proposition denoted by (36)-b is trivially true.[7] If questions denote partitions, as we have assumed here, this analysis explains why they are deviant in the scope of *believe*.

Let us turn to *wonder*. While *believe* involves $[\exists]$, let us assume *wonder* involves [Neg] and [Q].

(37) a. x wonders A
b. $[\text{Neg}](\text{Bel}_x[\text{Q}](A))$

Recall from (4) that [Q] is the identity function and [Neg] is a negative universal quantifier. (37)-b then expresses the proposition that x does not believe any of the propositions in A. Since universal quantification requires a multi-membered domain, A needs to contain a source of genuine alternative sets. The presence of [Q] selects wh-interrogatives as unique possible candidate for this task. Other indefinites like, for example, *anyone/someone* associating with $[\forall]/[\exists]$ would lead to the following representation $[\text{Neg}](\text{Bel}_x[\text{Q}]([\forall]/[\exists](A)))$ that involves vacuous quantification. We correctly predict, therefore, that A needs to be a question in this case.

[6]The present analysis is not completely equivalent to Groenendijk & Stokhof's (1984) partition theory of questions in that it only captures the *de re* reading of questions like *Which students called*. To get the *de dicto* reading we would have to change the original Hamblin semantics. Furthermore, the present account does not directly apply to polar and multi-constituent questions. All these issues definitely deserve further investigation.

[7]Unless we assume, contrary to standard modal logic for belief, a non-serial accessibility relation.

Finally let us turn to *know*. I would like to propose the following analysis for *know*, where [true] is defined as in (39).

(38) a. x knows A
b. $\text{Bel}_x[\text{true}](A)$

(39) $[\![[\text{true}](A)]\!]_{w,g} = \{\iota p.p \in A \ \& \ w \in p\}$

Intuitively, x knows A is analyzed as x believes the unique true proposition in the set denoted by A, if there is one, undefined otherwise. If *know* embeds an indicative sentence, as in (40), A denotes a singleton set, whose unique member is presupposed to be true capturing thus the factive nature of the embedding verb.

(40) a. John knows that Mary fell.
b. $\text{Bel}_j[\text{true}](\mathbf{fell}(m))$

Consider now the case of an embedded interrogative.

(41) a. John knows who fell.
b. $\text{Bel}_j[\text{true}]([\text{Q}](\text{SHIFT}_{\langle s,t\rangle}(\mathbf{exh}[\text{who, fell}])))$

In (41)-b, exhaustivity applies triggered by the presence of the wh-pronoun. The clause **exh**[who, fell] type-shift into a question denotation via the $\text{SHIFT}_{\langle s,t\rangle}$ rule. The resulting partition undergoes first the [Q] operation, triggered by the wh-pronoun, which leaves it unaltered, and then the [true] operation that selects the unique true proposition in it. Given the nature of partitions, [true] will always be defined and yield the unique true exhaustive answer to the question. Sentence (41)-a then means John believes the unique true exhaustive answer to the question *who fell?*, capturing, in this way, what is sometimes called the weak and strong exhaustivity of *know* illustrated by the validity of the following entailments:

(42) a. John knows who fell & Mary fell. ⇒ (weak exhaustivity)
b. John knows that Mary fell.

(43) a. John knows who fell & Mary didn't fall. ⇒ (strong exhaustivity)
b. John knows that Mary didn't fall.

In the next section we turn to free choice, the main application discussed in this article.

5 Main application: modal and subtrigging effects of FC items

Consider again, our starting examples:

(44) a. #[$_{IP}$ Qualsiasi/qualunque donna cadde]
'Any woman fell'
b. [$_{IP}$ Qualsiasi/qualunque donna può cadere]
'Any woman may fall'
c. [$_{DP}$ Qualsiasi/qualunque donna che provò a saltare] cadde.
'Any woman who tried to jump fell'

The main idea of the present article is that the same mechanisms playing a role in the semantics of free relatives and wh-interrogatives can also be applied here to explain the meaning and distribution of *qualsiasi/qualunque* in these examples.

On the present proposal, FC items trigger the application of **Exh**, just like wh-words do. In the unsubtrigged cases (44)-a and -b, exhaustification must apply at the IP level, and just like in the case of wh-interrogatives, $\text{SHIFT}_{\langle s,t\rangle}$ applies and generates sets of mutually exclusive propositions. In the subtrigged cases (44)-c, instead, given the presence of the post-nominal modifier, exhaustification can apply at the DP level. As in the case of free relatives with universal force, SHIFT_e and $\downarrow$ apply and generate sets of individuals. These are the proposed analyses for our three sentences:

(45) a. $[\forall](\text{SHIFT}_{\langle s,t\rangle}(\textbf{exh}[\text{anyone, fell}]))$ a′. | nobody fell | only d_1 fell | only d_2 fell | ... |

b. $[\forall](\Diamond(\text{SHIFT}_{\langle s,t\rangle}(\textbf{exh}[\text{anyone, fall}])))$ b′. | $\Diamond$ nobody fell | $\Diamond$ only d_1 fall | $\Diamond$ only d_2 fall | ... |

c. $[\forall](\downarrow\text{SHIFT}_e(\textbf{exh}[\text{anyone, who tried to jump}])\ \text{fell})$ c′. | d_1 fell | d_2 fell |

In the first two structures the value produced by exhaustification undergoes the $\text{SHIFT}_{\langle s,t\rangle}$ rule yielding the partition represented in (45)a′. In (45)-a, each alternative in this partition is stated to be true resulting in a contradiction. This explains why universal FC items are out in plain episodic sentences. In (45)-b′ the element of the partition are further expanded by the modal operator. Universal quantification in this case does no longer result in a contradiction. For these sentences, we obtain a stronger meaning than the one predicted by Menéndez-Benito (2005). For example, the possibility that nobody falls follows from (45)-b in our analysis, but not on Menéndez-Benito's account of a sentence like (44)-b (cf. (13)-b). I am not sure what the intuitions are here. If Menéndez-Benito is right, at least for Spanish, we can easily match her predictions by putting restrictions on the cardinality of the objects quantified over in the $\text{SHIFT}_{\langle s,t\rangle}$ rule (cf. definition (22)). Finally, in the subtrigged case (45)-c, exhaustification crucially occurs inside the DP. Therefore, the value it produces undergoes the SHIFT_e rule yielding as output in w the sum of people who tried to jump in w. To avoid trivial quantification, $\downarrow$ applies to this sum to produce a set of singular individuals. The VP denotation $[\![\textbf{fell}]\!]_{w,g}$ applies to the latter set producing the set of Hamblin alternatives represented in (45)-c′. Since this set occurs in the scope of a universal operator, the sentence obtains the desired interpretation: *everyone* who tried to jump fell.

6 The status of [∀] and exhaustification: a speculation

In the previous section we have proposed the following analysis for a sentence like (46)-a.

(46) a. Qualsiasi donna può cadere. 'Any woman may fall'

b. $[\forall](\Diamond(\text{SHIFT}_{\langle s,t\rangle}(\textbf{Exh}[\text{any woman, fall}])))$

A question that arise is where do the operators [∀] and **Exh** originate. Somehow speculatively, in this last section, I would like to propose a pragmatic origin for these covert operations.

A number of authors have shown that from (47)-a, which can be taken as the plain logical rendering of (46)-a, we can obtain via purely conversational/pragmatic means the free choice implicature in (47)-b (Aloni 2006).

(47) a. plain existential sentence: $\Diamond\exists x\ \textbf{fall}(x)$

b. conversational implicature: $\forall x\Diamond\text{ONLY}_x(\textbf{fall}(x))$

Specialized free choice morphology might have emerged as result of a process of grammaticalization of these originally pragmatic inference. We may hypothesize at least three diachronic stages wherein languages gradually developed free choice morphology (cf. Levinson 2000, ch. 4, on the development of reflexive pronouns):

stage 1 Languages with no specialized free choice morphology

stage 2 Languages in which emphatic indefinites may prefer free choice interpretations

stage 3 Languages with free choice morphology

Haspelmath (1997) cites a considerable number of languages which appear to do without specialized words or morphemes that encode free choice meanings, and, therefore, appear to exemplify stage 1. A language may be said to have reached stage 2 when it has developed a more or less specialized expression for free choice uses. These expressions are not true free choice items, because they are not necessarily interpreted as such. An example of a stage 2 language might be German. The emphatic expression being *irgendein*, which must be stressed to receive a free choice interpretation (Haspelmath 1997, e.g. p. 127), and whose free choice effects are defeasable (Kratzer and Shimoyama 2002). Italian and other Romance languages appear to be examples of stage 3 languages with specialized free choice morphology. In these languages, the originally pragmatic inference (47)-b has been integrated in the semantic component of the sentence as in (46)-b. The employment, to this purpose, of mechanisms that are widely held to play a role in the semantics of questions (propositional quantification, propositional alternatives, exhaustification) does not come as a surprise given the important role of wh-morphology in forming free choice items in many of the languages of the world.

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