Semantic modulation. Modelling nouns of entities

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Summary: This work presents a theoretical model aimed to account for several cognitive mechanisms crucial for lexical generation or selection. A system of categories and transformations is posited to account for the different modes of reference to entities in the construction of discourse. This model synthesises and integrates already existent accounts of cognitive categories and transformations in a unified directional construct. In this paper the model is applied to Catalan.

∎ 1 Introduction

It is obvious that, when we speak, we can refer to the same things with different words, depending on our communicative needs. Imagine the detached leg of a wooden chair. We could refer to it precisely as *a leg of a chair*, but also as *a wooden stick*, *a stick*, or simply *wood*.

It is also an obvious and a kind of symmetric fact that we can use the same word to refer to things closely related but actually different. We are not speaking now about the somewhat clear distinctions established by polysemy, but rather of more subtle forms of modulation of the meaning of words – often not reflected in dictionary entries. For example, in Catalan, it is customary to use the word *cervesa* ('beer') in any of the following phrases: *posa'm una cervesa* ('get me a beer'), *posa'm més cervesa* ('get me more beer'), *la cervesa és bona per la salut* ('beer is good for health'), or *les millors cerveses són les alemanyes* ('German beers are the best in the world').

I have already analysed separately these two phenomena in Climent (1998) and from the point of view of the formal representation of partitive nouns in Climent (2001). Here, I formulate a unified model which I call *semantic modulation*, by which various phenomena that have been earlier theorised separately and with different purposes are now presented as a single integrated network of mechanisms of conceptual conversion

between lexical categories. Cognitive reality is postulated for such mechanisms; therefore, the present work falls within the theoretical framework of cognitive linguistics. The model is limited to common nouns naming entities, leaving aside those that denote events or processes.

Specifically, I propose to enhance the traditional descriptions of nominal classes by assuming the hypotheses that (a) many linguistic units emerge from image schemas (Johnson, 1987), and (b) the operations of recategorisation between them correspond to cognitive operations of conversion (Talmy, 2000 and Lakoff, 1987) or conceptual blending (Fauconnier, 1994) of image schemas; and I posit that (c), overall, these categories and conversions form a coherent system able to account for systematic changes or variations on the meaning of nouns, including phenomena such as regular polysemy, parasynonymy, metonymy, individuation, multiplexing, or generic reference. I also posit that these transformations start from an initial category which is schematic of each entity and consist in adapting its meaning to an active conceptual domain in discourse (i.e. to designate a concept in it) using the lexical tools accessible to the speaker at that moment.

This work is applied to Catalan although for ease of exposition I will give the examples only in English when the linguistic effects are the same in both languages.

∎ 2 Noun classes in descriptive grammar

An important dimension of the semantic elasticity of words has been described, for example, in Croft and Cruse (2004: 116), as "sub-sense units with near-sense properties", which include *facets*, *microsenses*, or the dimensions of Pustejovsky's (1995) *qualia structure*. However, the type of lexical elasticity that I present here under the name of *semantic modulation* is more basic and systematic, and as such, it has been reflected in descriptive grammars of Catalan and Spanish – e.g. Solà et al. (2002); Bosque and Demonte (1999) – in the form of major classes of nouns, mainly dichotomous (*countable–uncountable [or mass]*, *individual–collective*, *concrete–abstract*), which coexist with special categories, such as *quantifier nouns* or *event nouns*, and special functions, such as the generic reference. The members of each of these classes respond to certain grammatical behaviours: conditions on pluralization,[1] restrictions on combinations with specifiers, or acceptance

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1   Other nouns with special conditions of number marking, such as *pluralia tantum*, singular nouns with plural value and others are described in Alcina and Blecua (1975: 530–535).

of combinations with certain predicates (prepositions, verbs) – among others.

In addition, speakers, naturally and unconsciously, perform various operations that Bosque (1999) calls *recategorisation*, Climent (1998) *reference alternations*, Talmy (2000, and previous work) *intercategorial conversion* and Lakoff (1987) *image-schema transformations*; i.e. systematic changes of class by which, for instance, a noun originally countable acquires the grammatical features of a mass noun and as well a new denotation congruous with this latter class.

■ 3 Theoretical framework

This study falls within the theoretical framework of cognitive linguistics and takes as basic tools the notions of *conceptual* or *image schemas* (Johnson, 1987; Lakoff, 1987; Langacker, 1987; Talmy, 2000) in relation to those of *boundedness* and *multiplexity* (Jackendoff, 1991; Talmy, 2000). In this section I will summarize very briefly those ideas which are relevant for my work.

■ 3.1 Image schemas

Image schemas (Johnson, 1987) are defined as experiential *gestalts* that emerge from sensory-motor activity; for example, when we manipulate objects, orient ourselves spatially and temporally, or direct our perceptual focus. They are established in the mind as patterns of these experiences, but not as static (propositional) conceptual knowledge, for which reason they radically differ from mental images or schemas. According to Johnson (1987: 30) they "are a primary means by which we construct or constitute order and are not mere passive receptacles into which experience is poured".[2] According to Lakoff (1987: 453) "they are neither context-bound, nor specific, nor conscious, nor effortful. […] They are relatively abstract schemas that organize what can be perceived and visualized, but they themselves cannot be directly visualized in the way a rich image can be." A quite complete and organized list of the image schemas pro-

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2   For example, the emergence of the image schemas THING and MASS would happen from the experiences of manipulating and perceiving solid and bounded objects (apples, stones) as opposed to the ones experienced with liquids, gels or grains (water, mud, sand). From now on we will use the terms *countable* and *uncountable* for the grammatical distinction and THING or INDIVIDUAL and MASS for the corresponding cognitive concepts.

pounded in the literature are summarized in Evans and Green (2006: 190). Recent and relevant research on image schemas include Hampe (2005), Oakley (2007) and Peña (2008).

◼ 3.1.1 Image schemas as motivation of linguistic phenomena

I also assume that the learning based on frequent use of form-meaning pairings, i.e. entrenchment, causes the attribution of lexical concepts to image schemas. For Gibbs and Colston (1995) polysemy, which in many cases resists to be defined starting from a nuclear, general, abstract meaning, can be characterized by metaphor, metonymy and image schemas. Therefore, the organisation of polysemic words is not arbitrary but it is structured by systematic and recurrent general cognitive principles. In their empirical and experimental study, Gibbs and Colston show how the different meanings of a word are motivated by different recurring bodily experiences. That way they prove the existence of image schemas and the fact that they lay the foundations for linguistic categorisation. Middleton et al. (2004) also illustrate, by means of psycholinguistic experiments, the experiential basis of the linguistic opposition countable-uncountable. The theoretical framework of such arguments can be found in Lakoff (1987: 104–109), where he accounts for the extension of a linguistic category, the Japanese classifier *hon*, which prototypically marks nouns denoting long thin things but ends categorising entities and objects in a way that a priori could seem to be arbitrary.

◼ 3.1.2 Transformations of Image Schemas

Johnson (1987: 26) argues that "there is a large and growing body of evidence for the existence of an image-schematic level of cognitive operations", and he also claims that Lakoff (1987: 428) provides evidence of various image schema transformations, defined as "schematic operations not propositional in character that are more abstract than the concrete level of rich images (mental pictures)". One of the transformations that Johnson suggests is MULTIPLEX TO MASS, in which the mental focus applied to a collection of objects *zooms* away until the individual elements are blurred and perceived as a homogeneous mass.

■ 3.2 Properties of entities and operations of conversion between them

In a related manner, but more centred on the relationship between cognition and grammar, Talmy (2000: 41–42) formulates the organisational principle of *intercategorial conversion*, a cognitive operation that is produced by the interaction between grammatical structures and types of lexicalisation. An example is *reification*, which is implemented in grammar by nominalisation. By this operation, an EVENT – thus conceptualized in the domain of time (e.g. *to call*) – comes to be conceptualized in the domain of space and therefore as a THING (*a call*); which in turn makes it possible to be *had* or *counted* (e.g. *you have two calls*).

A corollary of this principle is that of *inverted conversion*, by which, if a language has conversion mechanisms from A to B, often it also has them from B to A; but languages, typologically, favour one of the two directions: they have simple mechanisms to convert in one direction (i.e. lexicalisation) but they have to use more complex grammatical tools to go in the other one.

These operations are part of what Talmy calls *reconciliation processes* which are triggered by the association of a grammatical structure with a lexical structure bearing incompatible structural specifications. This concept is similar to *partial sanction* (Langacker; 1987: 69), i.e. the use of linguistic units in a partially innovative manner.

■ 3.2.1 Boundaries

Langacker (1987: 189–194) establishes in a programmatic manner the notions of *bounding* and *bounded region* as fundamental schemata for the conceptualisation of THINGS.[3] Talmy (2000: 51 and in previous works) also suggests that a category of the configurational structure system is the *state of boundedness*, which has two notions as members: *bounded* and *unbounded*. An entity is considered bounded when it is conceptualized as individuated and unbounded when it is conceptualized as continuous, i.e. without intrinsic characteristics of finiteness. Jackendoff (1991: 18) establishes the same distinction by means of the conceptual features: [+B] and [–B]. All

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3 An autonomous conceptual unit which is independent and has a certain stability in time and space. Prototypical *things* are physical objects and are expressed in language by nouns.

three authors assume that the state of boundedness corresponds to the linguistic distinctions between countable and uncountable for nouns and perfective and imperfective for verbs (Talmy, 2000) or between bounded events and unbounded processes (Jackendoff, 1991: 18).

For Talmy there are conversion operations that affect the state of boundedness. The notion *unbounded* is affected by the operation *bounding* or *portion excerpting*, through which a portion of an unbounded quantity is enclosed and placed in the foreground of attention (*a body of water*, *some water*). Jackendoff (1991: 23) postulates an equivalent conceptual function, *composed of*, that generates lexical individuations of mass nouns (e.g. from *coffee* to *a coffee*) and it is also applied to pluralization (*a pile of sand/bricks*, *a flock of birds*).

The inverted operation, which Talmy calls *debounding* and Jackendoff *grinding*, causes the conversion of countable nouns into uncountable – e.g. *There is cat all over the driveway*. For Evans and Green (2006: 186), building up on Lakoff's proposal (1987), these transformations can be considered as motivated by transformations between the corresponding image schemas, and they have grammatical effects.

◼ 3.2.2 Internal structure

Talmy (2000: 48) defines *plexity* as the state of articulation of quantity into equivalent elements: when the quantity equals one, the element is an *uniplex*, and when it equals more than one, it is a *multiplex*. Furthermore, he defines the cognitive operation of *multiplexing*,[4] which is triggered by the occurrence of lexical forms that intrinsically refer to a *uniplex* in grammatical contexts that denote an *unbounded multiplex*. The most typical example is pluralization, that is, when the plural marker applied to a *uniplex* lexical unit mentally provokes *multiplexity*. Talmy also points out that even though mechanisms that convert a unit into a *bounded multiplex* (notions such as *committee*) could exist, he has not found them in any language.

Along these lines, he postulates the opposite operation, *unit excerpting*, which is achieved in English through structures such as *a piece of* [multiplex] (e.g. *furniture*). Jackendoff (1991: 22) postulates the equivalent function *element of*.

Similarly, Talmy (2000: 55) defines the *state of dividedness* of entities, so that they can be conceived as internally composite (discrete) or internally

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4   Jackendoff (1991: 20) calls this operation *pluralization*.

continuous. The entities of the first type are multiplex, and of the second, mass.

■ 3.2.3 Jackendoff's unified interpretation

Talmy's (2000) differentiation between uniplex and multiplex, and its articulation with conceptual boundedness has been formulated in a more simple manner in Jackendoff (1991) by pairs of features [±I] (*internal structure*) and [±B] (*boundedness*), which, by combination, create entities [+B–I] (*person*), [+B+I] (*committee*), [–B+I] (*people*) and [–B–I] (*water*). As opposed to Jackendoff, Talmy (2000: 59) postulates uniplex as a category which is discrete but lacks specification of boundedness. On the other hand Jackendoff, as opposed to Talmy, posits two types of [+I] (multiplex) entities: the bounded (*committee*) and the unbounded (*people*).

■ 3.3 Abstract entities

Even though the theoretical status of the ontological metaphor (Lakoff / Johnson, 1980) has evolved throughout time, its fundamental basis has not: one of the most common functions of conceptual metaphors is to understand abstract entities (events, emotions, ideas) in terms of concrete entities. As they said (p. 25), "once we can identify our experiences as entities or substances, we can refer to them, categorize them, group them, and quantify them (and, by this means, reason about them)".

   On his part, Langacker (1987: 189–194) postulates that the notion of bounding should be interpreted abstract enough to overcome the limitations of its spatial origin. This allows him to extend the general dichotomy individual-mass to abstract entities, so that i.e. many nouns referring to events are conceptualized as bounded and behave as countable (cf. supra: reification), while other types of abstract nouns (e.g. *love*) are conceptualized and behave grammatically as *abstract mass nouns* (Langacker, 1987: 208).

■ 3.4 Generic reference

Generic reference is the expression in the discourse of the category rather than of an instance or a quantity of the type. If we take a look at simple examples of generic sentences, such as *the tiger is a feline predator* or *tigers are feline predators*, we see that they refer to the subject entity (tiger/s) not as individuals in a specific time and space, but rather as a class or category in

any time and space. It is difficult to distinguish by purely grammatical indicators those nouns that have generic reference from those that designate specific entities – it seems that detection of generic reference needs to be made based on the context.[5]

Radden and Dirven (2007: 106–111) distinguish *classes* from *categories*, claiming that the former consist of individual elements (e.g. tigers), and the latter have as their members subcategories (e.g. Bengal tigers, Siberian tigers…). They also postulate that generic reference is applied to classes: it is metonymically constructed from one or more elements of the class, since ideally, all of its elements share certain characteristics. They claim that the speaker, when employing generic reference, thinks of a category but he places it in discourse by means of the class. We can notice that in this view mass nouns would not be able to create classes, since they do not consist of elements, therefore they could only create categories.

On the other hand, Lakoff (1987: 456) postulates that the logic or the mathematics of classes can be understood as being based on the metaphorical understanding of classes as metaphorical projections of the image schema CONTAINER (composed of an inside, a boundary, and an outside).

■ 4 Proposal of a unified model

In this work I develop the following idea exposed by Lakoff (1987: 428) and Johnson (1989: 26): in languages there are grammatical transformations motivated by transformations of image schemas; in other words, there are transformations of image schemas with linguistic correlation.[6]

On this basis, I posit that these recategorisation mechanisms are not an unstructured compendium but the whole set constitutes an organized system of category shift mechanisms whose function is to adapt lexicalized concepts to the Idealized Cognitive Model (ICM) active in discourse. This adaptation usually implies a modulation of the original meaning of the concept; therefore the goal of the transformations is both semantic and pragmatic.

An ICM (Lakoff, 1987: 68) is the structured and complex whole of knowledge that the speaker has of a conceptual category, e.g. a situation

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5 Krifka et al. (1995: 8–14) provide various tests for the detection of genericity in English and, in general, Carlson and Pelletier (1995) is devoted to this type of reference.

6 And both the transformation between image schemas and their linguistic implementation are conceptual operations.

and its participants.[7] I understand ICMs as the interface between conceptualisation and linguistic convention; that is, they include, among other knowledge, the lexical denomination of the different concepts involved in the situation. Thus, the ICM for office work includes the reception and the processing of written "papers", called "documents", that as a whole can also be called "documentation", or from a pejorative point of view, "paperwork" or even "red tape". The ICM for bars in Catalonia includes the knowledge that the beer is served either draught in portions called "canya", "gerra" etc. (quarter or half pints, approx.) or either in bottles, denominated according to their sizes "mitjana" (0.33l), "quinto" (0.20l), etc.

I assume the hypothesis that the traditional categories of nouns in descriptive grammar (countable, uncountable, collective…) correspond to image schemas and that the mechanisms of shift between them are accomplished by the following set of conceptual operations: transformation, blending and profiling of image schemas.

My next hypothesis is that each entity-denoting lexical concept prototypically belongs to one of these categories,[8] and it is precisely from this anchorage that it can be recategorized. Recategorisation is a conceptual (semantic) operation implemented in discourse through grammatical means, such as pluralization, partial sanction or the formation of partitive phrases. I also hypothesize that the concatenation of these transformations is always possible but progressively more costly and therefore less likely, as each new recategorisation drives the concept away from its prototypical class.

■ 4.1 Conceptual categories

Below I list and give a simple description of the image schemas relevant for this work. All of them are consolidated postulates except for AGGREGATE which is my own.

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7   I assume with Cienki (2007) that the lakoffian notion of ICM includes other related notions, such as Schank and Abelson's (1977) *scripts* or Fillmore's (1982) *frames*.

8   This hypothesis opposes those that, in line with Borer (2004), assume an original neutrality of nouns' semantics, i.e. they will be implemented in the language (e.g. either countable or uncountable) depending on the grammatical context. In my view, hence, one of the realisations, the prototypical one, is always more natural and the other one more forced.

THING (INDIVIDUAL, OBJECT). It emerges as an image schema from inter-
action with objects and generalises over what is common to objects, e.g.
having weight and shape, occupying a bounded region of space, etc.
(Evans / Green, 2006: 191)

MASS. I assume that it emerges from the experience of manipulating liq-
uids, gels or fine-grained materials, i.e. substances that cannot be manipu-
lated in differentiated elements.

MULTIPLEX. It has been described as an image schema as well under the
name of *collection* (e.g. Evans / Green, 2009: 90). I assume that it emerges
from the experience of manipulating small objects of the same type (e.g.
cherries, nuts) and of perceiving groups of things of the same type (e.g.
flocks of birds, herds of cattle). Jackendoff (1991) describes two types of
multiplex: bounded (*a committee*) and unbounded (*buses*, *cattle*). Moreover,
for Radden and Dirven (2007: 76–78) those entities designated through
pluralia tantum are also conceptualized as multiplex, since they are perceived
as things that consist of similar parts.

AGGREGATE. I postulate the existence of this image schema and assume
that it emerges from the cognitive operation of *melding* (cf. infra) and based
on perceptual properties of the vision of entities at different distances. For
Lakoff (1987: 442), this operation blurs the individual elements to mentally
create a homogeneous mass. However, I hypothesize that the speaker
remains aware of the existence of the constituent elements, i.e. the fusion
into a homogeneous mass is not total.

A linguistic proof of this are linguistic facts such as (1) the possibility
for nouns in singular of *ad-sensum*[9] concordance or to be antecedents of
plurals (which is ungrammatical for mass nouns): *la policia van arribar tard*
'the police [SING] arrived [PL] late', *quan la policia va arribar, van trobar...*
'when the police [SING] arrived [SING], they found [PL]…' (Bosque, 1999);
(2) their possibility to be arguments of predicates that normally require
plurals (*recopilar informació* 'to gather information'); (3) the various possibili-
ties of combinations with partitives – e.g. masses do not allow 'group of' o
'row of' but aggregates do –; and (4) the possibility to make inferences
about their components (*the army arrived* > soldiers arrived).

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9   For Radden and Dirven (2007: 75) the *ad-sensum* concordance is an effect of profiling
    (cf. Langacker, 1987); in the example the constituent elements (individual policemen)
    are profiled but the whole is not.

CONTAINER. This is one of the most classic examples of image schemas. It emerges from the multiple experiences related to being situated within a thing (e.g. a cradle, a room) or to place a thing inside another one (Johnson, 1987: 21). It is structured by the notions of interior, boundary and exterior. As it bears *gestalt* properties, the interior and the boundary form the FIGURE and the exterior forms the GROUND.

The main hypothesis of this work is that each noun of entity is prototypically anchored to one of the first four categories of the list – THING (*tree*), MASS (*grass*), MULTIPLEX (*forest*) or AGGREGATE (*cattle*) – and any of its derived interpretations is reached by transformations. These transformations are described below.

■ 4 Transformation operations

Each type of transformation operation is characterised by restrictions of application to the original categories and it necessarily results in another category of the system. The new image schema is the semantic result of the transformation. With respect to form, the following types of correlations with the semantic change can be produced: morphological changes (*person > persons, papers > paperwork*), contextual or combination changes (*fire > a fire*), application of the partitive construction (*water > a glass of water*) and changes in lexical selection (*persons > people, beer > a pint*).

From the point of view of lexical semantics, the model takes account of the following metonymical phenomena: certain types of regular polysemy (*lamb* [animal] vs. *lamb* [meat]), plurals and singulars with non-prototypical values (*aigües* 'waters',[10] *intel·ligències* 'intelligences'[11]), quasi-synonymy (*cigarettes/tobacco, persons/people*), the individuation mechanism (*a wine, an amount of people*) and the generic reference.

■ 4.2.1 Operations on concepts of entities

Below I will depict the conceptual operations that form the core of the model. They prototypically apply to concrete entities, but they can also apply to abstract entities once they have been reified.

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10 Meaning either bottles of water or kinds of water.
11 Meaning types of intelligence.

∎ [1] Massification

This conceptual operation, which is metonymic in nature, has been given various names by different linguists, e.g. *grinding* or *debounding*. It has been typically associated to the mentioning of meat (e.g. *to eat lamb*), but it is easy to find it denoting other masses that constitute objects, food-related or not, (e.g. *menjar pernil* 'to eat ham', *sabates de cocodril* 'crocodile shoes', *there is cat all over the driveway*) and often in extended or figurative senses (*fa olor de rosa* 'it smells of rose', *no hi ha sofa per a tothom* 'there is no sofa for all of us' = there is no room enough in the sofa).

The operation is triggered by the need to mention in discourse some entity derived, constituent or associated to an entity anchored to the image schema THING, i.e. prototypically conceptualized as a bounded object. From the semantic point of view, the derived entity is conceptualized as lacking boundaries, or whose boundaries remain outside of the focus of attention – and therefore, since it has no internal structure, it corresponds to the image schema MASS. The derived entities which are tangible typically correspond to the substance of which the thing is made of (meat, leather); in the extended or figurative senses they correspond to an aspect of their ICM (*smell*: the flowers smell, *room to seat*: the sofas serve for a number of people to seat on them). I postulate that these extensions of meaning are ascribed to MASS because the corresponding target concept (e.g. the smell, the space) is prototypically anchored to such image schema. Grammatically, the transformation is reflected by the adoption of the superficial features of MASS, i.e. the morphological and combinatory features of uncountable nouns.

There are cases in which this type of grammatical transformation is not needed, because convention allows the existence in language of a specific lexical form for the unbounded concept, e.g. *cow/beef, cigarette/tobacco, shoe/footwear*. In these cases the conceptual transformation, when adaptation to the ICM is needed, is being implemented through lexical selection of that existent word.

∎ [2] Multiplexing

Obviously, pluralization is the morphologic mechanism that implements multiplexation from nouns of THINGS. I assume, along Jackendoff (1991) and Talmy (2000) that this operation generates unbounded multiplex[12] (in the surface: non-specified plurals) and that it does not generate bounded multiplex.

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12 Surely, of the same type as the THING of origin.

   Catalan also has lexicon not derived by pluralization which denotes multiplexity, both bounded (*família* 'family') and unbounded (*gent* 'people'), and this differentiation is linguistically relevant because such nouns have different grammatical behaviours.

   I postulate that we conceptualize two types of unbounded multiplexities: MULTIPLEX and AGGREGATES. The first ones are those which are created by the operation we are discussing in this section, superficially they are the unspecified plurals and are ultimately bounded through syntagmatic operations (combination with specifiers, e.g. *those persons*, or by constructing a partitive sentence, e.g. *an amount of persons*). AGGREGATES, I hypothesize, are created from MULTIPLEX by the application of the conceptual operation *melding* (vid. [4] infra), through morphological means or by lexical selection. The conceptual difference between the two lies in the full awareness vs. partial blurring of the constituent elements.

   Another important aspect to take into account is that only bounded schemas can be multiplexed and that all bounded schemas can be multiplexed. The second condition implies that we can have pluralizations of THINGS (e.g. *persons*), of bounded MULTIPLEX (*two groups of persons*, *two families*), of bounded AGGREGATES (*two groups of people*) and of categories created by *profiling* (vid. [5] infra) such as *two pints* o *two beers*. But, as the first condition indicates, there cannot exist pluralizations of MASSES or AGGREGATES;[13] hence, plurals such as *waters* or *cattles* cannot be interpreted from the original and prototypical concept MASS or AGGREGATE, but rather from derived concepts created by *generalization* (classes or subcategories of water or cattle) or profiling (doses of water) – cf. infra these operations.

■ [3] Bounding

I postulate, partially against the description given by Talmy (2000), that *bounding* is not simply the operation opposite of *massification*, but rather a primitive operation that can be applied to any unbounded image schema (MASS, MULTIPLEX or AGGREGATE); it generates as a semantic result a bounded category whose content is that of the source unbounded category. In this sense my proposal is similar to that of Jackendoff (1991), who applies it to MASS and MULTIPLEX and assumes that it surfaces through the phrase [N of N] (e.g. *a pile of sand/bricks*) or the lexical individuation (e.g. *a*

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13 Neither, obviously, pluralization of MULTIPLEX, because they would have to be pluralizations of plurals.

coffee). In this last case, however, I postulate that it comes from a chain of transformations, so that after the bounding a profiling operation (Langacker, 1987) happens – cf. operation [5] infra.

I also hypothesize that bounding is a case of *blending* (Fauconnier, 1994)*,* i.e. the fusion or conceptual mix of two domains; I extend here fusion of conceptual domains proposed by Fauconnier to the fusion of image schemas. The idea is, simply, that boundaries are imposed to unbounded entities. And since the boundary is a concept that we assume it emerges from the image schema CONTAINER, the impositions of boundaries to a certain category (bounding) is necessarily a blending between such category and CONTAINER. Hence, the blending of the unbounded image schemas (MASS, MULTIPLEX and AGGREGATE) with the image schema CONTAINER results, naturally, in bounded concepts identical in internal constitution to the corresponding unbounded concept – see schematically these three conceptual fusions in Figure 1.
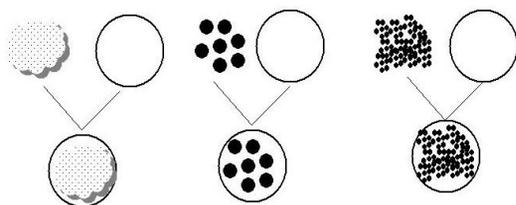

Figure 1.
Generation of bounded
concepts by blending

Bounding generates entities with conceptual boundaries (in terms of Jackendoff, entities [+B]; both [+B+I] and [+B–I]), in other words, if they are physical, they are prone to be reunited in a delimited space (e.g. *a glass of water*, *a bag of rice*, *a fire*, *five thousand soldiers*, *an amount of persons*, *a bunch of people*) and if they are not, they are prone to iteration (e.g. *a thought*, *a pile of emotions*).

At the grammatical pole, the resulting categories are countable and the basic grammatical concretion of this operation is basically the specification of plurals[14] and the partitive construction [N de N] in which the syntactic core is a partitive noun and the complement (the source unbounded entity) is the semantic core. Partitive nouns and common nouns can combine depending, on one side, on the type of the partitive noun (e.g. *container*, *group*, *portion*, *element*) and on the other, on the state of boundedness and

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14 Specification creates, from an unbounded multiplex entity (a non-specified plural: "soldiers"), a bounded multiplex entity ("the soldiers", "those soldiers").

other semantic factors of the common noun. Climent (1998; 2001) describes this combination for Spanish taking as a base the Jackendoff's (1991) features *Boundedness* and *Internal Structure*. Another way to implement this conceptual operation is the adoption of the combinatory features of countable nouns, e.g. *fire > a fire, thought > a thought*.

I also postulate that two conceptual operations posed by Talmy (2000) are actually contextual variants of the bounding operation, and thus it includes them. One is *discretizing*, i.e. the transformation of a mass into discrete elements, e.g. *beads of sweat*; and the other one the bounding of a mass (*bounding* o *portion excerpting*), e.g. *a piece of bread*.

An interesting problem and a challenge for our model is that in some cases it is not evident to postulate, for a certain concept, which image schema is prototypical and which one is derived or obtained by transformation. For instance, consider *pedra* ('stone'); in Catalan it is not straightforward to postulate which is the prototype: the MASS interpretation (*a house made of stone*) or the one of individual object (*one stone*). It might even differ among speakers depending on their particular experiences.

■ [4] Melding

As explained in Section 4.1, I assume the existence of this conceptual operation (Talmy, 2000: 56). I postulate that it generates a *blurry multiplex* (composed of the same constitutive elements of the MULTIPLEX of origin) where the speaker maintains his awareness of these constitutive elements. I call this generated concept AGGREGATE. I also assume that unbounded collective nouns (*people, cattle, furniture, timber*) are prototypically anchored to this category.[15]

This conceptual operation is implemented in language by means of three mechanisms: lexical selection (*persons > people, animals > cattle, cars > traffic*), morphological productivity (*paper* 'paper' *> paperassa, paperam* 'paperwork', *full* 'leaf' *> fullam, fullaraca* 'foliage'), and the mechanism that we could call *depluralization*, i.e. the recategorisation of plurals into uncountable singulars with expressive effects (Bosque, 1999), e.g. *no havia vist mai tant de cotxe* 'I have never seen so much car-SING' (meaning multiple cars).

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15 And also, *pluralia tantum* such as *tripes* ('guts'), *escombraries* ('garbage') or *estalvis* ('savings'), that even if existing in singular, they have either their own prototypical meaning in the plural form and as conceptualisation of an AGGREGATE, or the singular form expresses a different meaning, e.g. *estalvi* ('safe').

Regarding the formation of AGGREGATES through productive suffixation, it is necessary to underline two points. First, Talmy (2000) claims that this operation is conceptual, but it does not exist in language, i.e. it lacks linguistic implementation; yet, the data from Catalan shown above refutes this postulate. Second, that the suffixation that creates these words in Catalan takes as its base the singular form of the noun, not the plural, so it is problematic to claim that this grammatical operation is the implementation of a conceptual operation which takes MULTIPLEX (and therefore usually a plural form) as its base; it would mean that the operation directly converts THING into AGGREGATE; but this would contradict the characterisation that Talmy and Lakoff (1987) give of the operation.

Finally, it should also be noted that my model predicts that AGGREGATES can not be pluralized, since no unbounded category can be. It could only admit the plural form in the generic, categorial, sense: creating subcategories – cf. Section 4.2.2 [7] infra.

◼ [5] Profiling of a partitive construction
Profiling in a domain or base (Langacker, 1987) is one of the fundamental conceptual operations postulated in cognitive grammar. A classic example is the lexical concept *arc*, that is only defined in relation with its base: *circumference*. Here I apply this notion to the formation of lexical meaning from partitive constructions as a canonical form of expressing derived bounded concepts.

In partitive constructions (*a herd of sheep*, *a pint of beer*) the partitive noun (*herd*, *pint*) provides the bounding information to a concept that was originally unbounded. I hypothesize that in certain specialized partitive nouns, their repeated usage allows the construal in which its semantic contribution to the construction is profiled; e.g. *a herd* in *to go lock away the herd* or *a pint* with the meaning of a certain portion and way of serving beer. Hence, the entity that in principle would be designated by means of the full noun phrase is expressed more synthetically by the bounding element, leaving aside its content, and not even mentioning it.[16] In this operation then, adapting Langacker's terms to this situation, the boundary or container is formed as the profile and the content as the base.

The complementary operation happens as well: the profiling of the content, leaving the container as base. In this way, lexical meanings such as *una cervesa* 'a beer' or *un conyac* 'a cognac' are generated, from concepts and

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16 We could say that the construction is *apocoped*.

expressions such as *a bottle of beer*, or *a glass of cognac*. We see this operation in the scheme in Figure 2.
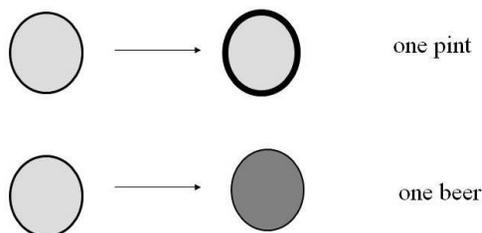

one pint

one beer

Figure 2. Profiling.

In both cases the generated concept is bounded, therefore it can be multiplexed – and hence, it can be pluralized – and can be treated as any other bounded entity (*pints*, *two beers*, *a case of beers*).

I also postulate that this mechanism is responsible of those meanings in which the name of a mass is used to denote an object made of that mass; so, the nouns *un suro* 'a cork', *una fusta* (literal translation: 'a wood') 'a piece of wood', *un ferro* (literal translation: 'an iron') 'a piece of iron'; would be created by profiling the content in constructions such as *un tros de X* ('a piece/bar etc. of X').

Regarding to reference, the transformation does not generate a new concept; the reference remains being the same as in the partitive construction of origin and hence, the semantic effect is circumscribed to the profiling of one of the elements of the concept – the *construal*, in Langacker's terms.

■ 4.2.2 Metaoperations

The operations described in Section 4.2.1 are the core of the model that I present here. Further on I will describe two operations of a general level, that I call metaoperations, as long as they are applied, either as origin, or as destination, to any image schema from the core of the model. In the first case, [6] has its origin in any concept of an abstract entity and its destination in concrete image schemas; and in the second case [7] can have its origin in any concrete entity concept and generates the reference to the category, i.e. its generic reference.

▪ [6] From abstract to concrete

The distinction between abstract and concrete nouns in descriptive grammar is "deceitful" for Bosque (1999: 45–49),[17] since, in his terminology, grammar does not seem to be sensitive to the material or nonmaterial nature of entities, and he claims that the nouns that designate abstract entities behave with the same parameters as those that designate concrete entities, i.e. such as countable or uncountable.

From the point of view of cognitive linguistics (cf. Section 3.3 *supra*) we consider that abstract entities can be conceptualized in terms of concrete entities so that the speaker applies to them the corresponding grammatical behaviour. Thus, I assume here that such transformation projects the abstract entities in image schemas of the basic types described here for concrete entities. From this attribution and by virtue of it, abstract entities receive the grammatical configurations and can undergo the transformations common to concrete concepts.

Typically the projection would be towards MASS, since most of the abstract concepts are construed as unbounded (i.e. undifferentiated or constant), but the direct projection towards bounded schemas is totally possible: in order to create individuated or episodic concepts – boundings of the Langacker's (1987: 189) *abstract mass*. In this way, in Catalan, temporal concepts, such as *time*, or mental concepts, such as *thought* are projected in image schemas of the MASS type, but directly related concepts such as *century* or *idea* are projected in image schemas of type THING. Notice as well that one same abstract concept, for example *love*, can receive depending on the context, either MASS interpretations (*much love*) or THING (*an irrational love*).

Beside these two basic image schemas, it should be noticed that abstract concepts can also be projected towards MULTIPLEX, e.g. *cabòries* 'worries'.

The grammatical effect of these projections is that abstract lexical units, once projected to the corresponding image schemas, will behave as uncountable, countable, or as *pluralia tantum* respectively. And also, that once the unit acquires the corresponding image schema type, it can undergo the transformations which are common to it (cf. Section 4.2.1 *supra*), such as multiplexing for individuals (e.g. *centuries*, *ideas*, *thoughts*, *loves*) or bounding for masses (e.g. *a bit of love*, *a ray of hope*).

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17 Bosque (1999) describes Spanish but his observations are fully applicable to Catalan with respect to this point.

Finally, it is necessary to underline that the projection of the abstract concepts towards types of concrete concepts is language dependent, e.g. the difference in lexicalization between Catalan and English for the cross-linguistically synonym pairs *consells* [count, plural] = 'advice' [mass, singular] and *consell* (count, singular) = 'piece of advice' (count, partitive construction).

◼ [7] Categorisation and formation of classes or subcategories

How is a category created? I understand the category as the conception of all possible entities of a certain type (for things; or, for masses, the whole possible amount) in any possible place or time. And I claim that it is created by the blending of two domains.[18] On one side we have the CONTAINER image schema, in the sense proposed by Lakoff (1987) for set theory. And on the other side we have a image schema emerging from the recurrent experimentation of instances that are equal, similar or with similar properties, to which we apply the basic cognitive operation of analogy (or perception/attribution of similarity). The blending creates a unique bounded set, in a way that another one with the same properties is not conceivable since it stands for the conception of all the possible entities of a type in any time and space, and only this (Figure 3).
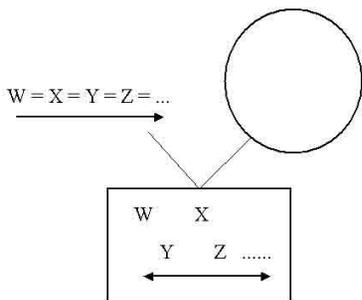

W = X = Y = Z = ...

Figure 3. Categorisation as blending.

I pose that the unique nature of the concept category created in such manner does not allow it to be multiplexed; in consequence, the pluralization of the corresponding linguistic category necessarily licenses (since it is not possible to create a multiplicity of the whole) the expression of subcategories –i.e. a subset: sets included in the generic set. In the case of

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18 For Radden and Dirven (2007), the category is created by metonymy, that is by attributing to the whole the observed or attributed properties of instances.

THINGS, since both an instance and a set are bounded concepts, there is ambiguity between the pluralization of instances and that of subcategories, and that is why, in Catalan, the expression of subcategories needs some type of linguistic subspecification. In the case of masses, the result of pluralization is not ambiguous (because the masses, as unbounded categories, are not multiplexable) and thus the plural form expresses clearly the notion of subcategories and they can only be confused with doses (content-profiled entities, cf. operation [5].[19]

◾ 5 Prototype effects and concatenation of transformations: semantic modulation

In this section the ideas exposed so far converge – especially that of the prototypical anchorage of nouns – and it is shown how the postulated operations are not isolated mechanisms, but rather they are part of a system which defines how they can be chained.

◾ 5.1 Prototype effects

By postulating the existence of transformations we accept that there is an asymmetry between two or more modes of reference of a concept, i.e. one is the basic (*prototypical*) and the other the derived. This implies in its turn a prediction: effects of prototypicity in the sense developed by Lakoff (1987: 59–67) for linguistic categories have to happen; in our case, empirical manifestations of the fact that there is a basic meaning which is the best example of the concept.

  We propose here three possible effects of prototypicity or ways of empirical investigation of its existence:

a) Psycholinguistic. Psycholinguistic experiments should reveal that the speaker perceives one form/meaning as cognitively simpler, thus the basic one and the other as derived.

b) Diachronic. In the evolution of language, a form/meaning has existed firstly and the other have appeared afterwards.

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19 An interesting case that deserves more attention is that of big unique masses ("the universe", "the earth", "the sea", "the sky"). Being unique, they are entities that resemble categories and have their own syntacticosemantic function. They do not function exactly as THINGS, neither as MASSES; their quantification indicates instances ("two seas"), while the defined singular form ("the sea") does not denote an instance, but rather the totality.

c) Frequency. The basic form/meaning is used more often that the derived, or more regularly (except possible *islands of use*, conventionalized in registers or well defined contexts).

In some cases, the prototypicity effect seems obvious:

- Multiplexity (operation [2]). In a large part of the lexicon, the plural (MULTIPLEX) is formed by morphological derivation of the singular (THING). Therefore the individual form is the basic one.
- Individuation by partitive construction [3]. The partitive construction adds grammatical complexity to the formulation (unbounded) of origin; therefore it is the derived one.
- Profiling [5]. The profiling of a semantic aspect of a concept is only possible taking as basis the complete concept. Thus the profiled concept is necessarily the derived one.
- From abstract to concrete [6]. According to the fundamental principles of language assumed by cognitive linguistics, this operation happens always in this direction, since, as in conceptual metaphors, it is the one that allows conceptualisation and linguistic communication.

Other cases would have to be checked empirically:

- From THING to MASS (operation [1]). In many cases there does not seem to exist an indisputable prototypical formulation; hence, both directions of the transformation could be postulated – e.g. pedra 'stone'.
- Melding [4]. It is a similar case, the contrary operation could also be postulated as basic, in which the mental zoom approaches the target and perceives its granularity accordingly.

Finally, there are cases where the direction of the operation seems clear in a general sense but can have important exceptions:

- From instance to generic (operation [7]). It seems clear, along with Rosch (1977, cf. Evans / Green, 2006: 262), that categorisation emerges from the perceptual stimuli. The opposite does not seem conceivable in everyday life, even if it could happen in fields of abstract reasoning, such as philosophy or linguistics.

■ 5.2 Chaining of transformations

If the same word or lexical concept appears in various of the predicted modes of reference, and these can be grouped in pairs corresponding to the postulated transformations, it seems reasonable to postulate in its turn

the existence of a chain of transformations, in which a certain element will always be the derived in one of the pairs and the basic in the next one. The element in which the chain of transformations begins can be understood as the prototypical for the concept, from which the meaning is progressively modulated.

This postulate makes the following prediction: there will be effects of prototypicity in the chains of transformations so that the effects will be weakened by each transformation. Thus, each new possible transformation is less probable, and if it happens, is does so with less intensity with respect to the prototype – in the established empirical terms, i.e. less usage, delayed diachronic appearance, perception of meaning less basic for speakers; *cf.* Section 5.1 *supra* –. In other words, long chains of transformations could potentially exist, but they are increasingly unlikely. This directional tendency resembles that of increase of entropy.

So, the model presents the proposal of possible transformations and concatenations of transformations, but the effective realisation of each new change will depend on both the conventionalisation and the progressive decrease of probability of existence of the transformation, as it distances from the prototype, i.e. the initial state.

In Figure 4 we see a diagram of the model and the concatenations. The central part shows the operations at the entity level, and the two peripheral parts show the metaoperations of reification and generalization, which can have as destination and origin (respectively) any basic entity of the general model. The arrows correspond to the direction of the operation and the numbers are the same we have used in Section 4 for listing them.
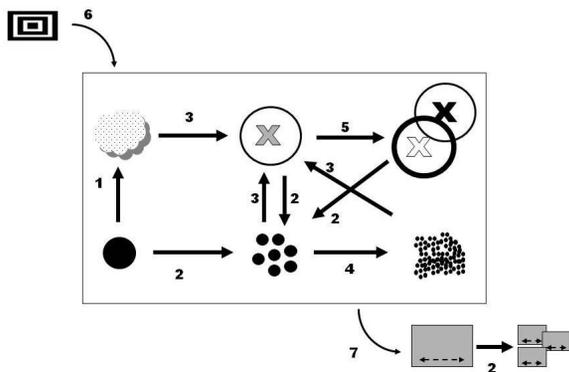

Figure 4. Model.

The scheme shows, in short, the following predictions according to the transformations and their direction:

a) THING can be transformed into MASS but not the contrary [operation 1].
b) The transformation from MASS to THING is implemented basically through an intermediate step, the BOUNDING by means of a partitive phrase [3], and the subsequent PROFILING of the content [5].
c) All the UNBOUNDED modes of reference are boundable, and this is basically done by means of partitive constructions [3].
d) All the BOUNDED modes of reference are multiplexable [2].
e) The AGGREGATES are formed by the blur of MULTIPLEX, but not the other way around [4].

Below we will show the capacity of semantic modulation that the speaker makes when he concatenates transformations. Examples are extracted from the corpus CUCWeb.[20] Let us consider the following uses of *tomàquet* ('tomato') or its plural form:

(1a) vam menjar entre tots tres una sardina i un *tomàquet* florit.
      'among the three of us we ate a sardine and a rotten <u>tomato</u>'
(1b) 400 gr de botifarra negra, 1/2 vas de *tomàquet*, 1 ceba
      '400 gr of black sausage, 1/2 cup of <u>tomato</u>, 1 onion'
(1c) els agricultors han regalat als ciutadans [...] melons, *tomàquets* i raïm
      'the farmers offered to citizens […] melons, <u>tomatoes</u> and grapes'
(1d) pa de pagès [...] i *tomàquet* ben madur, però que no ho sigui massa
      'rustic bread […] and ripe <u>tomato</u>, but not too much'
(1e) un pot buit de *tomàquet* fregit
      'an empty jar of fried <u>tomato</u>'
(1f) s'hi abonen un parell de *tomàquets* pelats
      'we add a couple of peeled <u>tomatoes</u>'
(1g) 4 kg de *tomàquet* de branca; 200 g de confitura de roses
      '4 kg of branch <u>tomato</u>; 200 g of rose jam'
(1h) el licopè (dóna el color vermell al *tomàquet*)
      'lycopene (it gives the red color to <u>tomato</u>)'

(1a) corresponds to the use I pose as prototypical: an object, a tomato as individual object. (1b) refers to the liquid or sauce made of crushed tomatoes. (1c) to the pluralized usage of the individual, i.e. some tomatoes.

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20 Except (1a) extracted from corpus CTILC and (1g) extracted from the website <http://www.clubdecuines.cat>.

(1d), taken from a list of ingredients of a recipe, refers to having some individual tomatoes available – and not as sauce as in (1b) nor having just one element, like in (1a) –; this use is found as well as the complement in partitive sentences such as (1g) and is referentially equivalent to MULTI-PLEX or plural.

(1e), (1f) and (1g) are individuating constructions formed by a partitive noun (container, lexicalized quantity and measured quantity, respectively) and the concepts exemplified in (1b), (1c) and (1d), i.e. MASS, MULTIPLEX, AGGREGATE.

Finally, (1h) refers to the category, i.e. the generic concept.

I postulate that these modes of reference are formed by means of trans-formations according to the model – Figure 5 presents the appropriate subset. As said before, it is assumed that the concept of tomato as a THING (1a) is the prototypical one (i.e. is the first image schema that emerges in the speakers' mind from the perception and/or manipulation of tokens of the given fruit). From this one, the derived concept of the example (1b) is generated by means of the operation [1] *massification*.
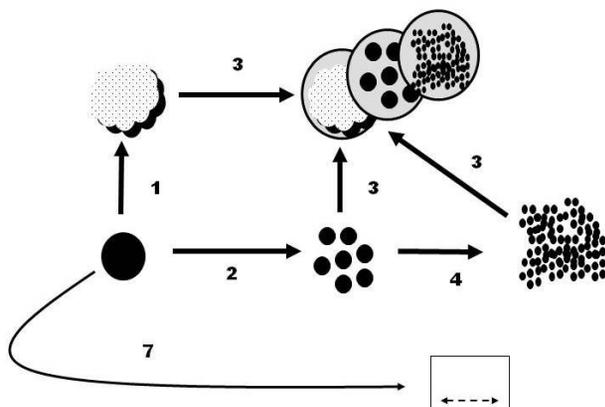

Figure 5. Generation of the modes of reference of 'tomato'.

Operation [2], *multiplexing*, generates a MULTIPLEX (example 1c) also from the prototype THING. Then, from the MULTIPLEX, the operation of *melding* [4] generates the AGGREGATE (example 1d), i.e. a larger and undif-ferentiated awareness of a plurality of individuals, grammatically indicated here by the use of the singular to name it.

Further on, the operation of bounding [3] departs from the unbounded concepts already generated (MASS, MULTIPLEX or AGGREGATE) and bounds

them (the speaker conceives them with awareness of their limit) using the mechanism of the partitive construction (examples 1e, 1g, 1g).

Last, the generic reference (example 1h) is generated from the perception and reiterated usage of the individual prototype (*categorisation*, operation [7]).

I will finish with an example of the application of the model presenting the uses departing from a MASS prototype, i.e. *cervesa* 'beer'. Let us consider the following sentences extracted from the corpus:

(2a) teníem de tot, vi, (...), *cervesa*, pastissos
      'we had everything, wine, (…), <u>beer</u>, pastry'
(2b) 2 copes diàries, sigui de *cervesa*, vi o licors
      '2 daily glasses, either of <u>beer</u>, wine   or liquors'
(2c) La Raquel bebent *una pinta* en un pub de Londres
      'Rachel drinking <u>a pint</u> in a pub in London'
(2d) Mentrestant, es pot prendre un refresc o *una cervesa*
      'Meanwhile, you can have a soda or <u>a beer</u>'
(2e) Moritz etiqueta les seves *cerveses* en català
      'Moritz labels its <u>beers</u> in Catalan'
(2f) Et pots prendre les teues *pintes* en pau i ballar una estona
      'You can have your <u>pints</u> in peace and then dance a while'
(2g) Has rebut mai una *caixa de cerveses* amb el teu ordinador?
      'Have you ever received <u>a case of beers</u> with your computer?'
(2h) el meu criteri de que *la cervesa* i Porsche fan una bona combinació
      'My criteria that <u>beer</u> and Porsche make a good combination'
(2i) és ara una elegant cerveseria amb més de 60 *cerveses* (provau la nova
      Paulaner de blat)
      'it is now an elegant brewery with more than 60 <u>beers</u> (try the new
      wheat Paulaner)'

In this case (from now on consider Figure 6 on the following page) I assume that the prototypical concept is the one of liquid, MASS, (2a), from which the individual use through partitive construction is generated by operation [3], i.e. 'two glasses of beer' (2b).

The conventionalisation of some of these types of constructions, e.g. "a pint of beer", allows, through the operation of profiling [5], the naming of doses of the drink as in the examples (2c) and (2d), i.e. "a pint" or "one beer"; in the former the bounder is profiled (in this case a measure but usually it can also be a container) and in the later the content (the liquid).
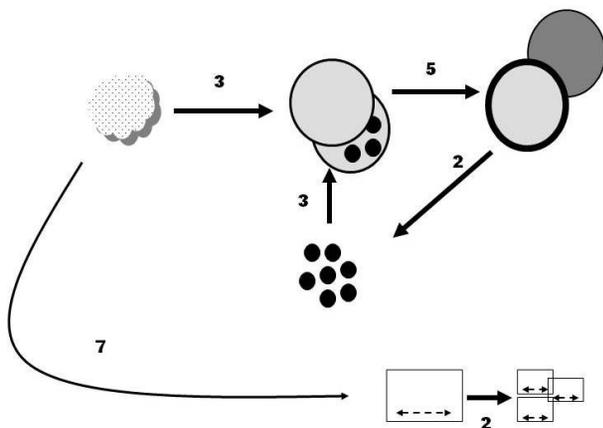
Figure 6.
Generation of
the modes of
reference of 'beer'.

Further on, as noticed in examples (2e) and (2f), these profiled concepts, being bounded concepts, can be multiplexed (operation [2]). Even more, these MULTIPLEX can be in their turn bounded if operation [3] is applied again and thus a new individuated concept is generated: the one in (2g), "case of beers".

Finally, (2h) is an example of the generic use, corresponding to the expression of the category (operation [7] from the prototype of the perceivable entity); and in (2i) we see how the multiplexation of the category (grammatically pluralization: operation [2]) results in the concept, also generic, of multiple subcategories. Notice that it can not be understood that this plural, "60 beers" is formed directly from the prototype MASS (in the model, mass nouns are not pluralizable to generate the meaning of a multiplex entity), neither from the individuated doses of (2d) because (2i) does not refer to individuals but rather to classes or types.

▪ 5.3 Comments on processing

This model does not postulate that the speaker is always performing online the transformations each time he emits the word corresponding to a derived mode of reference; I rather claim that the speaker disposes, as a linguistic mechanism, of the skill to do it and uses it when necessary – in the same manner that s/he disposes of the skill to generate plural from a new word in singular.

I assume that this skill is implemented by the cognitive processes of entrenchment by usage (Bybee, 2006) and subsequent retrieval and analogy (Hofstadter, 2001). In the cases where a word has already been used re-iteratively by the speaker in some derived mode of reference (especially, because this meaning has been conventionalized) I assume that the sign is already available in memory, and it is straightforwardly accessed without making any transformation, even though the awareness of resulting from some kind of semantic modulation can probably exist in the majority of the cases. For instance, the profiled lexical concept "pint" relative to beer is most probably conventionalized for most speakers rather than generated *online*. However, in an example such as (3), probably for a number of speakers the fact of mentioning portions of bread as *barretes* ('loaves'), is generated *online*:

(3)   Posa les barretes al forn i deixa-les durant deu minutets.
       'Place the loaves in the oven and leave them in for ten minutes'

■ 6 Conclusions and future work

In this study I presented a theoretical model intended to be a plausible model of the cognitive functioning of speakers in an important aspect of the production or selection of lexical units in the generation of discourse. The model includes, synthesises and reformulates several phenomena theorised separately in the framework of cognitive linguistics, and it pre-sents them as an integrated and concatenated set of mental transforma-tions.

The basic ideas are: (i) that the traditional nominal classes of descriptive grammar correspond to image schemas; (ii) that there is a central or pro-totypical categorisation in these terms for each entity: (iii) that from these prototypes specific directional cognitive operations generate the derived categorisations, and (iv) that this system accounts for the various modes of reference of nouns of entities.

This being a theoretical model, from this point on an important effort of empirical testing is needed, indeed. First of all, it has to be ascertained on the basis of the analysis of large-scale corpora that the facts presented (the different modes of reference for each word or concept) are systematic and pervasive in language. Then it will be necessary to check that for each case considered, one concept is the prototypical one (i.e. perceived as more

basic by the speakers, more usual, diachronically preferred) and the other the derived. A derived product of this research can be the annotation of sense of words or concepts as prototypical in lexical knowledge bases. Previously, to make this empirical research possible, the grammatical and contextual correlations of each mode of reference need to be established with precision.■

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