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Surprise routines in scientific writing: A study of French social science articles*

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Emotions are almost absent from scientific articles except surprise, which plays a specific role in this genre. Surprise markers such as *contrairement à nos attentes* (‘contrary to our expectations’) or *ce résultat relativement surprenant* (‘this somewhat surprising result’) are used in the framework of a scientific prediction model, implicit or explicitly formulated. A corpus linguistic study of adjectival and verbal markers allows us to determine several trends: a) contrary to other genres such as novels or newspaper articles, surprise is not polar, that is to say it is neither positive nor negative, but stylistically “neutral”, b) surprise is far more source-oriented than experiencer-oriented, c) surprise generally involves the reader as a witness, and contributes, with other rhetorical markers, to "interlocutive" dialogism, d) surprise often occurs in a prefabricated discursive scenario including several steps : (i) prediction model, (ii) observed facts, (iii) expression of surprise (or absence of surprise), (iv) explanation of surprising facts. Finally, we can question the status of surprise as an affect in scientific writing. It seems to be more a state of consciousness associated with the observation of complex facts. In any case, it appears to be a complex state, with rich conceptual content.

Keywords: scientific writing – emotions – surprise - stance

1. Introduction

This paper aims at identifying the linguistic properties of the semantic field of surprise in scientific writing, especially in French research articles in the social sciences. Studying affects in scientific texts might seem a little… surprising since scientific writing is often considered as a neutral genre where the subjective dimension is rarely present, although recent studies have shown that scientific authors are often more visible in their writing than is frequently believed (e.g. Fløttum, Dahl, & Kinn, 2006; Tutin & Grossmann, 2014). This subjective dimension frequently occurs in attitude and stance markers such as evaluative lexicon (e.g. Swales & Burke, 2003; Tutin, 2010) or opinion markers (e.g. Hyland, 2002). However, the emotional dimension, strictly related to feelings, is almost completely absent from this genre with the exception of surprise, which is quite widely used in contexts such as the following:

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(1) [1]*Ce résultat relativement surprenant s'explique, à nos yeux, par une définition…*
'This somewhat surprising result can be explained, in our view, with a definition…'

(2) *Sans surprise, ces résultats nous ont permis de valider l'hypothèse posée comme générale*.
'Unsurprisingly, these results have allowed us to validate our general hypothesis.'

Surprise markers involve lexical expressions meaning a "an unexpected or astonishing event, fact, etc." (Oxford English Dictionary), whether they are multiword expressions or not, and regardless of their part of speech. The presence of this affect in scientific articles could be related to the fact that surprise is non-polar, i.e. neither a positive nor a negative affect but a neutral one, and is therefore not a prototypical emotion (Ortony, Clore, & Collin, 1999). In this particular genre, the expression of surprise is almost always a reaction to scientific facts (results, statements, etc.) and the experiencer of the affect is generally the scientific author(s) or the scientific community. Actually, as we will see, surprise markers seem to be used to establish a strong reader-writer interaction, similar to the use of statement verbs as evidential markers (when confirming the validity of scientific facts) (see Grossmann & Tutin, 2010a) or hedges and epistemic modality in order to enable interpersonal negotiation (e.g. Hyland, 1998).

In this article, we aim to demonstrate that the expression of surprise is fully routinized in this specific genre, not only where phraseology and specific prefabricated expressions are concerned, but also in the use of stereotyped rhetorical functions regarding scientific evidence. We also wish to explore the extent to which the expression of surprise is similar or different here than in other written genres.

We begin with an overview of the notion of surprise in scientific articles and its relation to rhetorical strategy. We will then present a corpus study of adjectival and verbal surprise markers derived from a sub-corpus of the Scientext project (which includes 344 research articles across 10 disciplines) before analyzing syntactic and semantic properties. These elements will then be used in the final section devoted to enunciative, i.e. formal linguistic properties involving the reader-writer interactions, and discursive and textual properties.

2. Scientific writing and surprise markers

Scientific writing is an important part of scientific activity, especially in the field of social sciences and humanities, and studies focusing on the genre of published research articles reveal interesting facts about the epistemology of disciplines. Far from being neutral, scientists produce strongly argumentative texts where authorial position can be expressed in the evaluation of scientific objects and opinions, as well as in positions taken towards peers (Grossmann, Tutin, & Garcia Da Silva, 2009; Tutin & Grossmann, 2014). However, the expression of emotion is quite rare in this genre, with the exception of surprise, which often appears in routinized expressions such as *de façon surprenante* ('surprisingly'*), les résultats sont étonnants* ('the results are surprising'), *contre toute attente* ('against all expectations'), and *il est surprenant que* ('it is surprising that').

[1] Translations are provided to allow readers who do not speak French to better understand the examples. For this reason, these translations follow the French syntax as far as possible. However, due to the differences between French and English, this is not always possible and the reader should bear in mind that the features under discussion are always those present in the original examples rather than the translations.

Emotions are unlikely to be central to scientific texts, contrary to other genres such as readers' letters or editorials in newspapers (cf. Plantin, 2011). As scientific discourse is not built on emotions, we can therefore assume that surprise markers are intentionally used as part of a rhetorical strategy. Following Plantin (2011) and Celle and Lansari (2014), after Caffi and Janney (1994), we can contend that surprise does not fall within the scope of "emotional communication", where the emotion is spontaneously expressed, but rather within the scope of "emotive communication" with the "intentional strategic signalling of affective information in speech and writing" (Caffi & Janney, 1994, p. 348). As mentioned by Plantin (2011, p. 140), "intentional communication and the strategic use of emotions contrast with the incursion of emotions in language activity… Controlled emotion contrasts with experienced emotion."[2]

According to Boch, Grossmann, and Rinck (2007) and Grossmann and Wirth (2007), surprise markers belong to markers of non-congruence and are used in the framework of an argumentative device related to expectations: "The writer creates expectations in the reader, awakening curiosity by showing interest in the issue, by not readily providing an answer to the questions…" (Boch et al., 2007, p. 112, our translation). Expectations can be explicitly formulated in a "prediction model" (*we assume that… our hypothesis is… our method should find…*), especially in the introductory section of a research article, as the following example illustrates:

(3) *La première hypothèse postule qu'un état émotionnel suffisamment intense devrait produire une quantité substantielle de pensées intrusives…* [psychology-407-introduction]
'The first hypothesis is that a sufficiently intense emotional state is expected to produce a substantial amount of intrusive thoughts.'

More frequently, though, expectations are implicitly assumed and are related either to the "doxa" (e.g. "scientific texts are devoid of subjectivity") or to peer-shared scientific knowledge (e.g. "the emotion of surprise has a specific status in the field of emotions, as it is non polar"). In scientific writing, as in other genres (see Celle & Lansari, 2014; Kern & Grutchus, 2014), surprise is generally formulated when observed facts contradict expectations.

By studying surprise markers in scientific writing, we also wish to explore the extent to which surprise markers are similar to those observed in other genres such as literature or newspapers. Since we are mainly concerned by the issue of surprise, we will focus on non-congruence markers although congruence markers are probably involved in the same kind of rhetorical process as surprise. We will look at the extent to which there is a semantic and syntactic specificity to scientific writing. Though surprise is not a polar affect itself, is polarity involved in the surrounding context of surprise markers? And in this genre, can we consider, as claimed by Kövecses (2003, p. 33), that "surprise is not a socially very complex phenomenon, and consequently, that there is not a great amount of conceptual content to be associated with it"?

[2] Our translation.

3. Corpus study of the semantic field of surprise in scientific articles

3.1 Methodology

In this study, we focus on expressed emotions relying on explicit surprise markers in a corpus of 344 French research articles in 10 disciplines within the social sciences and humanities,[3] drawn from French peer-reviewed journals (3.2 million words). This subcorpus is part of the extended Scientext Corpus, a free corpus available online developed in the framework of an ANR[4] project. The corpus has been tagged using a syntactic parser, and allows queries on specific lemmas, parts of speech, or syntactic functions. For example, it is possible to extract all the nouns syntactically related to a surprise adjective (*frappant* 'striking', *surprenant* 'striking' or *étonnant* 'astonishing'), with an attributive or a predicative relation, as shown in Figure 1 and in Figure 2.

```
//TITRE: Surprise adjectives related to nouns

(ATTRIB,#2,#1) = (SUJ,#3,#1) (ATTS,#3,#2) ;
$surprise=frappant,étonnant,surprenant

Main = <lemma=$surprise,#1> && <cat=N,#2> :: (ATTRIB,#1,#2) OR (ADJ,#1,#2);
```

Figure 1. A syntactic query (nouns syntactically related to 3 adjectives of surprise)

100 occurrences. Page: 1

▼N°	▽ Contexte gauche: 5 mots	▽ Occurrence:	▽ Contexte droit: 5 mots
1	en 1867 à Neuchâtel une assez	étonnante Histoire	universelle de la pédagogie .
2	; d' où d'	étonnants paradoxes	entre les projets immobiliers ou
3	et ce particulièrement si des	éléments sont surprenants	, comme l' énigmatique scène
4	Une telle	perspective n' est pas surprenante	dans la tradition américaine où
5	est bien réelle et la	convergence avec la psychanalyse qui débute à peine est ici particulièrement frappante	.
6	de ces petits coquillages au	destin étonnant	a été fort bien retracée
7	l' histoire de nos	étonnants petits coquillages	...
8	) , font état d' une	étonnante mainmise	du géniteur sur les biens

Figure 2. Surprise adjectives syntactically related to nouns (extract of the concordances)

[3] The disciplines in question are anthropology, economics, geography, history, linguistics, psychology, educational sciences, political sciences, information sciences, and sociology.

[4] Agence Nationale de Recherche – the French National Research Agency, which provides funding for research projects on a selective basis. The website of the project is : http://scientext.msh-alpes.fr

Surprise markers were extracted from texts with queries using available lexical resources of emotion for French: a) the lexicon for affective annotation (Augustyn et al., 2008) and b) the Emotaix Lexicon (Piolat & Bannour, 2009) developed for the study of affective discourse in psychology. These resources already contain lexical classes of emotions such as 'surprise', 'joy', and 'sadness'. Words included in the category of 'surprise' were selected and merged. The list of surprise words includes 51 adjectives, 17 nouns, 24 verbs, and 6 adverbials[5] (see appendix). Although this lexical list may not be exhaustive, we believe that it is representative of single words belonging to the semantic field of surprise.

Drawing upon these resources, relevant concordances of our corpus were disambiguated, since surprise lexicon can be ambiguous. For example, *frapper* ('to strike') is quite frequent as a verb of surprise. However, literal meanings can also be encountered, as in the following example:

(4) *La misère frappe violemment les populations les plus fragiles.* [sed-the-480-body]
'Misery violently strikes the most vulnerable populations.'

Furthermore, we only selected surprise contexts associated with the writer/reader of the scientific text[6], and consequently surprise expressions associated with external experiencers were not taken into account. For example, we excluded example (5) because surprise is not associated to the reader/writer but to one of the survey respondents in a study of anthropology. Conversely, example (6) was selected, since surprise is associated with the reader/writer of the article, even though the experiencer is not explicitly present.

(5) *Lorsque je précisais à mes enquêtés être issue d'une " Faculté des Sciences du Sport ", certains furent étonnés, d'autres, énervés …* [ant-art-415-body]
'When I explained to my interviewees being from a "Faculty of Sport Sciences", some were surprised, others angry ...'

(6) *Ces deux extraits présentent un parallélisme frappant.* [lin-the-646-body]
'These two excerpts show a striking parallelism'

Surprise words all have their semantic specificity but, like most emotion words, they all involve two semantic roles, at least implicitly: an experiencer and a source (or a cause). Some lexical units are experiencer-oriented, for example *s'étonner* (*'to be surprised'*), while others are source-oriented like *surprenant ('surprising')* or *étonner* ('to astonish'). Nouns (e.g. *surprise, étonnement* 'surprise, astonishment') express the concept with a neutral orientation. As we will see below, in scientific writing, experiencers are often implicit while sources are always explicitly present.

3.2 Lexical markers of surprise

Our corpus extraction and selection revealed the presence of 325 occurrences of surprise markers, mostly adjectives and verbs (226 adjectives, 8 nouns, 75 verbs, and 16

[5] The list of adverbials will need to be completed.
[6] Which are statistically the most frequent cases.

adverbials). Our corpus of more than 3.2 million words contained relatively few references to surprise. Nouns and adverbials were the most infrequent; therefore we decided to focus on the two most productive parts of speech, adjectives and verbs, by analyzing their semantic and syntactic features. The syntactic and semantic analyses will then be used in the enunciative and discursive analysis in section 4.

3.2.1 *Surprise adjectives*

As mentioned above, surprise adjectives were the most frequent part of speech found in our corpus (226 occurrences[7]). All adjectives were source-oriented (*résultats surprenants* 'surprising results', *il est étonnant que* ... 'it is astonishing that …'), which is to say that all of them were related to sources and not to the experiencer. Nevertheless, it should be noted that the words *surpris* ('surprised') and *étonné* ('astonished'), which are both experiencer-oriented, were analyzed as past-participle verbal forms and not as adjectives (see 3.2.3). However, we will see below that *surpris* and *étonné* were infrequent in our corpus, probably due to the impersonal style of scientific writing.

Four adjectives (*surprenant* 'surprising', *frappant* 'striking', *étonnant* 'astonishing', *inattendu* 'unexpected') constituted 70% of this category, dominating the distribution as can be seen in Figure 3. Several adjectives that are frequent in general language (*merveilleux* 'marvellous', *incroyable* 'incredible', *stupéfait* 'amazed') were almost completely absent, along with very intense adjectives, adjectives including a polar dimension, or adjectives belonging to a colloquial register. Scientific writing therefore uses the most neutral and the least polar surprise adjectives.

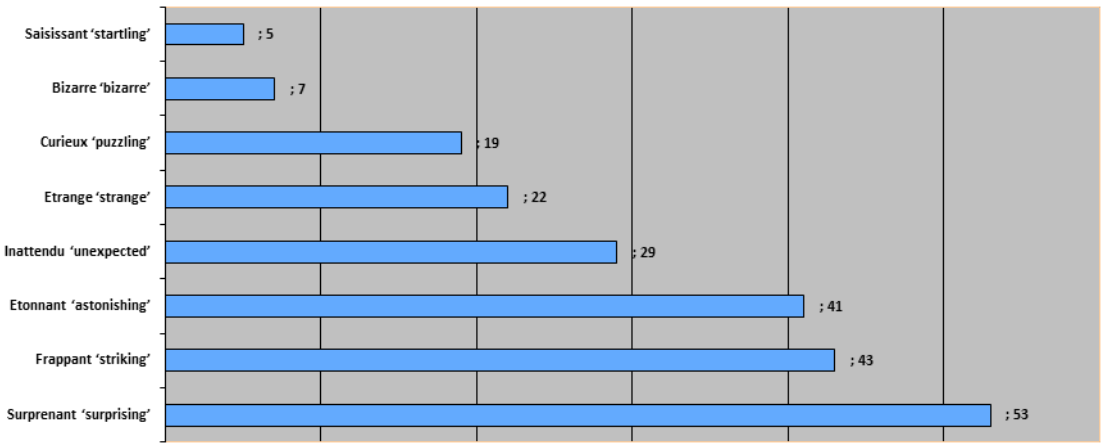

Figure 3. The most frequent adjectives of the semantic field of surprise

As mentioned above, there was almost no explicit mark of the experiencer, even in a large co-text, for example in the surrounding sentences. Implicitly, when unexpected facts are observed, the experience of surprise is shared by both writer and reader, and even the discourse community (See section 4.1).

[7] They include –*ant* forms erroneously analyzed as verbs.

Concerning syntactic constructions, we can observe that they were quite varied (See distribution in Table 1).

They can be attributive, as in the following example:

(7) *Il ne serait pas difficile de débusquer d'autres exemples d'analyses surprenantes ou contradictoires,*…[linguistics-202-body]
'It would not be difficult to track down other examples of surprising or contradictory analyses'

Predicative constructions were also quite productive (see (8)) and, very interestingly, we noticed a large proportion of impersonal constructions (*il est* Adj *de* 'it is Adj' or *il est* Adj *que* 'it is Adj that') where the clause introduced can be considered as the source of surprise (e.g. (7)). This shows that these adjectives are often associated with facts or events, more than with simple objects.

(8) *Ce constat est d'autant plus surprenant que la société gabonaise valorise la solidarité familiale et parentale dans l'ensemble des interactions quotidiennes.* [sociology-83-body]
'This finding is all the more surprising given that the Gabonese society values family and parental solidarity throughout daily interactions.'

(9) Quel que soit le type d'impact attribué aux évolutions démographiques, il est frappant de constater l'importance de ce facteur dans le débat allemand (Kabisch et al., 2006). [geography – 348 – body]
'Regardless of the impact attributed to demographic changes, it is striking to note the importance of this factor in the German debate'

Syntactic function	Attributive	Predicative	Impersonal construction	Other
	44.0%	32.0%	21.8%	2.2%

Table 1. Syntactic distribution of surprise adjectives

In one-fifth of occurrences, surprise adjectives were included in negative clauses. Almost half of the cases in impersonal clauses were found with *que*, as in the following example.

(10) Il n'est donc pas surprenant que l'approche de Vygotsky ait une forte influence en Russie (en dépit du fait que le travail … [economics-275-body]
'It is therefore not surprising that Vygotsky's approach has a strong influence in Russia (despite the fact that work …'

In about 10% of cases, hedging could be observed with epistemic modal verbs such as *sembler* or *pouvoir* or with adverbs such as *plutôt* 'rather'. This reinforces the impression that surprise is quite weak and that this feeling can be "negotiated" with the reader, as is often the case with hedging in scientific writing (see Hyland, 1998). Moreover, several adverbials related to the apparent, but not proven, character of surprise were observed (e.g. *a priori, apparemment, à première vue,* 'at first sight, apparently, on first glance') (see 11), but this surprise did not resist a thorough examination of the facts. The authors went on to show that they were able to provide a logical explanation of these facts, as we will see below (4.2).

(11) *Un tel résultat pourrait a priori paraître extrêmement curieux : on s'attendrait à ce que les processus à longue mémoire permettent des prévisions bonnes à court terme* … [economics-36-body]
'Such a result could seem extremely odd at first sight: one would expect that long memory processes would provide good short-term forecasts ...'

Finally, we noticed several verbless sentences including surprise adjectives, as in the following examples:

(12) *Plus surprenant encore, les résultats engrangés au fil de ces multiples efforts de recherche sont substantiellement cohérents.* [educational science-482-body]
'Even more surprising, the results achieved through these multiple research efforts are substantially consistent.'

(13) *Fait curieux, qui conforte et éclaire notre propos : le texte n'a pas de co- texte* ... [linguistics-38-body]
'An odd fact, which reinforces and clarifies our argument, is that the text has no co-text … '

The use of verbless sentences in the semantic field of surprise has already been observed by Novakova and Sorba (2014) with the noun *stupéfaction* 'amazement'. This increases the element of surprise, as the emotion is mentioned before the cause. We will see a similar effect below (4.2.2) with the use of pseudo-cleft sentences.

On a semantic level, we analyzed the different kinds of sources related to surprise adjectives. In attributive and predicative constructions, different semantic types of nouns emerged:

- Quality nouns such as *aspect* 'aspect', *caractère* 'character', *contraste* 'contrast' dealing with the properties of observed objects;
- Results pertaining to observed objects: *constat* 'statement', *élément* 'element', *exemple* 'example', *résultats* 'results', *phénomène* 'phenomenon';
- Logical relations: *effet* 'effect', *conséquence,* 'consequence', *lien* 'link' ;

It should be highlighted here that no polar nouns, whether positive or negative, were found and that no trace of polarity could be found in the co-text of surprise adjectives. Many of these nouns have a large scope and can be considered as "signalling nouns" (Flowerdew, 2003), whose meaning is contextual with an endophoric function. In the following example, the word *oubli* ('oversight") summarizes a complex fact previously mentioned in the text. Moreover, many of these anaphoric nouns are introduced with the help of demonstrative determiners, a very common discursive device in scientific writing (Boch & Rinck, to appear).

(14) *Si l'on admet qu'un statut plus élevé réduit les coûts de production (toutes choses égales par ailleurs), Podolny devrait en toute rigueur appliquer la loi des coûts et conclure que la hausse du statut tend à faire baisser le prix de vente. Or, il ne le fait pas. Cet "oubli" est étonnant puisque dans l'enquête empirique de son article il applique bien cette loi* …[sociology-552-body]
'If we assume that a higher status reduces production costs (all else being equal), Podolny should theoretically apply the law of costs and conclude that higher status tends to lower the selling price. But he did not. This "oversight" is surprising since, in the empirical investigation of his article, he applies this law …'

We also noted several collocations and preferred associations between nouns and adjectives (although beyond the scope of this study) such as *contraste frappant* 'striking contrast', *effet inattendu* 'unexpected effect', and *résultat surprenant* 'surprising result'. These collocations can be explained by the semantic properties of each adjective and contribute here to the routinized flavor of surprise markers.

Sources in impersonal constructions are infinitive clauses and *que*-clauses. Infinitive clauses mainly include verbs with an evidential function (*voir* 'see', *constater* 'note',

and *observer* ‘observe’ (see (11)), while *que*-clauses (often negative as mentioned above) introduce scientific facts.

(15) *Tout d'abord il est assez frappant de constater que les cadres évacuent largement leur fonction évaluative : la production d'une fiche d'évaluation et l'attribution d'une note* … [information science-547-body]
‘First of all, it is quite striking to note that executives largely set aside their evaluative function: producing a scorecard and a rating ...’

(16) *Dès lors, il n' est guère étonnant que le "culte" d'Angela Davis s'étiole après 1973* [history-513-body]
‘Therefore, it is hardly surprising that the "cult" of Angela Davis waned after 1973’

In summary, surprise adjectives used in these scientific articles are generally stylistically neutral and moderately intense. They are source-oriented and the experiencers (writer and reader) are generally implicit. Surprise is often toned down with hedging (and is negated in 20% of cases), and adjectives are used to qualify scientific facts and qualities. Polar words are absent in both sources and the co-text.

3.2.2 *Surprise verbs*

Occurrences of surprise verbs were far less numerous than surprise adjectives (74 vs 226), although verbal forms included passive past participles, e.g. *je suis surpris* ‘I am surprised’ or *étonné* ‘astonished’. All the verbs belong to Ruwet’s second class of verbs (Ruwet, 1994; Novakova, Goossens, & Grossmann, 2013), i.e. verbs which have the experiencer as the direct object and the cause as the grammatical subject. But with passive and pronominal alternations, these verbs can become experiencer-oriented.

Three verbs (and their passive or pronominal alternations) were most present in our corpus: *étonner/s’étonner/être étonné* ‘amaze, astonish’ (30 occ.), *surprendre/être surprise/se surprendre* ‘surprise’ (27 occ.) and *frapper/être frappé* ‘strike’ (17 occ.). As is the case for adjectives, the most intensive and polar verbs (e.g. *sidérer* ‘stupefy’, *méduser* ‘baffle’, and *estomaquer*, ‘flabbergast’) were absent, but contrary to adjectives, half of the verbs were experience-oriented (36/74), as in the following example:

(17) *On pourrait donc être surpris que seulement deux familles du Brabant se soient établies en Flandre après 1450, alors qu'avant cette date* … [history-184-body]
‘One might therefore be surprised that only two families of Brabant were located in Flanders after 1450, whereas before that date …’

The other half is source-oriented, as in:

(18) *La première chose qui frappe, dans l'analyse de cette élection est la difficulté à retrouver les clivages habituels en politique…* [geography-550-body]
‘The first thing that strikes one in the analysis of this election, is the difficulty to find the usual political divisions ...’

Among the source-oriented verbs, we found only four occurrences of the experiencer (*nous* ‘we’).

A third of the verbs appeared with a negation, which was a greater proportion than for adjectives. Interestingly, though, similar to the occurrences with adjectives, affirmative clauses were often toned down with epistemic modals (*on peut s’étonner* ‘we may be surprised’) or adverbs (*sans doute* ’probably’). ‘Pure’ surprise without negation or hedging represented only half of the occurrences. We also noted (see also Novakova et

al. (2013) in novels and newspapers), frequent pseudo-cleft constructions, especially with *frapper*, which thus seems more typical of the semantic field than the genre:

(19) *Si une telle prodigalité demeure somme toute exceptionnelle et limitée essentiellement au XIIIe siècle, ce qui frappe plus encore est le souci des hommes d'approvisionner les indigents en victuailles, …* [history-63-body]
'While such extravagance remains altogether exceptional and limited primarily to the thirteenth century, what is more striking is men's desire to supply the needy in victuals, …'

This construction could be compared to verbless clauses with surprise adjectives, where it contributes first to placing emphasis on the expression of surprise and second, to mentioning the source of the surprise. Several other recurrent verbal expressions were observed such as *on ne s'étonnera pas…* 'one will not be surprised that'… X *ne laisse pas de surprendre…* 'X is nonetheless surprising', and *aussi ne serait-on pas surpris…* 'one will therefore not be surprised…'. These prefabricated expressions contribute to the formulaic style of mentions of surprise in scientific articles.

If we now look at the semantic roles of surprise verbs, among experiencers (35/74 occ.), we find mainly occurrences with personal pronouns: 24 *on* 'one', 6 *nous* 'we' (4 are subject 'we', 2 are direct object 'us'), only two *je* 'I' and two NP (*l'observateur* 'the observer', *un regard distancié* 'a distanced view'). The use of these pronouns shows that experiencers are not highlighted (we will return to this point in 4.1).

Regarding the semantic role of source, contrary to other genres (e.g. dialogues in Celle and Lansari (2014), novels and newspapers (Novakova et al., 2013)), we did not encounter examples such as *nous sommes surpris* 'we are surprised' without any mention of the source. In the genre of scientific writing, sources are obligatory arguments while experiencers are optional arguments. Looking at the syntactic type of the source revealed a large number of clauses (21 occ/74. *que*-clauses, *si*-clauses, and infinitive clauses). Pronominal sources (*ce, cela*), which have an endophoric function, were more frequent than with adjectives (12 occ.). Nominal sources of surprise verbs were quite similar to what was observed in the case of adjectives: many of them could be considered as "signalling nouns", but this feature was even more pronounced with surprise verbs, with frequent generic nouns such as *chose* 'thing' and *fait* 'fact'. For surprise verbs, Novakova et al. (2013) noticed a duplication of syntactic actants of cause in some syntactic contexts such as pseudo-cleft sentences. In scientific writing, we often notice a duplication of discursive source arguments (as observed in example 19): the signalling noun or the pronoun is the syntactic actant, but the real semantic actant has to be found in the larger context.

In short, our observations regarding verbs confirmed the trends regarding adjectives. Verbal surprise markers are stylistically neutral, not very intense, and place more emphasis on sources than on experiencers – the former are obligatory, contrary to the latter. As is the case for adjectives, sources are facts or signalling nouns or pronouns related to facts. Since experiencers are discrete and hedging frequent, the expression of surprise is definitely not a sign of strong subjectivity in scientific writing.

4. Enunciative and discursive features

Having examined the formal properties of surprise markers, we will now turn to the use of these elements in scientific texts. First of all, we will address the topic of the

experiencer to identify who experiences surprise in scientific texts. Then we will look at some discursive properties of surprise in scientific writing.

4.1 Enunciative properties

Who exactly experiences surprise in scientific writing? We saw previously that experiencers are often implicit with surprise markers: they are completely absent with source-oriented adjectives, and only present in half the cases of surprise verbs. When present, they are represented using mostly *on* 'one' or *nous* 'we', and rarely *je* 'I'. But *nous* and *on* are polyfunctional and can have several referential values in scientific writing (Fløttum et al., 2006; Tutin, 2010; Hartwell & Jacques, 2014). They can refer:

a) to a single or plural author (e.g. *nous pensons,* '*we think*'…),

b) to the author and the reader (e.g. *comme nous pouvons le voir dans cette figure,* '*as we can see in this figure'*),

c) to the author and the scientific community (e.g. *on considère souvent que la surprise n'est pas une émotion polaire…* '*one often considers that surprise is not a polar emotion…'*),

d) seldom with *nous,* more frequently with *on,* to a generic human being (e.g. *en général, nous pensons tous/on pense tous que la surprise est une émotion passagère… 'generally, we all feel that surprise is a brief emotion'*).

Close examination of *on* and *nous* (we shall leave aside *je* for which we have only two occurrences) shows that several referential values can be found with surprise verbs, although disambiguation is quite tricky and requires thorough examination of the textual context. In some examples, the experiencer refers strictly to the author. In this case, surprise is often related to the scientific narration and is a step in the scientific study. The tense here can be the *passé composé* as in the following example:

(20) *Nous l'avons dit plus haut, <u>nous avons été frappés</u> par le fait de nous retrouver devant quelque chose de très complexe* [educational science-574-body]
'As we have said before, <u>we were struck</u> by the fact that we faced something very complex:

Far more frequently, *nous* et *on* refer to a larger community, including the author and the reader but also the scientific community. Surprise expressed by the author engages the reader as a witness and is related to the expectations of the discourse community. This is especially true when modals or hedging are used, such as in the following example:

(21) *<u>On pourrait donc être surpris</u> que seulement deux familles du Brabant se soient établies en Flandre après 1450, alors qu'avant cette date…* [history-184-body]
'<u>One might therefore be surprised</u> that only two families of Brabant were located in Flanders after 1450, whereas before that date …'

By including the reader and the discourse community in the observation of unexpected facts, the author establishes complicity with the reader: they share the same references and the same expectations. The author's surprise is not personal: it is a shared feeling – or may simply be a statement of non-congruence with regard to expectations – which would be experienced by any observer in the same community. While scientific writing has an inherent interdiscursive dimension, the expression of surprise – like other types

of markers (for example, statement markers with evidential functions *comme nous pouvons le voir dans la figure 1* 'as we can see on Figure 1', cf. Grossmann & Tutin (2010a; 2010b)) – is clearly an aspect of "interlocutive" dialogism.

4.2 Discursive properties of surprise in scientific writing

In this section, we will address two aspects of discursive properties: the thematic role of surprise arguments and the stereotypical discursive scenario of surprise in our corpus.

4.2.1 *Thematic observations*

As previously discussed, surprise experiencers are very often shadows of more predominant sources. We wished to look more precisely at the thematic positions of the surprise-experiencer-source trio in our corpus by examining the first element occurring in discourse.

Concerning adjectives, all source-oriented, we observed several interesting facts. While most occurrences seemed to follow the source-surprise order (*un fait frappant* 'a striking fact'*; ces résultats sont frappants* 'these results are striking'), in some cases the reverse order was also observed. Several surprise adjectives (*frappant, étonnant, curieux,* 'striking', 'astonishing, 'curious') occurred in a prenominal position, which appears as a marked position compared to the more ordinary postnominal position in French:

(22) *Il est possible d'aller chercher dans les arcanes du droit administratif des éléments de compréhension de cette <u>étonnante asymétrie</u>* [political science-380-body]
'It is possible to hunt through the labyrinths of administrative law for the elements necessary for understanding this <u>surprising lack of symmetry</u>'

Surprise was also mentioned before the source in some verbless sentences, as observed above (cf. examples 12 and 13) or in impersonal constructions where infinitive or *que*-clauses were obviously located after the adjectives.

With verb surprise markers, while in most cases we found sources or experiencers in the first position, we also noticed that a large number of experiencer-oriented verbs had an implicit grammatical subject, as in the following example:

(23) Comment <u>ne pas être frappé</u> par la diversité et l'irréductibilité des sens octroyés à cette notion dont, au demeurant, l'usage … [educational science-383-body]
'How is it possible <u>not to be struck</u> by the diversity and irreducibility of meanings ascribed to this notion, the use of which, incidentally,…'

As with pseudo-cleft sentences (see example 19), this reinforces the impression that the emphasis is placed on the surprise predicate rather than on the experiencer.

To sum up, in our corpus, the observation of thematic position shows that emphasis is placed on sources. Interestingly, though, several marked constructions seem to be used to emphasize the surprise predicate, in order to create a dynamic scientific narrative.

4.2.2 *Scenario of surprise*

If we now look at the discursive scenarios involving surprise in our corpus, some regularities can be identified. When attempting to analyze the argumentative

construction of this emotion (see Micheli, 2010), several topics can be highlighted, as observed by Novakova and Sorba (2013) with the verb *stupéfier* ‘amaze’ in the journalistic genre. In scientific writing, surprise clearly occurs in the framework of a scientific prediction model, although this model is more frequently implicit than explicit.

The surprise scenario (or the absence of surprise) is thus generally associated with a number of discursive sequences, some of which are optionally realized. The chronological order of these sequences of the surprise scenario does not necessarily correspond to the sequential order in the text, as described below:

1) Sequence 1: Scientific expectations

As stated earlier in section 1, expectations can be expressed explicitly, as in *on s'attendrait à ce que les processus à longue mémoire permettent des prévisions bonnes à court terme* ... (‘one would expect that long memory processes would provide good short-term forecasts…’). Given the size of the corpus, we could not examine all the occurrences exhaustively, but implicit expectations, be they common sense or shared knowledge of the discourse community, seem far more frequent in this genre than explicit expectations.

2) Sequence 2: Observations of facts

The facts observed constitute the source of the predicate of surprise, in its widest sense. As mentioned earlier, the source role immediately associated with the surprise predicate is often an endophoric element or a signalling noun whose antecedent has to be found in the textual environment. The fact is generally associated with an observation or a statement.

3) Sequence 3: Congruence or non-congruence with expectations

Surprise (or the absence of surprise) is related to the extent of observed facts being congruent with expectations..

4) Sequence 4: Explanation of surprise

Scenarios of emotions should also take into account post-emotion effects (Plantin, 2011). We observed that surprise was often toned down in scientific writing or considered as apparent (e.g. *surprenant à première vue* ‘surprising at first sight’). In scientific writing, surprise is often followed by a specific sequence of explanation: surprising facts can actually be explained (and thus do not remain that surprising). Either the prediction model has to be revised or the facts are actually more complex than assumed, as in the following example:

(24) BENSAÏD et de PALMA [1995] concluent à une transmission supérieure à "un pour un" de la politique monétaire	FACT
Ce résultat surprenant tient,	SOURCE and SURPRISE
pour une part, au fait que le coût marginal des ressources est, dans leur article, assimilé au taux	EXPLANATION

de la politique monétaire,.

> ‘BENSAÏD and Palma [1995] conclude that there is a transmission greater than "one for one" of monetary policy. This surprising result is due, in part, to the fact that the marginal cost of funds is, in their article, likened to the rate of monetary policy….’

This simplified scenario remains representative of those found in our corpus, although the rhetorical strategies of surprise need to be studied further.

5. Conclusion

While surprise is fairly present in the lexicon and discourse strategies of research articles of French social sciences, they do not have a very emotional flavor in this genre, for several reasons:

- Surprise is more source-oriented than experiencer-oriented. The human dimension is set aside in favor of the objective dimension. In other contexts, such as literature or dialogue, the focus is the experience of surprise by a person. In scientific writing, the objects of surprise, in this case, scientific facts and scientific objects, take center stage, while experiencers are either absent or diluted in the discourse community.
- The lexical environment is not polar. While surprise in itself is not good or bad, the context is often polar in literature or newspapers; in scientific writing, there is simply surprise, corresponding to the non-congruence of predicted facts. This seems to be a specificity of this genre compared to other genres (Kern & Grutchus, 2014; Novakova & Sorba, 2014).
- Surprise is not a strong feeling, if it is one. Surprise is often apparent (or attenuated) and is almost always accompanied by an explanation. It is used mainly to establish complicity and to strengthen the scientific narrative, as highlighted by Boch et al. (2007), as evidence or congruence markers are also used. Some stylistic effects such as verbless clauses or pseudocleft sentences seem to further support this analysis.
- Contrary to what is commonly accepted as a specific property for this feeling, surprise is not in this genre a passing affect. It is more a routinized process associated with a discursive scenario in the sociolect of the scientific community.

Finally, we question the status of surprise as an affect in scientific writing. It seems to be more a state of consciousness associated with the observation of complex facts expressed in stereotypical rhetorical scenarios. In any case, it appears to be a complex state, with rich conceptual content. Finally, these findings confirm that while a kind of subjectivity may be present in scientific writings through stance or opinion markers, the affective component is definitely not a part of them. Furthermore, they reinforce the particular status of surprise in the field of affects/emotions.

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Appendix

List of surprise markers

Adjectives

ahuri,abasourdi,abasourdissant,ahuri,ahurissant,baba,bizarre,cloué,coi,confondant,confondu,curieux,déconcertant,déconcerté,ébahi,ébaubi,éberlué,ébouriffant,ébouriffé,épatant,épaté,époustouflant,époustouflé,estomaqué,étonnant,étonné,étrange,foudroyant,frappant,frappé,inattendu,incroyable,interdit,interloqué,invraisemblable,médusé,merveilleux,pantois,prodigieux,renversant,renversé,saisissant,sidérant,sidéré,soufflé,stupéfait,stupéfiant,suffocant,suffoqué,surprenant,surpris

Nouns

abasourdissement,ahurissement,ébahissement,éberluement,ébouriffement,effarement,épatement,étonnement,saisissement,sidération,soubresaut,stupéfaction,stupeur,surprise,sursaut,tressaillement,tressautement

Verbs

ahurir,abasourdir,ébahir,bluffer,époustoufler,étonner,interloquer,clouer,sidérer,surprendre,sursauter,tressaillir,éberluer,tressauter,ébouriffer,épater,estomaquer,frapper,méduser,renverser,scier,sécher,souffler,stupéfier

Adverbials

de façon surprenante, de façon étonnante, de manière surprenante, de manière étonnante, incroyablement, imprévisiblement, étonamment, contre toute attente