

Romance fractional numerals

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Goal. We aim to account for the syntactic complexity of computational fractions. Our data includes Romance fractional numerals of the type illustrated by *la tercera parte*, *cuatro doceavos* (Spanish). Fractional numerals are proportional quantifiers that denote the concept of rational number. The only simple fractional numerals are the expressions for ‘half’, which may be categorized as an adjective (*medio*), or a noun (*mitad*), or even a morpheme (*hemi-ciclo*). Other fractional numerals are conveyed by complex expressions, which in Romance languages may consist of “CARD ORD_N”, “CARD ORD *parte*”, or even “ART ORD *parte*”.

Questions. Why are ordinal numerals used to name computational fractions? Do fractions keep some sort of ‘ordinal’ meaning? Why can unit fraction NPs be combined with the definite article? We conjecture the use of ordinals and definite article are remnants of the computing strategies used in the invention of the concept of fractional number.

Previous accounts

1. **Fractions are N.** They assign case to a N, which may be a restrictor denoting N or another numeral. Fractions, like cardinals, are semantic modifiers of type $\langle\langle e,t\rangle, \langle e,t\rangle\rangle$. All numerals share a common basic (cardinal) meaning: they denote partitioning of an individual: “S is a partition Π of an individual x ... if it is a cover of x and its cells do not intersect”. (Ioin, Matushansky, Ruy 2006:2.1). The lexical entry of fraction *three* is (1). In their proposal, cardinals differ from fractions in that they are constraint by an Atomicity condition on the restrictor denoting N.

2. **Syntactic Structures with two Ns.** Numeral words and quantifiers are heads of a QP, which subcategorize two arguments in the extension of the same NP. The internal argument is governed by the numeral/quantifier word, which assigns the N partitive case. The restrictor denoting DP whose referent is linked to the internal argument, occupies the Spec,QP position (Giusti 1992). The syntax of *tre dei libri* is (2). A problem with such an account is that a fraction N is not directly merged with the N that describes the restrictor. The numeral is in a partitive relation with the DP-restrictor inside a PP partitive complement.

3. **Syntactic Structures with one N** (Kayne 94, Martí 2002, Corver and Zwarts 2006). The numeral N in Spec,NumP is base generated as a DP-internal predicate in a post-nominal position. Corver and Zwarts (2006) propose for cardinal N or PP (*(around) twenty children*) that the Numeral N is generated in a post-nominal position inside DP, and is moved to the Spec,NumP position. In their model, the syntax of Romanian *treizeci de lei* (thirty of lei, ‘thirty lei’) is (3).

An important problem for such an account with a single N is that a partitive predicate denotes a relation among at least two arguments. Therefore, partitive constructions need to be constraint by an anti-uniqueness requirement (Barker 1998). Baker proposes that the partitive meaning is a lexical feature of a partitive preposition PTV-*of*, which is homonymous with the structural case marker GEN-*of*. PTV-*of* denotes a **proper** partitivity predicate, which Baker defines as (4). Because a proper partitivity predicate requires to have at least two entities in its extension, a proper partitivity predicate is incompatible with a **uniqueness** implication.

Our proposal

Fractional number denoting NPs such as “*dos terceras partes*”, “*cuatro doceavos*” describe a world-independent property of a rational number $>0 <1$ ($2/3$, $4/12$). Their meaning is obtained by applying two operators to arguments in the domain of numbers: a partition operator, encoded through the head N, and a multiplication operator, expressed by the plural number morphology affixed to the partitive nominal head.

In our model for the syntax of fractions, we generalize Kayne's (2005) syntactic account of multiplicative cardinal numerals to fractions. Kayne proposes to add to the base of multiplication of a cardinal such as *three hundred* a nominal suffix overt or covert (NSFX) denoting 'a group' (5). In our account, the N *part* (overt or covert), or a fractional part denoting suffix denotes a partition operator and is the head from which a fractional numeral NP is projected. The partition operator subcategorizes two arguments: a dividend number argument saturated by a unit denoting number coindexed with the unit denoted by the set described by the DP restrictor, and a divisor argument, specified by the numeral adjective (*doce-ava parte*) (6), or the cardinal root of a partitive N (*doce-avo*) (7). The DP describing the domain of quantification is in a PP partitive complement of the fractional number NP, and stands in a proper partitive relation with the fraction numeral.

The ordinal numeral suffix still keeps its original ordinal meaning in unit fraction denoting DPs (*la tercera parte, la doceava parte*): The ordinal morpheme indexes the minimal part that results from a fractional partition of the unit referred by the restrictor into a number of parts ($>0, <1$) specified by the cardinal root of the ordinal numeral adjective (8). The shift in meaning of the ordinal suffix from an ordinal (ORD) onto a proper partitive (PTV) denotation was forced when ordinal numerals were used in NPs that name common fractions (*(la) doce-ava parte; (#los) cuatro doce-avos*) (9), (10).

(1) $\llbracket \text{third} \rrbracket = \lambda P_{\langle e, t \rangle} . \lambda x_e . \exists y_e [y \in P \wedge \forall z [z \in P \rightarrow z \leq y] \wedge \exists S_{\langle e, t \rangle} [\Pi(S)(y) \wedge |S|=3 \wedge x \in S \wedge \exists \mu [\mu \in M \wedge \forall s_1, s_2 [s_1 \in S \wedge s_2 \in S] \rightarrow \mu(s_1) = \mu(s_2)]]]$
(Ionin, Matushansky & Ruys 2006:12)

(2) $[_{QP} \text{ de-i libri}^i [_{Q'} \text{ tre} [_{N} e^i . \text{PTV}]]]$

(3) $[_{NumP} \text{ treizeci}_j [_{Num'} \text{ NUM} + X_i \text{ de} [_{DP} \text{ lei} [_{X'} t_i t_j]]]]$ (Corver and Zwarts 2006:54)

(4) $\llbracket \text{of}_{PTV} \rrbracket = \lambda x_e . \lambda P_{\langle e, t \rangle} . \lambda y_e [P(y) \wedge y < x]$

(5) [three [hundred NSFX]] books

(6) $[_{NumP} \text{ cuatro} [_{-S} [_{nP} \text{ doce-ava.PTV} [_{NP} \text{ parte } pro^1]]]] \dots [de [los \text{ estudiantes}^1]]$

(7) $[_{NumP} \text{ cuatro} [_{-S} [_{NP} \text{ doce-avo.PTV } pro^1]]] \dots [de [los \text{ estudiantes}^1]]$

(8) $[_{DP} \text{ la}^i [_{NumORD} [_{12, xi} [_{R-ORD} \text{ doce-ava}^i] [_{NP} \text{ doce-} [_{parte } pro^1]]]]]]$

(9) $[_{NumP} \text{ cuatro} [_{OP-MULT} -S] [_{nP} \text{ doce-ava.PTV-} [_{NP} \text{ parte } pro]]]]$

(10) $[_{NumP} \text{ cuatro} [_{OP-MULT} -S] [_{NP} \text{ doce-avo.PTV}]]$

References

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