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“*Chaque* vin a sa lie.” versus “*Toute* nuit a un jour.”

DOES THE DIFFERENCE IN THE HUMAN PROCESSING OF
“*chaque*” AND “*tout*” MATCH THE DIFFERENCE BETWEEN THE
PROOF RULES FOR CONJUNCTION AND QUANTIFICATION?

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Abstract

This paper claims that the difference between the way French native speakers use the two universal quantifiers “*tout*” and “*chaque*” corresponds rather well to the proof theoretical difference between 1) proving $P(a_i)$ for each element a_i in the domain and conjoining them and 2) proving $P(x)$ for a generic element x . Experiments have been designed (but not yet realized) in order to support this claim.

Semantic and discursive properties of *tout* and *chaque* In spite of the abundant literature on quantification in French, little if not any attention has been paid to the types of discourses in which quantifiers are used. Likewise, relatively few studies have investigated the differences between *tout* and *chaque*, which are both universal quantifiers, ranging over singular entities.

Our starting observation with [12], is that *tout* is naturally used in generic sentences (see also [11]), whereas *chaque* is blocked. Not to create confusion, we do not provide English translations for *tout* and *chaque* and use the metalinguistic TOUT/CHAQUE.

- (1) a. Tout lion a une crinière
“TOUT *lion has a mane.*”
- b. * Chaque lion a une crinière. (no generic reading)
“CHAQUE *lion has a mane.*”

- (2) a. Tout homme est mortel.
 “TOUT *man is mortal.*”
 b. *Each man is mortal. (no generic reading)
 “CHAQUE *man is mortal.*”

The general tout, comparison with n’importe quoi *Tout* has been argued to be a Free Choice Item (FCI) (see [12]) and to have an intrinsic modal semantics (although there exist a variety of proposal, their common core is that FCI are modals). A comparison between *n’importe quoi* and *tout* that enriches the already noted differences, can help us spelling out in greater details the semantics of *tout*. Firstly, FCI are not as natural as *tout* in generic sentences, or, at least, they do not lead to the same interpretation.

- (3) # N’importe quel homme est mortel.
 “Any *man is mortal.*”

Clearly *tout* can sustain a case in which an infinite set is used. *N’importe quoi* does not. To interpret (3), we would need to fix a set of relevant men, and pick any one of those. This leads us to conclude that *tout* is the absolute general universal quantifier in language.

Another piece of data leading to this conclusion is the contrast between *tout* and *n’importe quoi/qui* with respect to sub-triggering. Sub-triggering, is the term coined by [14] to describe the fact that episodic sentences can be rescued when the NP head noun is modified by an adjective or a post-nominal modifier. For English *any* [5] proposes that the sub-trigger introduces a spatio-temporal restriction that prevents the any-quantifier to range over the totality of possible worlds or situations.

- (4) a. *Mary read any book.
 b. Mary read any book that she bought.

We observe an opposite behavior with respect to sub-triggering. With imperatives, FCI do not require sub-triggering, *tout* does (note that *tout*, despite [12] can be used in imperatives, granted that sub-triggering is used).

- (5) a. Prend n’importe quelle carte !
 “Take *FCI card!*”
 b. Prend *toute carte/toute carte qui puisse te faire gagner !
 “Take *TOUT *card / TOUT card that allows you to win!*”

Why do we have to accommodate here a restriction ? Because the context (a card game) presupposes the existence of a limited set of cards, and this restriction clashes with the default information of absolute generality of *tout*. A restriction for the domain of quantification of *tout* is thus needed for the sentence to be felicitous.

As we mentioned, current analyses of FCI and *tout* in particular, rely on a modal semantics. It is tempting to extend this line of analysis and to use a modal semantics also for capturing the absolute generality of *tout* (even if our description in fact departs in some ways from [11]).

While modal analyses are enlightening in many respects, they raise the question of how we can construct or compute the set of all possible worlds. Restricting via ordering sources the set of relevant worlds in a natural way out of the problem. However, here we explore an alternative route asking when can one assert a given sentence and how can one refute an asserted sentence. Studying the condition of asserting and refuting a statement is a different but worth studying semantics. This will be our choice. However, we want to first consider the types of sentences in which *tout* and *chaque* are used, further justifying the use of a semantics that can capture the conditions for assertion and refutation, rather than a purely truth conditional approach.

Chaque vs. tout: an analytical and a synthetic quantifier The starting point of our description of the types of statements in which *tout* and *chaque* are used, will consist in acknowledging that *tout* and *chaque* are employed, respectively, in prescriptive and descriptive statements. We substantiate this labels by spelling out the ingredients of prescriptivity and descriptivity.

Prescriptive statements are grounded in rules of the form $P(x) \rightarrow Q(x)$ [11]. The rule must pre-exist, and it is meant to reveal a non-accidental association between the P property and the Q property. We will observe that the statements in which *tout* is used are analytical generic ones, akin to indefinite generic statements. [3, 15, 4, 13, 16]

We will argue that observation of each of the entities is not needed, as the ability of the domain of quantification of being infinite reveals. *Tout*-statements, being universals, hardly tolerate exceptions but they nevertheless do: if one of the entities is not conformed to the rule, one might even discuss whether it really belongs to the class one quantify over.

Chaque is used in descriptive statements. It requires the domain of quantification to be finite; moreover, the content in the scope of the quantifier can be accidental to the entities in the restriction (unlike what happens with *tout*, for which only intrinsic properties of the class are targeted). The notional category ‘universal quantification’, with *chaque*, we show, takes the form of a closure over

a domain, each of the entities of which has been inspected. Typically, *chaque*, cannot be used as a generic [12].

We refer to *tout*-universal quantifier as *analytical universal quantifiers* and to *chaque*-type of quantifier as *synthetic universal quantifier* in order to disentangle the type of the statements in which they are used.

The two proof-theoretical views of universal quantification The model theoretic view of universal quantification is completely naive: $\forall xP(x)$ is true whenever $P(x)$ holds for all x in the domain. Most authors consider $\forall xP(x)$ is nothing than a short hand for $\&_{x \in D}P(x)$ which is not necessarily a first order formula e.g. when D is infinite (or worse, uncountable, like instants or places). This conjunctive view presupposes that the domain is clear, and this is rather rare in natural language.

In order to model meaning, we think that sense (Sinn) is more faithful than reference or denotation (Bedeutung) and a natural candidate for the sense of a sentence is the set of its proofs — and this differs from the usual interpretation of sentences as sets of situations in which the sentence happens to be true. [7] From this proof-theoretical view, there are two natural ways to assert a universal statement.

One is the standard proof rule (\forall_i): for a variable x about which nothing is assumed you are able to infer $P(x)$, hence you can conclude $\forall x.P(x)$ (example: simply assuming that n is integer you show that there exists four squares whose sum is n , so you can conclude that every integer is the sum of four squares, or for more linguistic examples, with “*tout*” see [11]). Gentzen deductive systems NK or LK [8] give a clear account of this rule, and Hilbert generic element $\tau x. P(x)$ introduced in [10]. This is an ideal element that, with respect to P has nothing particular, so when it enjoys P so does every other element: $\forall x.P(x) \equiv P(\tau x.P(x))$. This τ that is an *in situ* quantifiers is also the dual of the better known ε operator that has been used for modelling definite and indefinite noun phrases— see e.g. [17]

The other natural rule, known as the ω -rule is quite different. It was introduced by Gentzen in [9] to establish the consistency of arithmetics: assume you have a proof of $P(n)$ for each n , then you can conclude that $\forall nP(n)$. This rule is closer to the model theoretic view, and it presupposes that the domain D is known, here $D = \mathbb{N}$. Observe that the ω -rule requires an infinite number of premisses, so a proof with an ω -rule has an infinite width, although any of its branches is finite.

The difference between the two rules \forall_i and ω can be made intuitive as follows: the usual proof rule \forall_i yields to statements that are true in *any* model, while the later rule ω only derives statements that are true in the intended model with domain D . Observe that there do exist statements that are true in one model and not in others: completeness theorem says that the formulae of first order logic that

are true in any model are exactly the ones that are provable in first order classical logic; a non provable formulae can be true in one model and false in another model. There is also a structural difference: formulae and proofs cannot refer to entities in the model; although the logical language may include constants, those constants cannot properly refer to elements of models: elements of models vary from a model to another one, and furthermore an interpretation may map different constants onto a single element in the model. Hence these two views of quantification are quite different although they may coincide for a particular language and theory, in particular on a well-defined finite domain.

“Chaque” as a conjunction and “tout” as a generic In common French, as far as our intuition and data are correct (see below), it seems that *chaque* needs a precise the domain which on the other hand can be totally contingent. Exceptions are less welcome with *chaque* than they are with *tout* — the collective universal quantifier *tous les* is the one that better tolerates exceptions. [12] This is absolutely consistent with the interpretation of *chaque* as $\&_{x \in D}$. On the other hand, “*tout*” especially in “*tout X*” may be applied to a possibly vague class.

As opposed to “*chaque*”, “*tout*” requires the assertion to be perennial in some sense, which prevents “*tout*” from applying to very particular classes that are not perennial as suggested in [11, 12]. This makes “*tout*” close to the proof theoretical $\forall x$ or better to the $\tau x.P(x)$. Observe that it is also close to the generic “*un*” in this respect.

Next, how do we refute an assertion with “*chaque*”? There is only one possibility which consists in finding one element that does not enjoy the property. This is consistent with “*chaque*” being a conjunction. Now how does one refute a “*tout*” assertion? One way is to exhibit an element *a* not satisfying the property, in the (often imprecise) domain *D* under consideration: this is a switch from a real quantification to a conjunction over the domain, and the asserter may object that *a* is not in the imprecise domain *D* he was thinking of. Another way is to object a “*tout*” assertion is to remain in the conceptual level, and to say that a subdomain of the domain of the “*tout*” does not enjoy the property. Here as well the asserter may object that they are not part of the intended domain, but it is going to be more difficult.

We explored a bit the proof theoretical interpretation of natural language quantification in [1].

Verifying our intuitions: ongoing experiments We have attempted to use corpora to substantiate our hypothesis, by looking for data in a dialog corpus of rather spontaneous speech (CID). Universal quantifiers were too rare to draw any conclusion though, and it seems necessary to deploy some specific experiments. First,

we are testing the sensitivity of these quantifiers to different types of domains and most notably vague and precise ones. We expect a complementary distribution between *tout* and *chaque*. Second, we are testing how *tout* and *chaque* sentences are refuted. We test for (i) individual exceptions and (ii) type exceptions.

Our tests take the form of judgments elicitation in the first place. We are planning to create more elaborate experiments, where fillers and control sentences are used thus completing our questionnaire. This type of experiments will be finalized, once we will have sharpened the hypothesis with standard introspective methods. The design of the data base, the web programming of the questionnaires and the storage of the answers for statistics will be the project for two groups of four third year students, from January to May.

Future work There are further questions completing this study that we would like to develop.

Firstly we would like to compare the processing of quantification by standard subjects and dyslexic subjects, and children in particular. Indeed, a recent study on the difference between the understanding of negation (and to a lesser extend of Aristotle quantified sentences A E I O) by standard and dyslexic children has greatly helped to understand the human processing of such sentences. [6]

Secondly we would like to extend the study to “*tous_les*”, a (the?) third wording of universal quantification in French [12], which in contrast with *tout* and *chaque* insofar as it refers to the domain as a whole. How does “*tous_les*” compare with “*tout*” and “*chaque*”? The same question may apply to “*les*” (although *les N* is considered to be a referential expression, rather than a quantificational one [4]), and to the generic “*un*” (which we can foresee close to “*tout*”)

Thirdly we would like to also use experiments whereby subjects, after listening to a sentence, match pictures that are presented to them with the relevant sentence. Pictures are presented on the screen of an eye-tracker which records their eye glaze. This will allows us to gain some insights into how subjects understand quantifiers. We already used such experiments in a study showing that “*chaque*” in object position takes scope more easily than “*tous_les*” does in the same object position [2]

Concluding remark The difference between the “*chaque*” and “*tout*” proverbs in the title possibly comes from the actual existence of the domain of quantification, “*vins*” possibly being understood here as *barrels* — this is comforted by the dependency of the “*lie*” on the “*vin*” via “*sa*” — while the “*tout*” proverb seems to be speaking of the eternal essence of “*nuit*” — observe that “*jour*” also is an essence, introduced by the generic “*un*”, hence not dependent on the “*nuit*” — which do not precisely determine the domain of the quantifier.

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