# Colligation and the cohesive function of present and past tense in the scientific research article

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Le temps verbal est traditionnellement analysé comme une catégorie grammaticale au niveau de la proposition. Nous argumentons ici que le temps peut être également conçu comme un marqueur de cohésion textuelle, au moins dans les textes scientifiques en anglais. La fonction primordiale du temps serait de former une chaîne de références cohésives dans le développement linéaire du texte. Chaque temps grammatical a une distribution contrastive et prévisible dans le texte, ce qui est indissociable du type de procès sémantique exprimé par le verbe, ainsi que la construction lexico-grammaticale dans laquelle le verbe est employé. Nous tâcherons de démontrer ces principes en analysant les différentes formes de *be* et *have* dans un corpus de textes pharmaceutiques. On peut observer une corrélation étroite (dite 'colligation') entre le temps grammatical, la construction lexico-grammaticale, ainsi que les différentes fonctions majeures du genre scientifique (explication, évaluation, etc.).

**Introduction**

Tense has often been seen as a grammatical category, especially in traditional grammar, where conjugations are compared with aspect and modality, or in discourse theory, where verb forms are seen as the traces of underlying cognitive operations (Culioli 1999). However, I propose here that tense is as a marker of cohesion; that is to say an anaphoric feature of the clause which signals a 'continuing' or a 'contrastive' relation with other finite clauses at the level of the text (Halliday and Hasan 1976). The referential function of tense appears to be particularly relevant to textual cohesion in scientific articles in English. Using examples from the *Pharmaceutical Sciences Corpus* (Gledhill 1995, 2000a, 2000b), I attempt to demonstrate here that there is a correlation not only between tenses and the lexico-grammatical constructions in which different verbs are used, but also between the various sub-sections of scientific texts. Such a close correspondence between grammar, lexis and text is known as 'colligation' in the British empirical tradition (Firth 1935, Hoey 2005). One aim of this paper is therefore to examine the extent to which the different tenses of English 'have colligations', in the same way that lexical items 'have collocations' (*strong tea, auburn hair* etc.). My hypothesis is that the colligations of

the present and the past tense can be associated with abstract genres of English science writing such as 'explanation, evaluation' and the like.

In the first part of this paper, I present an overview of the various approaches that have been proposed to deal with tenses in scientific discourse. I then present a micro-analysis of tense in a single text, and then a macro-analysis of various forms of the past and present of *be* and *have* in a larger corpus of scientific texts.

## 1. Tenses in science writing

It is not difficult to understand why tenses have often been overlooked in science writing. While tense usage is often seen as more or less stable across different registers, the modal verbs and the passive are well-known to be more frequently used in scientific texts than in the general language, and have consequently come to be seen as the emblematic features of the genre (Hanania & Akhtar 1985, Shaw 1992, Hyland 1994, Banks 1994). But it could be argued that tenses are just as crucial to science writing, especially since a change of tense often corresponds to a subtle signal that a claim is being made. For example, an innovative finding in a scientific paper may be reported in the past tense (henceforth PAST). If the claim is then quoted elsewhere, in journals or textbooks, it is reformulated as an established fact and thereafter the research community refers to it in the present tense (PRES). The fact that tense is an obligatory feature of finite clauses means that, in formal writing at least, all clauses in scientific English contain a rhetorical signal of the relationship between the author's opinion and the subject matter.

However, this picture is an oversimplification. Most linguists who have examined the question generally agree that the primary tenses in science writing have a much more specialised set of interpretations than in the general language. However, there does not seem to be much agreement about what these are. Lackstrom et al. (1973) and Oster (1981) point out that PRES expresses 'universal laws, processes, repeated actions, definitions, descriptions, observations', and 'material properties'. Malcolm (1987) distinguishes between the 'timelessness' implied by PRES, and 'time-boundedness' implied by PAST (1987: 38-40). She argues that an important function of PAST is to focus on the experiment at hand, distinguishing between the objective experience of the researchers and the abstract, subjective ideas expressed by PRES. Salager-Meyer's large-scale study of verb forms in Abstracts (1992) shows that

PRES is used to emphasise the relevance of previous research, whereas PAST indicates the undeveloped nature of previous findings. Tense emerges from these studies as a stable, but diffuse grammatical category which corresponds to various binary semantic divisions such as *action / activity, designation / denotation, authorial stance / subject*. I would want to argue, however, that our interpretation of an individual tense marker must also depend on the lexical pattern in which the tense is used, not to mention the surrounding textual role of the marker in relation to or in contrast with previous verb forms.

Studies on the distribution of tenses have also revealed a very complex picture. Halliday and James (1993) discuss the distribution of tenses in general and scientific English, noting that PRES / PAST is the type of binary grammatical system in which one term is unmarked, with a stable ratio of distribution of around 90% : 10%. But even if this ratio were stable in the scientific research article, the context of use does not have to be the same as in the general language. Much research has been done on the distribution of forms within the different sub-sections of the research article, for example Barber (1962), Gerbert (1970), Hawes and Thompson (1997), Biber, Conrad and Reppen (1998) and White (2004). Heslot (1982) and Hanania & Akhtar (1985) establish that while PRES is the key tense in Introduction / Discussion sections, the PAST becomes prevalent in Methods / Results. Swales (1990) presents a synthesis of work done on the distribution of tenses and other verb forms; including the passive (PASS). The following table sums up the relative frequency of verb forms according to Swales (1990: 105):

|  | **Introduction** | **Methods** | **Results** | **Discussion** |
|---|---|---|---|---|
| **PRES** | high | low | low | high |
| **PAST** | mid | high | high | mid |
| **PASS** | low | high | variable | variable |

These data clearly belie the notion that grammatical features are evenly spread across the research article, a point that can be made about grammatical items as well (Gledhill 2000a, 2000b). It is significant that Swales' explanation for the transition from one form to another in different sub-sections is couched in terms of proximity to the author's message (reported in Swales and Feak 1994: 184):

The differences among … tenses are subtle. In general, a move from past to present perfect and then to present indicates that the research reported is increasingly *close* to the writer in some way: close to the writer's own opinion, close to the writer's own research, or close to the current state of knowledge.

This is certainly a plausible account, and one that suggests a contrastive role for different verb forms. But, Swales and Feak's view seems to contradict the conclusions of other linguists, namely that the PAST is closer to the research at hand. However, all of these researchers appear to share the view that the PRES and the PAST have reasonably predictable meanings even though, as we have seen, they are unable to pin them down. This also happens to be the central assumption among discourse theorists (following Culioli 1999), who claim that grammatical forms are 'operators', units which have a fixed reference and represent traces of cognitive operations. According to this view, tense usage is the result of a mental computation, complete and invariable in its reference, regardless of context. Unfortunately, such theories do not get us any closer to understanding how the different parts of the clause combine in order to create a message (the notion of 'syntax' is notably opaque in Culioli's approach), and they certainly do not explain how tense operates at a textual level.

But what is the alternative? It could be argued that the meanings that we commonly associate with PRES or PAST are contingent, and therefore our interpretation of them has just as much to do with the lexico-grammatical constructions in which they are used. This would account for the apparent 'specialisation' of the PRES and PAST tenses in science writing. Adamczewksi makes a similar point about the grammatical uses of *have*, whose interpretation ultimately depends on context: "Tout ce que l'on peut dire […] de tel ou tel emploi de HAVE n'est qu'un effet de l'interaction avec des marqueurs co-occurrents…." (1982: 150). In other words, grammatical forms only do half the work for us: they derive some if not most of their meaning from the typical constructions in which they are used. I discuss this 'contextualist' approach further in the discussion of colligation, below. However, before looking at colligation in detail, it is important to examine how tenses may vary within a single text.

## 2. Tenses and the Textual metafunction

In this section, I argue in that that tense should be seen as a form of textual signalling. There has been much research on cohesion in scientific texts (for example, Meyer 1988). However, tenses have not usually been considered as markers of cohesion, although their role in the development of narrative has long been recognised in the field of stylistics (Jakobson 1957, discussed in Short 1996). One reason for this oversight may be that in their original work on the

subject, Halliday and Hasan (1976) define cohesion in terms of overt textual signals operating beyond the level of the clause. Thus they are concerned with lexical signals of reference (*endophoric* and *exophoric reference,* including *repetition, synonymy, collocation*)*,* grammatical signals of reference (*ellipsis, substitution*) and grammatical signals of textual relation (in particular *conjunction*, which involves such relations as *matching*, *logical sequence*). So although grammatical systems such as articles, pronouns and the like qualify as forms of anaphora, tenses only merit discussion in terms of verbal ellipsis and the 'presupposition of tense' (Halliday and Hasan, 1976: 29, 192).

However, there is plenty of evidence to suggest that tenses do have a role to play in thematic structure, at least in the more abstract form of Given and New information (Halliday 1985). In textbook accounts of science writing, such as Smith and Bernhardt (1997), PRES is said to refer to previous facts or statements (= Given), whereas PAST is used to report specific methods and results arising from current research (= New). This rather paradoxical state of affairs can be seen in examples (1) and (2) (from the PSC corpus, Gledhill 2000a, 2000b):

PRES = Given information

1.  Although cholesterol **is** not fully responsible for the formation of liposomes, it
    is often used in pharmaceutical liposome formulation.

PAST = New information

2.  We **showed** that the parent compound was extensively metabolised.

It can be seen, in example (3), that the present perfect (PERF) has a hybrid function. Gunawardena (1989) and Schramm (1996) suggest that PERF is used to report previous research (= Given) within the context of current findings (= New):

PERF = Given (in support of) New information

3.  Clinical studies **have shown** that EPX is equivalent to MTX.

It should be pointed out here that in each of these cases, the tense does not specifically 'signal' Given or New information, at least not in the way usually understood by Halliday (1985). Instead tense 'correlates with' authorial stance, and this has to be gleaned from the context. In other words, PRES and PAST are only metatextual signals of Given and New; any contrastive or continued information is expressed elsewhere in each case. In (1), we can gather that the

clause complex is 'to be understood as Given' from the simple Relational Process *is* and the corresponding use of an evaluative Complement (*fully responsible for …*). Similarly the clause complexes in (2) and (3), are assumed to be 'New in relation to what has previously been shown' because of the use of plausible Subjects (*we, clinical studies*) and projections of Mental Processes (*showed that, have shown that*). Such correlations between verb form and clause function are good examples of 'colligation', as discussed below.

It is necessary at this point to demonstrate the cohesive role of tense in a single text. In order to do this I have chosen a paper dating from 1837 by a formerly well-known Scottish surgeon Robert Liston[1]. This text was chosen because of its brevity and also because, in early articles of this type, the substructure is absent, with no signal of different sub-sections (Moessner 2005). What happens instead is that the narrative cycles between the two macro-genres of 'evaluation' and 'description', and as a consequence the author shifts from one tense to the next. However, what is of interest here is not just the transition between PRES and PAST, but also the corresponding change in semantic processes. In the following extracts, all the Finite (= tensed) verb forms have been signalled in bold, with non-Finites (including Participles) underlined for comparison. Following Banks (1994), any passives in the text have been treated as a combination of a State + Event, i.e. a Finite verb (always a Relative Process) + a participle expressing a more specific Process.

In the first section, Liston exclusively uses PRES to discuss a cancerous tumour. The Process types here involve Material metaphors of caused movement which express Liston's perception of the shape and size of the tumour (*displace, project, produce*):

[…fibro-sarcomatous tumours] **attain**, though slowly, a great size, they **present** a globular or botryoidal (i.e. nodulated) form, **displace** the surrounding soft and hard parts, **project** from the countenance and, <u>deranging</u> the features, **produce** great and frightful deformity…

The second section, which is not signalled explicitly, moves from 'evaluation' to 'description'. Liston retains PRES but the Process types become Relational, especially *be* in passive clauses (PASS) of Mental observation, or as a lexical verb in Attributive clauses (describing parts of the tumour and its location on the face):

[1]    Liston, R. (1837) 'Excision of a remarkable tumour of the upper jaw, the case of Mrs Fraser, aged 40, from Banchory Ternan, Aberdeenshire.' In *Medic-Chirurgical Transactions,* Edinburgh.

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[…] The left side of the face is completely occupied by an immense growth, which
obstructs the eye of that side, rising to a level with the forehead, extending back
to the ear, and bulging down below the inferior maxilla, but not attached to it. From
the part of the tumour next to the ear to that part in front of the face it measures
about nine inches. The mouth is completely drawn to the left side, and there is
constant discharge of saliva from it. She keeps a handkerchief constantly applied to
it by the hand, to concentrate the sound of her voice when speaking, and to collect
the saliva. She is unable to open her mouth above three-fourths of an inch. The
tumour bulges considerably into the cavity of the mouth, but there is no difficulty
in swallowing. The nose is also twisted to the left side, but she can breathe through
it pretty easily… Numerous large veins are seen beneath the integuments of the
tumour, and arteries of considerable size are felt beating in it.
```

The third section is signalled simply by a change of paragraph. Here the tense changes to PAST as Liston sets out a description of his methods, expressed by Material passives (clinical processes of movement or caused movement such as *traversed, cut, loosened, divided, shaken*). The Agent roles of *surgeon* and *assistant* only appear indirectly at the beginning:

```
An assistant being ready to compress the common carotid artery, the soft parts were
divided by an incision which traversed the mesial surface of the tumour, and
terminated in the angle of the mouth. The alveolar process (the two central incisors
having been previously extracted), the palatine plate, and the nasal process of the
maxilla were then cut with the forceps. An incision was carried along the upper
surface of the tumour under the inferior eyelid to over the junction of the malar and
frontal bones, and prolonged from that, in the line of the zygoma, to near the
auricle. The bones were then cut, into the spheno-maxillary fissure and through the
zygomatic arch, - all this was done with but little interference with the vascular
supply. The connection being loosened, and the tumour shaken to its base, the soft
parts underneath were divided, and the mass was turned out without difficulty. The
bleeding vessels were secured.
```

The (again unsignalled) transition to the final section is more complex. There is a transition from narrative PAST (*nothing interrupted… The patient returned*) to PRES involving the verb *be* in Relational PASS and Attributive clauses as above. However, the difference between the fourth section and second, is that PRES can be associated here with the simultaneous description and evaluation of the patient's recovery. The process types involved are Relational or caused Relations (*interrupted, is enabled, is rendered more…*, *prevented, improves, forms*), or Mental (*would be imagined, is inclined to do*). The PERF at the beginning of the final sentence involves future reference (introduced after *until*), which would be unusual in a modern scientific text, but may be typical of this type of 'case-study':

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Nothing interrupted her recovery, and the deformity is much slighter than would be
imagined. The patient returned the following summer to have a gold plate fitted by my
friend Mr Nasmyth, of Edinburgh, with a portion attached to fill up the space (not
very large) in the cheek. Besides removing the deformity, the patient is thus enabled
t o swallow comfortably and articulate distinctly. During the cure, and until the
edges of the opening in the palate have cicatrized, and until the aperture has
contracted so far as it is inclined to do, the patient is rendered more comfortable
by wearing a little paste made of crumb of bread well kneaded, this prevents foreign
matters lodging in the wound, improves speech, and forms no bad dressing, a poultice
in fact to the part.
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Overall, this text has few lexical signals of textual transition. What it does have are clear changes in topical Theme, as well as a clearly identifiable flow of tenses from PRES to PAST and back to PRES (or more specifically in terms of 'verb forms': PRES, PRES PASS, PAST PASS, PAST, PRES PASS, PRES PERF). We can also see that there is a general correlation between tense and on the one hand and explanatory or descriptive discourse on the other. Of course, these uses coincide with the general semantic features mentioned above (PAST = close observation, PRES = distant evaluation). But it could also be argued that tense is being used contrastively in this text (especially at the beginning of each section). Subsequently, after the first use of a new verb form, its repeated use can be interpreted as a cohesive link with the on-going text.

Halliday and Matthiessen (2004 : 336-337) see tense essentially in terms of the Experiential metafunction (verb forms contribute to time-reference in the clause) and the Interpersonal metafunction (verb forms signal authorial stance). But, as we have seen, tenses also have a role to play either as a textual signal of continuity (no change from one finite clause to another) or of contrast (some transition has taken place). So, without denying the semantic contribution that tenses make, it is also clear that they also have a key role as part of the Textual metafunction.

## 3. Collocations and colligations

The term 'collocation' refers usually to lexical expressions such as fixed phrases and idioms (*auburn hair, to curry favour,* etc.) Since the advent of large-scale corpus studies, there has been a considerable amount of research on collocational patterns, especially of lexical items and terminology in science writing (Pavel 1993, Thomas 1993, Granger 1996, Pearson 1998,

Williams 1998). The collocational behaviour of grammatical features, however, tends not to be discussed, presumably because it is assumed that: i) grammatical categories collocate with anything, so there is little to be said about them in terms of phraseology, and ii) grammatical categories are the same across different registers, so there is even less to be said about their phraseology in technical writing. However, I have argued that grammatical items do in fact have collocational patterns (Gledhill 1995, 2000a, 2000b). Banks (1994:70) has similarly noted that grammatical categories such as the passive consistently co-occur with modals such as *can* and *may* in science writing. In the rest of this section, I argue that just as lexical items can be associated (as 'collocations') with other lexical items, the grammatical category of tense also enters into a similar type of relation, known as 'colligation' (Firth 1935, Hoey 2005).

Computational linguists usually define collocations in purely statistical terms of lexical 'co-occurrence' (Sinclair 1991, Williams 1998), whereas grammarians and lexicographers tend to concentrate on lexical 'constructions', that is to say the syntagmatic relations between different lexical items (Hausmann 1979, Hunston and Francis 2000). It is interesting to note that Firth's original conception of collocation is less concerned with collocation as a form of lexical unit, than with collocation as a cohesive relation between lexical items:

Collocations of a given word are statements of the habitual or customary places of that word in collocational order but not in other contextual order and emphatically not in any grammatical order. The collocation of a word or a 'piece' is not to be regarded as mere juxtaposition, it is an order of *mutual expectancy*. (Firth, 1935:12)

Halliday and Hasan (1976) develop this sense of the term, referring to collocation in terms of the relationship that can be established between chains of lexical items:

[…] *laugh…joke, blade…sharp, garden…dig* […] In general, any two lexical items having similar patterns of collocation – that is, tending to appear in similar contexts – will generate a cohesive force if they occur in adjacent sentences. (Halliday and Hasan 1976:285-6)

Given what I have claimed about the textual function of verb forms in the previous section, it should be possible to establish 'cohesive' relations of the same type for grammatical categories such as tense. Indeed, this appears to be what Firth (1935) has in mind when he coins the term 'colligation'. Cited in Mitchell (1975), Firth distinguishes between the collocation *push + through* and the colligation VERB + PARTICLE:

As collocations are nameable by words, so colligations involve the use of word-classes to name the collocational class. Colligational labels underline the necessary admixture of 'functional' and 'formal' as in the case of 'motive' verb + 'directional' particle. (Firth, in Mitchell 1957:121)

This is as near as I have come to finding a clear definition of 'colligation' in Firth's writing. Fortunately, Hoey (2005) has recently attempted to clarify colligation, arguing that it should be extended to include the mutual expectancy of sentential positions, as well as relations at the level of the text, which he terms 'textual colligation':

Colligation can be defined as 1) the grammatical company a word or word sequence keeps, 2) the grammatical functions preferred or avoided by the group in which the word or word sequence participates, 3) the place in a sequence that a word or word sequence prefers. (Hoey 2005:43)

It is clear from this definition that colligation is more than just 'grammatical collocation'. As far as Hoey is concerned, a colligation involves all of the lexico-grammatical features of a construction, including its lexical forms, its grammatical functions, as well as its syntagmatic features, both below and above the level of the group or even the clause. The notion of colligation turns out to be more appropriate to the study of tenses than that of collocation. In order to demonstrate this point more fully, in the following sections I discuss the colligations of PRES and PAST tense in a corpus of English science writing.

## 4. Tenses in the corpus

In this section, I set out the phraseological profile of various forms of *be* and *have* as they are used in the *Pharmaceutical Sciences Corpus* (PSC), an archive of half a million words from a selection of articles in the field of cancer research (Gledhill 2000a, 2000b). As has been noted for science writing in general, *be* is a dominant verb form in this corpus[2]. The PAST forms of *be* (*was* and *were*) are much more frequent in the PSC (1.2 / 1.0%) than in the *British National Corpus* (BNC) (0.85 / 0.3%). This is significant, because verbs are often less frequent in specialist texts compared to the general language, largely because they have a highly dense 'nominal' style. Thus the verb *have* is less frequently used in the PSC than in BNC, with the forms *has* / *have* / *had* representing respectively 0.18 / 0.2 / 0.19% of the PSC, as opposed to

[2] The forms that are relevant here are *is, was, were* and *been*. Forms such as contractions ('*s*) and the first person *am* do not occur in the PSC. In addition, the 3PL form *are* does not occur frequently enough to warrant discussion.

0.25 / 0.45 / 0.41% in the BNC. The verb *make* has an even lower relative frequency in the PSC: the forms *make / makes / made* represent 0.01 / 0.00 / 0.03% in the PSC versus 0.08 / 0.02 / 0.09% in the BNC. By the same token, some verb forms are more frequently used in science writing, especially past participles of lexical verbs such as *associated, shown, related* which account for between 0.8 and 1% of the PSC, as opposed to a frequency of less than 0.1% in the BNC. Clearly, the kind of statement we can make about a text on the basis of statistics is nevertheless rather sketchy. In the following paragraphs, I attempt to examine the present and the past tense forms (especially of the most frequent verbs, *be* and *have*) in their natural habitat.

Is it possible to show that PRES and PAST have different colligational patterns? It is possible to demonstrate fairly simple correspondences between tenses and lexical context in low-frequency verbs such as *to lead*. This verb is used in expressions of caused Relation. The PRES tense is used when the Subject refers to a 'Biochemical' entity or process:

```
1. response to DNA damage leads to an arrest of the cells
2. This in turn leads to increased conversion of the lactase
3. This process leads to inhibition of intracellular concentrations
4. altered membrane transport leads to degradation extracelluar matrix (ECM)
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In contrast, the PAST is used when the Subject is a nominalised 'Empirical' or other Mental process:

```
5. These observations led to comparative studies
6. these findings led to widespread use of hormonal aspects
7. Identification of cell response led to the investigation of radioimmunization
8. These results led to the selection of a battery of immune assays
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A similar contrast, although operating on different lines, occurs with *to appear*. In the PRES, *appear* introduces a Biochemical or 'Research-oriented' process which contradicts previous findings:

```
9. However, the function of p52... does not appear to stimulate DN synthesis
   directly.
10. Many tumours appear to have no relation to DNT oncogenic viruses
11. However, this appears to contradict some of our preliminary observations.
12. It appears to be an ubiquitous protein, although there is no correlation...
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In the PAST, *appeared* is used for a more specific evaluation of Empirical or observed data, often accompanied by a textual signal of contrast, such as *however*:

```
13. However, digoxin appeared to be less effective as inhibitor than cyclosporin.
14. The vestibular nerves and Scarpa's ganglion cells appeared to be well developed
    and normal.
```

15. The ossicles **appeared** to <u>be normal</u>; <u>however</u>, it was difficult to further estimate due to the artifacts.
16. significant adduct formation was observed <u>but</u> this **appeared** to <u>have little effect on</u> the structures of the proteins…

The general rule seems to be that PRES is involved in the expression of qualification or evaluation, while PAST is involved in quantification or descriptive report. This is consistent with the use of tenses we observed in the Robert Liston text, above.

The qualification / quantification rule-of-thumb also appears to apply to forms of *be* and *have* in the PSC. Putting the PERF and the PASS forms to one side for the moment, we can see that PRES forms of *have* tend to be used in clauses of Attribution, where the Complement is qualitatively evaluated:

17. surviving cells **have** <u>aberrant</u> morphology
18. the drug may **have** <u>important</u> implications
19. the current assays may **have** <u>limited</u> sensitivity
20. they **have** <u>negligible</u> agonist abilities

The PAST form *had* mostly occurs in Results sections and expresses quantified evaluation (it is notable that *had* co-occurs regularly with the indefinite determiner *a*):

21. mice **had** a <u>decreased</u> number of formations
22. animal tumours **had** a <u>greater</u> mean length
23. rat liver **had** a <u>higher</u> glucose count
24. patients **had** a <u>lower</u> frequency

A slightly different pattern involves a 'light verb' construction, in which a generic Material Process (Range) *no effect* is followed by an indirect Complement (Affected) *on + tumour* :

25. the vehicle [=drug] **had** <u>no effect on</u> tumor expression
26. ZAAf **had** <u>no effect on</u> the reduction of tumor size
27. treatment of narial cells **had** <u>no effect on</u> weight gain
28. methanol control **had** <u>no effect on</u> number of implantations

Turning now to the verb *be,* we can see that its PRES form *is* is mostly used in Relational clauses of Attribution to evaluate a (Biochemical) entity as a specific (Research-oriented) process (*predictor, issue, drawback, factor, model…*):

29. However, molecular radius **is a** <u>much better</u> predictor of scleral permeability than molecular weight.
30. Tolerance **is a** <u>complex</u> issue and may be due to pharmacodynamic influences.
31. This **is a** <u>serious</u> drawback because although an overdose of Marinol would almost certainly not be lethal, it does produce dysphoria
32. Experimental otitis media with effusion in rats **is a** <u>useful</u> model for studying the pathogenesis otitis media with effusion in humans.

The PAST form *was* is used in clauses of Identification, especially to reformulate a Research-oriented entity or event as an Empirical observation. It is notable that there is no longer any evaluation of the Complement:

33. The <u>criterion</u> for interference **was a** <u>mean glucose difference</u> between the test sample
34. The dermatopathological study demonstrated that the <u>tumor</u> **was a** <u>recurrence</u> of MFH storiform-pleomorphic type that had reached and destroyed the bone.
35. The first <u>step</u> **was a** <u>preliminary evaluation</u> of quantitative versus qualitative POC
36. This <u>study</u> **was a** <u>randomised, double-blind, right- versus left-side comparison</u> performed at five centers…

Existential clauses built around *there is / there was* have a more complex set of patterns. PRES is generally used for previous research findings which are evaluated by modifiers such as *little*:

37. **There is** <u>little</u> clinical <u>evidence</u> of the benefit of prophylactic antibiotics after snakebite [3-5]
38. **there is** <u>little</u> information concerning the restorative care provided for individual patients over time.
39. However, **there is** <u>little</u> <u>research</u> published concerning these applications (2-5)
40. Because there have been few studies of respiratory mucosal healing, **there is** <u>little</u> <u>scientific support</u> for the management of the mucosal surfaces

Similarly, a number of Mental processes of communication (nominal forms of RESEARCH processes: *agreement, mention, suggestion*) are introduced by *there is*. Some involve a projection (as noted below, this structure is generally associated with the PRES in research articles):

41. Yet **there is** no <u>agreement</u> on what could be the best regimen to select in this high-risk subgroup of patients.
42. However, in their series, **there is** no <u>mention</u> of a particular case with this variation. Aldoo

43. … **there is** a <u>possibility</u> that the stoma may need to be resited in the other site.
44. **There is** a <u>suggestion</u> that hHb1 may produce a milder phenotype and that dystrophy may be commoner with hHb1 mutations.

In contrast, the PAST *there was* is used in a Existential clauses which state a quantifiable change of data direction (*correlation, difference, increase*) qualified by the prepositions *between* or *in*:

45. We also found that **there was** <u>no statistically significant difference</u> **in** PRs between group 1 and 2 in both long and short protocol cycles…
46. **There were** <u>no statistically significant differences</u> **between** the biochemical contents in the RA and the LA.
47. For patients who were followed for three years after the initial visit, **there was** <u>no significant increase</u> **in** bone mass over time
48. **There was** <u>no correlation</u> **between** the histological type of AC and the presence of concomitant squamous cell lesions.

## 4.2 The present, the past and projecting clauses

In scientific texts, Mental processes reformulate or evaluate results, usually in the form of projecting clauses. The majority of these constructions involve the PRES tense. The following examples set out the three main types of projection to be found in the PSC:

49. These <u>findings</u> **indicate that** a cell <u>has become</u> committed to the.. lineage
50. **It is** <u>unlikely</u> **that** (X) does not <u>express</u> its gene products
51. **It is** <u>important</u> to <u>obtain</u> structural information

The only construction which allows two possible tenses is nominal projection ('fact' clauses). In such cases, there is a tendency for PRES to be used when a Research-oriented Subject (*goal, matter, practice, role, way*) is reformulated as a Empirical process (*maintain*, *prevent*, *use*, *aid*, *calculate*). These are generally evaluated in relation to specific results in the projected clause:

52. The <u>goal</u> of autoregulation in a tissue **is** to <u>maintain</u> relatively constant blood flow, capillary pressure and n
53. Another <u>important</u> <u>matter</u> **is** to <u>prevent</u> preoperative risk factors, which increase early
54. Currently, <u>standard</u> <u>practice</u> **is** to <u>use</u> an anticonvulsant to control the immediate convulsion

55. The most <u>practical</u> <u>way</u> to use this algorithm **i s** t o <u>calculate</u> the sum of coefficients for positive reactions

In contrast, the PAST is used to introduce the Research goals of the text at hand (*aim, goal, objective, purpose of ... this study*) in terms of Research-oriented processes (*investigate, study, determine, measure*). It is notable that no evaluation or hedging of the research process is provided in the Subject:

56. Another <u>aim</u> of the <u>study</u> **was** to <u>investigate</u> the possible role of MDR3 gene 1712delT mutation…
57. The <u>goal</u> of this <u>study</u> **was** to <u>determine</u> whether an infusion therapy, developed for the treatment of sudden hearing loss in the elderly, can induce recovery after progression in sensorineural hearing loss during childhood.
58. Our <u>objective</u> **was** to <u>determine</u> whether NPBI is increased in cerebrospinal fluid (CSF) from preterm infants with PHVD compared with preterm control infants.
59. The <u>purpose</u> of this <u>study</u> **was** to <u>measure</u> and compare peak temperatures reached during polymerization of 5 different materials used…

## 4.2 The present, the past and the passive

A very clear set of lexico-grammatical patterns can be observed for the passive. Following Banks (1994), passives are treated here as expansions of Relational clauses, that is to say as Auxiliary (expressing a Relational Process) + Participle (expressing a specific Process). In the PRES tense, the participle is usually a Mental process related to Research (*is + proven, understood*) or a Relational process related to Empirical observation (*is + related, associated, detected*). In most cases, participle *associated* is functionally equivalent to a complex preposition expressing 'measure' or 'causality' and the main Complement is introduced after a preposition. This can be seen in the formula (*Entity X*) *is associated with* (*Process Y*):

60. hypoglycaemia **is** <u>associated with</u> considerable increase in
61. The tumor mechanism **is** <u>associated with</u> acquisition of t-cell properties
62. The MAC tumor **is** <u>associated with</u> increased lactation
63. MOR phenotype **is** <u>associated with</u> enhanced stability

A similar use of PASS can be seen with *is related to* in which an Empirical observation is related to Biochemical items or processes. The pattern is shared by *is present in, is responsible for* etc.:

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64. risk **is** <u>related to</u> ethnicity
65. efficiency **is** <u>related to</u> stabilisation
66. the cause of toxicity **is** <u>related to</u> spasmodic polypeptides
67. The frequency in some tumor samples **is** <u>related to</u> the schedule of administration.

We can see then that PRES PASS is mostly used to characterise Subjects and express complex Relations. PAST PASS also has a consistent phraseology, especially in Methods sections where PASS is predominantly used to describe or report Clinical (Material) activities or Empirical (Mental) observations. The various patterns can be usefully sorted by the preposition which follows the participle and the Plural and Singular form of the Subject. The plural is used with Biochemical entities which are (destroyed) + *by* (means of destruction):

68. rabbits **were** <u>sacrificed</u> by severing the dorsal aorta
69. mice **were** <u>euthanized</u> after 82 weeks
70. the control groups **were** <u>necrotized</u> by $CO_2$ asphyxiation
71. the animals **were** <u>killed</u> by exsanguination

Singular items tend to correspond to Research-oriented processes. For example, (a statistical or measurement-related process) *was performed + using* (an Empirical method)

72. This <u>analysis</u> **was** <u>performed</u> using exponentially growing cells
73. clinical <u>determination</u> of the title compound **was** <u>performed</u> using an inverted microscope
74. baseline <u>calculation</u> **was** <u>performed</u> using the t-test
75. cell line <u>count</u> **was** <u>performed</u> using the Mann Whitney test


## 5. Conclusion

In this paper, I have argued that the present and the past tenses are not just grammatical features which express 'Ideational' time-reference at the level of the clause. Together with other verb forms such as the perfect and the passive, tenses can also be seen as cohesive markers of continuity and / or discontinuity at the level of the text. In scientific texts at least, and assuming that there are no other clues to rhetorical structure, a change of tense has a contrastive effect, but if the same tense occurs in a series there is no contrast. In other words, tenses form cohesive chains that are comparable to the sequences observed in many other cases of Thematic

structure. Of course, this 'Textual' view of tense need not distract from the 'Interpersonal' fact that the present and the past also express a subtle and constant form of evaluation of the message.

I have also argued here that tenses have 'colligations'; that is there is a very consistent and predictable correlation between tenses on the one hand and lexico-grammatical constructions. These constructions are highly delimited in the scientific research article : the PRES tense coincides with expressions of 'qualitative' attribution, 'empirical' projection and 'evaluative' (Mental / Relational) uses of the passive. The PAST is associated with 'quantitative' attribution and identification, as well as 'research-oriented' projection and 'descriptive' (Material) uses of the passive. But these patterns are not fortuitous correspondences. They should be seen as important indicators of patterns of thought which are well-established in conventional scientific discourse. These are ultimately related to the macro-genres which exist in more general forms of the language, such as technical 'description' and 'evaluation', among others. If we accept such a 'contextualist' view of language (as opposed to a 'conceptualist' one), this kind of evidence suggests that our interpretation of tense is coloured by the meaning of the clause as a whole. In other words, the role of tenses in the language system cannot be dissociated from the rhetorical constructions which are particular to modern technocratic discourse, and which are the reflection of systems of expression which are much more general than the patterns I have set out here.

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