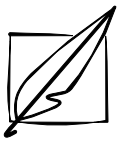

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Popularising scientific discourse for an academic audience: The case of Nobel lectures

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ABSTRACT

The language of popularisation has been the object of in-depth investigations from various perspectives. The overall idea is that it is not a distorted simplification of scientific knowledge for non-specialists but rather a reformulation and re-contextualization of scientific knowledge in a more direct form. Starting from this assumption, the present research aims at disclosing how and to what extent scientific knowledge is rendered in popularised language by members of the medical academic community for an academic audience, such as that of the Nobel Prize lectures. The investigation seems to suggest that there are differences in the communication strategies adopted to render scientific knowledge into effective popularised language, constructed as a set of communicative events which involve the transformation and recontextualization of specialist discourse. In this sense, it is primarily featured by the properties of the communicative context in which it takes place: participants and their role, their purposes, beliefs and knowledge.

1. Introduction

The language of popularisation has recently attracted interest in the field of linguistics. Attempts have been made to define the scope and boundaries of the discourse of popularisation (Hilgartner 1990; Jacobi 1990; Thoiron – Béjoint 1991; Cooter – Pumfrey 1994; Calsamiglia 2003; Gotti 2003; Myers 2003; Calsamiglia – van Dijk 2004; Paul 2004; de Oliveira – Pagano 2006; Giannoni 2008; Leake 2012). Other investigations have paid attention to the role played by the media in popularisation while bridging the gap between scientific knowledge and lay experience (Barton 1998; Beacco et al. 2002; Ciapuscio 2003; Moirand 2003; Dossena 2008), which can be expressed even through

metaphorization (Leane 2001; Skorcynska 2001; Knudsen 2003; Pramling – Säljö 2007). Research has also focussed on the language of popularisation for pedagogical purposes (Sharma 1972; Parkinson – Adendorff 2004, 2005).

The dominant view of popularisation is that it is a process by means of which scientific findings are disseminated outside the communities that produce, and to a certain extent 'own', such knowledge (Giannoni 2008: 212). This overriding yet naïve perspective of popularisation is based on the assumption that it is a simplification of specialized knowledge for non-specialists (Hilgartner 1990: 519; Myers 2003: 265). Such a distorted concept lies in the belief that genuine scientific knowledge is available to experts, whereas popularised knowledge targets non-experts. It also assumes that two types of discourse exist, one within and one outside scientific institutions and that popularisation is realized as a translation from one discourse to the other. Such a misrepresentation of popularisation implies the existence of an unbalanced power-relationship between experts and non-experts in which knowledge is assigned to experts (Myers 2003: 266). Yet scientific knowledge is expressed in as many contexts as possible, and a distinction based on scientific knowledge vs. popularised knowledge in turn requires the definition of the borders existing between 'genuine' experts or specialists and 'popularised' audiences (Hilgartner 1990: 525, 529). Indeed, as rightly claimed by Myers (2003: 267), popularisation is a process involving different actors, institutions, and forms of authority.

As a matter of fact, the boundary between genuine scientific knowledge and popularised representations is anything but clear (Hilgartner 1990: 524). Popularisation is indeed a matter of degree and operates along a continuum, going from researchers to the educated public with practitioners positioned somewhere in the middle (Hilgartner 1990; Myers 2003; Giannoni 2008). The contexts within which this continuum operates range "from laboratory 'shop talk', to technical seminars, to scientific papers in journals, to literature reviews, grant proposals, textbooks, policy documents, and mass media accounts" (Hilgartner 1990: 524).

Probably, the ambivalence of the concept of popularisation lies in the term itself: by popularisation we mean not only re-contextualizing and reformulating a (scientific) source text to allow for comprehension and accessibility by various audiences (Ciapuscio 2003: 210; de Oliveira/Pagano 2006: 626), who can thus elaborate lay versions of scientific knowledge to be integrated with existing knowledge; we also mean the diffusion of scientific texts among members of the scientific community stepping outside their very limited specialism (Myers 2003). There is therefore a need for disambiguating

the two forms of popularisation. On the one hand, there is the discourse of popularised science; on the other, the discourse of scientific popularisation. As we can see from Table 1 below, the discourse of popularised science texts refers to those texts which are used to set scientific knowledge in a readable and meaningful way addressed to non-specialist readers; the discourse of scientific popularisation refers to the type of texts used by expert members of the scientific community to disseminate scientific knowledge across specializations.

Table 1. Discourses of popularisation

	Discourse of popularised science	Discourse of scientific popularisation
Target	laymen, wider public	members of scientific community
Text type	mass media accounts; web documents (blogs; forums); government policy documents.	laboratory talk; grant proposals; project delivery; textbooks; mass media accounts; web documents (blogs; forums); policy documents.
Purpose	knowledge construction	knowledge dissemination

In other words, the discourses of popularisation are shaped by target and purpose (Gotti 2003). We need therefore to construct a new way of representing popularisation across a continuum going from popularised science to scientific popularisation (cf. Fig. 1).

Figure 1. Popularisation

To the best of my knowledge, the only studies carried out on the way in which discourse is 'popularised' by expert members of the scientific community for the sake of (a) professionals belonging to the same community and (b) members of a professional group of experts whose expertise is not within the same field as that of authors, are the ones by Giannoni (2008) and by Paul (2004), respectively. It is therefore the aim of this research to disclose how and to what extent scientific knowledge is disseminated as scientific

popularisation by the members of the medical academic community for other professionals outside the same profession. More precisely, I will investigate in what ways this occurs at such a prestigious academic event as the Nobel Prize Lecture. By comparing Nobel Prize Winner Lectures (NL) with the corresponding Research Article (RA)[1] the winners wrote and for which they were awarded, I will use a Corpus Linguistics approach in order to detect the key semantic domains in NL differing from the RA. This will show how popularisation can be achieved despite any possible professional-related conditioning effects. The discussion of the relative results will be carried out in the following paragraphs.

2. Methodological approach

The study analyses the NLs held in 2009, given by two Nobel Prize winners for Medicine or Physiology: Elizabeth H. Blackburn, who discussed the NL "Telomeres and Telomerase: The Means to the End" and Carol W. Greider, who presented the NL "Telomerase Discovery: The Excitement of Putting Together Pieces of the Puzzle" (with the related videos and slides). These will be later compared with the RA that the two Nobel Prize winners wrote back in 1985, that is "Identification of a specific telomere terminal transferase activity in Tetrahymena extracts"[2], where they scientifically described their discovery. The choice of these lectures was determined by the fact that (a) the two winners worked together in the project leading them to the telomerase discovery; (b) the two Nobel Laureates wrote together the RA about the telomerase discovery, which was eventually published in *Cell.*

The Nobel lectures were downloaded from www.nobelprize.org[3], and the research article was provided by the University of Bergamo Interlibrary Loan Office. Copyright permission to use and reproduce the Nobel Lectures was granted by the Nobel Prize Foundation[4]; copyright permission to use the above-mentioned research article for personal and non-commercial use is granted by *Cell* at http://www.cell.com/cellpress/TermsandConditions.

1 The NLs corpus comprises 23,875 words; the RA corpus includes 7,081 words.

2 The article was published in *Cell* (1985) 43(2/1): 405-13.

3 Elizabeth H. Blackburn's Lecture, "Telomeres and Telomerase: The Means to the End" was downloaded from http://www.nobelprize.org/nobel_prizes/medicine/laureates/2009/blackburn-lecture.html and Carol W. Greider's one, "Telomerase Discovery: The Excitement of Putting Together Pieces of the Puzzle" from http://www.nobelprize.org/nobel_prizes/medicine/laureates/2009/greider-lecture.html [27/09/2012].

4 Personal email received on April 12, 2012.

The documents were saved in pdf format and later transformed in text files for their use in concordancing software programs. The quantitative (Biber et al. 2007; Dörnyei 2007) and qualitative (Coffey – Atkinson 1996; Miles – Huberman 1994) analyses carried out in my research are based either on automatic or manual searches, or both. For the computer-based counts, Wordsmith Tool 4.0 (Scott 2007) and Wmatrix3[5] (Rayson 2009) search options have been used. The results, based on log-likelihood statistics ($p < 0.01$) and presented in standardised figures (per 1,000 words), were then accompanied by manual correction to rule out any non-relevant cases. For a classification of key semantic domains in the corpus, I scanned the target texts twice: the first time to locate any occurrence of such features; the second time to verify their actual status on contextual and pragmatic grounds.

3. Background

3.1 The Nobel Prize and the NL

The Nobel Prize in Physiology or Medicine, as described in Alfred Nobel's will, is dedicated to "the person who shall have made the most important discovery within the domain of physiology or medicine" (http://www.nobelprizemedicine.org/?page_id=2266 [18/10/2012]). According to the Nobel Foundation statutes, the Nobel Laureates are required "to give a lecture on a subject connected with the work for which the prize has been awarded" (http://www.nobelprize.org/nobel_ prizes/medicine/video_lectures.html [18/10/2012]). All NLs are theoretically open to the general public. It is usually rather difficult to find a place at the medicine lectures, since the main auditorium at Karolinska Institutet is quite small[6]. For this reason, they are also transmitted by video link to two other adjacent lecture halls. According to Tatiana Goriatcheva, Administrator of the Nobel Committee for Physiology or Medicine[7], the audience mainly consists of professors, scientists and research students from Karolinska Institutet as well as Stockholm University, and the Nobel Laureates know in advance that it is this type of audience they are targeting.

5 Available at http://ucrel.lancs.ac.uk/wmatrix3.html.

6 Email communication by Jonna Petterson Informatör/ Public Relations Officer Nobelstiftelsen (Oct. 8, 2012).

7 Email communication by Tatiana Goriatcheva, Administrator of the Nobel Committee for Physiology or Medicine (Oct 18, 2012).

The 2009 Nobel Prize for Physiology or Medicine was awarded to Elizabeth H. Blackburn, Carol W. Greider, and Jack W. Szostack "for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase" (http://www.nobelprize.org/nobel_prizes/medicine/laureates/2009/blackburn-diploma.html, [20/10/2012]). The NLs the two Laureates held in Norway were about this outstanding discovery.

4. Discussion

At a superficial level, the most evident difference between the RA and the NLs lies in the type of headings and subheadings they have, as we can see from Table 2 below.

Table 2. Different headings and subheadings

Headings & subheadings		
RA	Greider's Lecture	Blackburn's lecture
1	2	3
Summary **Introduction** **Results** • Cell Free Extracts Contain a Telomere Elongation Acfivity That Incorporates Only dGTP and dTTP • Addition of Teiomeric Sequence Repeats Is Template Independent • The Sequence $(TTGGGG)_n$ Is Added to the Synthetic Telomere Primer • Tetrahymena $(TTGGGG)_n$ Repeats Are Added In Vitro to a Yeast Teiomeric Oligomer	Identifying the puzzle: telomere sequences defined Curious facts about telomeres: some pieces of the puzzle Collecting more pieces of the puzzle: telomere sequence addition Looking for telomere elongation: defining the edges of the puzzle A puzzle-solving strategy: getting the assay right Testing ourselves: do the pieces really fit, or are we forcing them? The next part of the puzzle: sequence information	**INTRODUCTION** **BEGINNING THE ENDS** *"You corn kernels, …may you succeed, may you be accurate."* Popul Vuh **THE TELOMERE CONCEPT** *"This is the beginning of the end."* Charles Maurice de Talleyrand 1754-1838 (announcing Napoleon's defeat at Borodino). **DIVING INTO POND WATER** *"Now this is not the end. It is not even the beginning of the end. But it is, perhaps the end of the beginning."* Sir Winston Churchill, Speech in November 1942 **THE LINES OF EVIDENCE THAT LED TO THE CONCEPT THAT TELOMERASE ACTIVITY EXISTED TETRAHYMENA CELLS BY A BIOCHEMICAL APPROACH** *"If your knees aren't green by the end of the day, you ought to seriously*

1	2	3
• Elongation Activity Is Present in Both Newly Developing and Vegetative Tetrahymena Cells • Enzymatic Properties of Telomere Elongation **Discussion** **Experimental Procedures** • **Cell Cultures** • **Extract Preparation** • **Synthetic Oligomers** • **In Vitro Reaction Conditions** • **Gel Electrophoresis** • **Quantitative Incorporation Assays** • **Preparation of S100 Fractions and Micrococcal Nuclease Digestion** **Acknowledgments** **References**	Following the clues: is there a template? A change in venue: seeing the puzzle from a different perspective Is this the right puzzle piece? Models can show the solution to the puzzle Solutions to puzzles show the way to more interesting questions **Acknowledgments** **References**	*re-examine your life."* Bill Watterson (American Author of the comic strip Calvin & Hobbes, b. 1958) **THE DISCOVERY OF TELOMERASE** *"…to make an end is to make a beginning."* T.S. Eliot 1888-1965, Four Quartets: "Little Gidding" **DEMONSTRATION OF THE REVERSE TRANSCRIPTASE ACTION OF TELOMERASE *IN VIVO*** *"They didn't have to walk around to see what was under the sky; they just stayed where they were. [And] as they looked, their knowledge became intense."* Popul Vuh, p. 165. **DEMONSTRATION OF THE NEED FOR TELOMERASE FOR CELL GROWTH** *"Like as the waves make towards the pebbled shore, So do our minutes hasten to their end."* William Shakespeare, 1564–1616, Sonnet 60. **TELOMERES AS PROTEIN-DNA COMPLEXES** *"Having well polished the whole bow, he added a golden tip."* Homer ("Smyrns of Chios"), The Iliad (bk. IV, III). **TELOMERES AS A DYNAMIC HOMEOSTATIC SYSTEM** *"Stability is not immobility."* Klemens von Metternich, Austrian statesman, 1773–1859. **SIMILAR MOLECULAR MACHINERIES: DIFFERENT LIFE HISTORIES** *"Have regard to the end."* [*Lat., Finem respice* (*or Respice finem*).] Chilo of Sparta (Chilon).

1	2	3
		TELOMERASE IN HUMAN HEALTH AND DISEASE a) *Telomerase in cancer cells* *"We ought to consider the end in everything." [Fr., En toute chose il faut considerer la fin.]* Jean de la Fontaine, Fables (III, 5). b) *Telomere maintenance and human life histories "The end crowns all, And that old common arbitrator, Time, Will one day end it."* William Shakespeare 1564–1616, The History of Troilus and Cressida (Hector act IV, v). **ACKNOWLEDGEMENTS** **REFERENCES**

As we all know, RAs need to have a distribution of information following the IMRD moves and steps that characterize each of the RA sections (Maci 2012). In addition to the IMRD structure, RA authors have to present an abstract, the purpose of which is "to meet the need to share information within the community of specialists who are constantly seeking to connect the findings of other researchers to their own" (Giunchi 2002: 277). RAs begin by presenting the context and background information, and must end by stating outcomes and research conclusions. This is clearly perceivable from the RA taken into consideration here, which follows the IMRD pattern with a violation in the sense that the *Methods* section is inserted *after* the *Discussion*. This move-shifting is, in my opinion, determined by the urgency underlying the importance of the discovery, which could be rhetorically emphasized only by breaking with the conservatism of the IMRD structure and transferring the methodological approach which led to the discovery of the telomerase enzyme to the end of the paper.

In terms of genre structure, the NLs have a story line as all narratives do: the narrative path defined by the paragraph headlines creates human-interest stories. In Greider's Lecture, the discovery was the solving of a *puzzle*; in that of Blackburn, the discovery, related to the *end* of the DNA message, is shown as metaphorically represented by history, politics and literature. In addition, this story has a beginning (found, for example, in excerpts (1) and (4), taken from Greider's and Blackburn's lectures, respectively), a complicating action, a resolution (as expressed in quotes (2) and (5) of

Greider's and Blackburn's lectures), and an evaluation (seen in passages (3) and (6) quoted from Greider's and Blackburn's lectures, respectively) in much the same way as indicated by Labov's schemata (2001, 2002) of fully--formed oral narratives[8]:

(1) Tracing the beginnings of the interwoven stories of science can be arbitrary, as beginnings are so often lost in the mists of time. For me, arguably the story of telomeres and telomerase began thousands of years ago […] (Blackburn 2009: 257)

(2) I tried to identify the proteins on *Tetrahymena* telomeres, but did not succeed in this. It was others' work, initially using yeast molecular genetic approaches, that unlocked the door to telomeric proteins. (Blackburn 2009: 272)

(3) Certainly, these findings and implications are taking the field of telomere and telomerase biology into realms far from the single-celled pond microorganisms in which I began this work. (Blackburn 2009: 278)

(4) The story of telomerase discovery is a story of the thrill of putting pieces of a puzzle together to find something new. This story represents a paradigm for curiosity-driven research and, like many other stories of fundamental discovery, shows that important clinical insights can come from unlikely places. (Greider 2009: 297)

(5) At first it was frustrating: if telomerase was already being inactivated by Oligo3 and adding RNase H had no further effect, how could I do the experiment? This frustration soon faded when, having talked about this result with my friends and puzzling more, I realized there was a much more interesting explanation for these results. […] (Greider 2009: 312)

(6) When I went to the lab to develop the X-ray film, I was thrilled to see a repeating pattern of elongation products that extended up the gel. (Figure 5B). (Greider 2009: 315)

In narratives, the chronological order of events is usually interrupted by flashbacks, mainly responsible for the to-and-fro course typical of story--telling, thanks to many endo- and exophoric references that are meant

8 According to Labov, oral narratives are structured by the following parts: *Abstract*, *Orientation*, *Complicating action*, *Resolution*, *Coda* and *Evaluation*, with the latter pervading all the other components.

to facilitate comprehension. A similar pattern seems to be followed in Blackburn's and Greider's NLs; however, the redundancy created by flash-backs does not seem to be necessary as the scientists have elaborated a *written* NL with referential signposts that allow readers to understand and make sense of their texts. The chronological order of the event is, thus, respected.

The NLs can be seen as a story-telling of how the two scientists started their research which brought them to the discovery and, at the same time, an explanation of the scientific value of the discovery itself. The opening paragraphs of their lectures are reported in excerpt (1) and (4), which, in Labov's terms, can be considered the *beginning*. After speaking for some time about both Blackburn's lab staff (where Ms Greider was a post-doc researcher) and the way in which they worked together, the two scientists introduce the *complicating action* in their NL narratives, which is here quoted in examples (2) and (4): both Blackburn and Greider report their frustration and inability to find any explanations for their intuition. These excerpts, however, contain the first hint at the *resolution*, the way in which the scientists found the solution to their problems. Excerpts (3) and (6) offer, respectively, Blackburn's and Greider's indication of their *evaluation* of the whole story: as Labov indicates (2001, 2002), *evaluation* may overlap any of the oral narrative components and does not necessarily follow the chronological order of the events (as is the case of the excerpt (6) here reported).

Interestingly, all these narratives are accompanied by figures which are extremely technical and are clearly for a specialized audience, as we can see in Figure 2 below, and which are not present in the original research article:

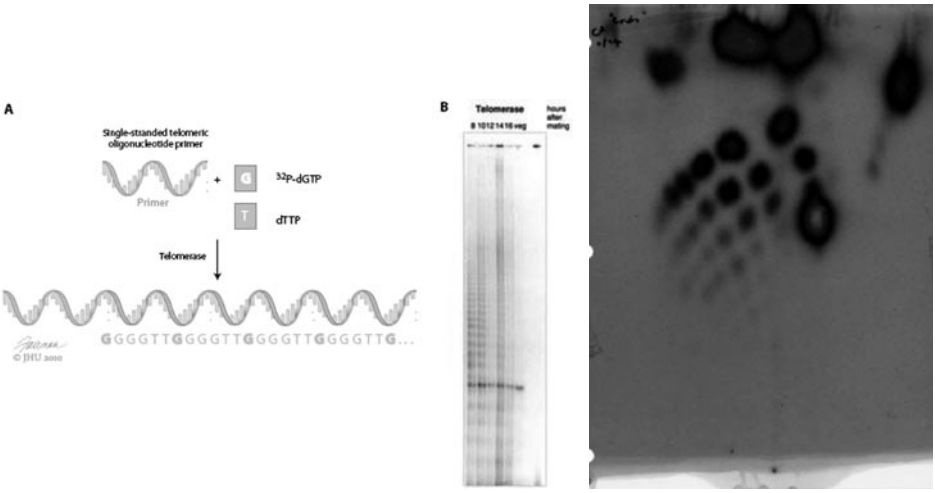


Figure 2. Use of specialized figures (Greider 2009: 350 – left; Blackburn 2009: 261 – right)

As Giunchi (2002: 288) claims, these narrative features entail the tendency to relate discourse in medical popular texts to the real world of the reader through the inclusion of constituent elements such as those that "stress the local angle" by providing the reader with technical explanations of concepts and principles upon which research is based.

In order to see what popularised angle things are seen from in the NL, I used WMatrix software to compare the two subcorpora on the basis of their semantic fields[9]. The summary of the results (only the top 20 semantic fields out of 199) are offered in Table 3 below. As we can see, the NL semantic fields pivot around the technicalities of the hard sciences. Nevertheless, there are some semantic areas, namely *person pronouns &* (*person*) *adjectives*[10]; *not understanding*; *boosters*; *farming and horticulture*; *food*; *thought and belief*, which are unexpected as they do not seem to pertain to scientific discourse, as indirectly confirmed by their total absence as key semantic domains in the RA corpus.

Table 3. Nobel Lecture (left) vs. research paper (right) key semantic domains

Key semantic domains	
Nobel Lectures	Research Article
1	2
person pronouns & adjectives	scholar surnames and enzyme names
likely	numbers (figures and years)
(chemical/physiological) substance and material	genetic abbreviations
interested, excited and energetic	physical structure of enzymatic DNA
Time: period	measure unity

9 WMatrix automatically tags words at the lexical, grammatical and semantic level. Computation is based on log-likelihood statistics ($p < 0.01$) to show key items at the top. Semantic tagging is generated by USAS, the UCREL (University Centre for Computer Corpus Research on Language, Lancaster) semantic analysis system, a software tool for undertaking the automatic semantic analysis of English spoken and written data.

10 It is true that (*person*) *pronoun & adjectives* are perceived as belonging to a grammatical category rather than a semantic one. Nevertheless, within the 21 USAS semantic categories listed in hierarchical order, the last one is denoted as "Z: names and grammatical words" (http://ucrel.lancs.ac.uk/usas/). Such a category includes deictical items which help the construction of the contextual reference necessary for meaning-making. Pragmatics, too, considers pronouns, through grammatical expression of deixis, as semantically constructing the speaker's context (cf. Huang 2007).

1	2
People (human disease/cell population)	(chemical) quantity
Not understanding (puzzle)	(chemical) inclusion
Existing (verb *to be*)	(physical) quantity – little
comparing: different	(physical) quantity – much/many
telomere	DNA structural repetition
knowledgeable	cell fusion
time: beginning	(chemical) substances and materials (solid)
getting and possession (have/get/ obtain/maintain)	DNA message transmission
degree: boosters	knowledge
part (microscopic enzimatic)	(chemical) marker
work and employment (lab)	long/tall/wide
science and technology (experiments and radioactivity)	(chemical) preparation
cause-effect/connection	ratio
time period: short	quantity increase
disease (cancer/dementia)	absence
time: old age (aging and senescence)	measurement: volume
linear order (DNA and RNA sequence)	(chemical) substance: liquid
trying hard (experimental attempts)	(chemical) colour – darkness
important (medical significance)	(chemical) dry
moving, coming, going (experimental process)	(chemical) colour – light
alive (cell immortality)	temperature: hot
farming and horticulture	general actions /making
anatomy and physiology (chromosome and cells)	substance and material: liquid
food	(chemical) reaction
thought and belief	temperature

While some key semantic domains, such as the *substance and material* domain, are present both in NLs and RA, the complete absence of the semantic domains listed by WMatrix as *person pronouns & adjectives*; *not*

understanding; *boosters*; *farming and horticulture*; *food*; *thought and belief* in the RA corpus suggests that the lexical items they include can be regarded as strategic indicators of popularised forms of knowledge dissemination. For this reason, therefore, in the following paragraphs I will concentrate on their description. Leaving aside, for the moment, the semantic field categorized by WMatrix as *Z: names and grammatical words* which the subcategory *Z8 pronouns etc.*[11] belong to (and for which an analysis will be provided in the following paragraphs), here I will consider the categories of *farming and horticulture*; *food*; *interested, excited and energetic*; *not understanding*; *boosters*; *thought and belief*.

The semantic categories of *farming and horticulture* and *food* (both of them belonging to the *F – Food & Farming* macro-category computed by WMatrix) can be accepted as borderline between specialised and non-specialised semantic areas (and consequently, between popularised and technical language) because of the presence of telomerase in food or farming products, as Greider and Blackburn (1985: 405) indicate in their RA (my emphasis):

(7) Structural and functional studies of chromosomes and linear piasmids in yeast have shown that the only DNA elements essential for telomere function are the simple G+C-rich teiomeric sequence repeats, in the correct orientation

and reconfirm in their own NLs:

(8) The identification of tandem repeats in the telomeres of Tetrahymena was followed by the identification of similar repeats in the telomeres of other organisms, including Oxytricha, Physarum, *yeast*, and trypanosomes. (Greider 2009: 297)

(9) It was known that "like begets like", so that if one used the kernels from the biggest ears of *corn* in the planting for next year, a better *crop* would result. (Blackburn 2009: 257)

That the semantic categories of *farming & horticulture* and *food* can be regarded as having a scientific rather than popularised value seems to be indirectly confirmed by the fact that the NL keyword list generated by a comparison

11 See http://www.comp.lancs.ac.uk/ucrel/usas/.

between the NLs and the RA[12] does not contain any occurrences of either *crop* or *corn* as keywords (as seen in example (9) above). Furthermore, though the item *yeast* (27 hits, STTR[13] 1.13) is included as an NL keyword, it has an extremely weak keyness, since it occupies position no. 1,670[14]. In addition, a closer analysis of the *F Food & Farming* category elaborated by WMatrix indicates that this group is characterized by the words (*orto-/phyro-*)*phosphate* (27 hits STTR 1.13), *bicarbonate* (3 hits, STTR 0.13), referring to chemical substances, and by the words *cultivation* (12 hits, STTR 0.50) and *field* (16 hits, STTR 0.67), for which their metaphorical meanings related to the concepts of *virus cultivation* and *chemical field*, respectively must be intended. Interestingly, none of these words is found in the RA, which may indicate that they are used in the NLs because of their popularising contribution to the NLs themselves.

The semantic area of *interested, excited and energetic* (see Figure 3 below), belonging to the macro-category defined in WMatrix as *X Psychological actions, states & processes*[15], reveals the presence of such terms as *interest** (16 hits, STTR 0.67), *curious* (7 hits, STTR 0.29), *excit** (5 hits, STTR 0.20) and *active* (20 hits, STTR 0.83), which are all absent in the RA.

While *interest** and *active* are ambivalent as they can refer both to the author's concern or interest in the activity done in the experiment and also to the scientific relevance (*interest**) and activity of the chemical elements involved in the experiment itself (*active*), the words *excit** and *curious* are indications of the author's personal evaluation of the lab practice and the consequent discovery (my emphasis):

(10) Drawing out the telomere elongation model helped to clarify my thinking about telomerase. Thinking about the model also immediately raised several new questions that I was *curious* to address. For

12 See Tables 4 and 5 below.

13 In Corpus Linguistics, the ratio between types and tokens is indicated by its acronym TTR, where *tokens* are the running words of the corpus, i.e., the number of words contained in the corpus; *types* refer to each different kind of word in a corpus. Since the resulting figure may vary according to the length of the texts forming the corpus, the TTR is normally *standardized*; in other words, in order to be sure that the TTR represents fair results and percentages, the ratio is calculated for the first 1,000 running words, then calculated afresh for the next 1,000, and so on to the end of the text or corpus (see Hunston 2002: 17).

14 That *yeast* has no keyness in the NL corpus does not come as a surprise, since the lexeme is also found in the RA with 37 hits (STTR 5.22), which seems to confirm its use as a specialised term.

15 See http://www.comp.lancs.ac.uk/ucrel/usas/.

t yet also at times wonderfully	exciting	. The willingness to keep an ope
damentally this story shows how	curiosity	and an interest in solving inter
tory shows how curiosity and an	interest	in solving interesting problems
sity and an interest in solving	interesting	problems can lead to a lifetime
blems can lead to a lifetime of	exciting	discoveries . IDENTIFYING THE PU
, albeit with some variation .	CURIOUS	FACTS ABOUT TELOMERES : SOME PIE
E Liz Blackburn and others were	interested	to know how the simple repeats f
was first identified , several	curious	facts about telomeres were uncov
seen in gel in part A. A second	curious	fact was that the telomeres in t
t a conference , they were both	interested	in DNA ends . They knew about th
DNA ends . They knew about the	curious	structure of telomeres and their
, Liz and Jack noticed another	curious	fact : the Tetrahymena telomeres
hey had started out . They were	curious	to know why . So , together with
iz and Jack the existence of an	active	elongation mechanism in yeast ,
incorporate DNA precursors more	readily	than a piece of DNA containing n
hat if there was an enzyme that	actively	elongated telomeres , we might b
lly present in the nuclei to be	active	. We also added radiolabeled dCT
of endogenous DNA . These were	exciting	times. once I could repeatedly s
come in to the lab every day ,	eager	to test the next set of experime
Cech , who had a long-standing	interest	in both telomeres and RNA , was
h RNAse . He agreed that was an	interesting	experiment . Throughout the day
erase) . I would then take the	active	fractions and subject them to an
gure 7B) . I then examined the	active	fraction to look for an RNA that
ays present when telomerase was	active	. I purified the RNAs from activ
tive . I purified the RNAs from	active	fractions , and labeled them wit
manner , after each column the	active	fractions were loaded on a subse
ine agarose B) Gel showing the	active	fractions for each of the column
NAs , all RNAs from each of the	active	fractions was end labeled with 3
tes . To do this , the RNA s of	interest	were cut out of a high-resolutio
inants that were present in the	active	fractions due to the high abunda
RNA as the best candidate ; my	interest	was really a hunch since I had s
uzzle . Since telomerase was an	interesting	enzyme and our experiments clear
uence on the sequencing gel was	exciting	, as it mirrored what would be e
THE RIGHT PUZZLE PIECE ? It was	exhilarating	to have the sequence of an RNA t
realized there was a much more	interesting	explanation for these results .
Oligo 3 binds to and blocks the	active	site of telomerase . This inhibi
TO PUZZLES SHOW THE WAY TO MORE	INTERESTING	QUESTIONS Drawing out the telome
everal new questions that I was	curious	to address . For example , does
th . But the key is to keep the	excitement	and to follow the leads that are

Figure 3. *Interested, excited and energetic* semantic field

> example, does the proposed translocation step actually occur? […] This question, which I had not thought of before I drew the model, was suddenly a burning one for me. I went on to tackle this next puzzle in a later paper (Greider, 1991). Many other questions arose as we continued our work on telomerase. […] Putting together puzzle pieces is challenging, fun, and extremely gratifying, especially when they lead to new understanding in biology. This process of making a hypothesis and following leads is not a linear one: there are many twists and turns in the path. But the key is to keep the *excitement* and to follow the leads that are the most rewarding. (Greider 2009: 315)

The excerpt in (10) above seems to represent in words what goes on in the scientist's mind (which is also explicitly indicated by the nominalised forms *thinking* – which in the NLs occurrences three times, STTR 0.12 – and by

the past form *thought* – which appears eight times in the NLs, STTR 0.33) when s/he knows that the solution to the problem is somewhere in the data they have, but s/he does not know how to find it. The reader follows with the same *crescendo* tension the scientist feels following his/her thoughts, and begins to realize the excitement forerunning the imminent discovery, when all the pieces of the puzzle are suddenly set in the right place.

The *non-understanding* semantic domain, belonging to the macro-category defined in WMatrix as *X Psychological actions, states & processes*[16], is characterized by the terms *puzzle* (27 hits, STTR 1.13) and the unique occurrence of the item *perplexing* (STTR 0.04), as we can see in Figure 4 below):

? PUTTING TOGETHER PIECES OF THE	PUZZLE	Nobel Lecture , December 7 , 200
ıe thrill of putting pieces of a	puzzle	together to find something new .
rating , at times misleading and	perplexing	, but yet also at times wonderfu
ıg discoveries . IDENTIFYING THE	PUZZLE	: TELOMERE SEQUENCES DEFINED Tel
JENCES DEFINED Telomeres posed a	puzzle	for biologists for a many years
) , 1941 ; Muller , 1938) . The	puzzle	of how these ends functioned rem
? TELOMERES : SOME PIECES OF THE	PUZZLE	Liz Blackburn and others were in
? COLLECTING MORE PIECES OF THE	PUZZLE	: TELOMERE SEQUENCE ADDITION Whe
and they saw a way to use these	puzzle	pieces to perform a long-shot ex
using this strategy . This last	puzzle	piece was a very important one.
TION : DEFINING THE EDGES OF THE	PUZZLE	When I joined Liz s lab in May o
ı so we had another piece of the	puzzle	. But how did our nine-month sea
ı our nine-month search for this	puzzle	piece unfold ? Figure 4 . Initia
ɜ most productive way to solve a	puzzle	is to attack it with the right s
ve described above , we sat and	puzzled	about the fact that both the tel
, 1985) . THE NEXT PART OF THE	PUZZLE	: SEQUENCE INFORMATION The next
have the final key piece of the	puzzle	. Since telomerase was an intere
) A CHANGE IN VENUE : SEEING THE	PUZZLE	FROM A DIFFERENT PERSPECTIVE I f
This clone was clearly a central	puzzle	piece . I went on to verify that
ı been right . IS THIS THE RIGHT	PUZZLE	PIECE ? It was exhilarating to h
ılts provided the most important	puzzle	pieces . The RNase H experiment
this result with my friends and	puzzling	more , I realized there was a mu
f telomerase . The other unusual	puzzle	piece was Oligo8 . This oligonuc
ɛting all of these pieces of the	puzzle	together , I felt there was good
ELS CAN SHOW THE SOLUTION TO THE	PUZZLE	In writing the paper on the iden
lackburn , 1989) . SOLUTIONS TO	PUZZLES	SHOW THE WAY TO MORE INTERESTING
. I went on to tackle this next	puzzle	in a later paper (greider , 199
lprize. org) . Putting together	puzzle	pieces is challenging , fun , an
often arise after one part of a	puzzle	is solved ; the rewarding thing
The pleasure of figuring out the	puzzle	and finding out things not known
ideas that have made solving the	puzzles	fun , and opened up new puzzles

Figure 4. *Non-understanding* semantic field

The use of the term *puzzle* characterizes Greider's NL only, which could be expected because *puzzle* occurs in almost all the headings and subheadings of the NL. Interestingly, however, in 17 out of the 27 occurrences of *puzzle*, the term appears within the text rather than in the subheading:

16 See http://www.comp.lancs.ac.uk/ucrel/usas/.

(11) Many new questions often arise after one part of a *puzzle* is solved; the rewarding thing about curiosity-driven science is being able to pick from these new questions those that seem the most interesting to me. (Greider 2009: 313)

In all occurrences, the term *puzzle* does not have a negative connotation. Indeed, the lexeme is accompanied by approbation terms, because, as the scientist puts it, solving the puzzle is *pleasing* and *rewarding* (Greider 2009: 315). The author does not seem to speak about the bewilderment she encountered in her lab activity; she rather interprets the *puzzle* as a mental-exercise fundamental in her research:

(12) The story of telomerase discovery is a story of the thrill of putting pieces of a puzzle together to find something new. This story represents a paradigm for curiosity-driven research and, like many other stories of fundamental discovery, shows that important clinical insights can come from unlikely places. In this paper I describe the process of scientific discovery- at times frustrating, at times misleading and perplexing, but yet also at times wonderfully exciting. The willingness to keep an open mind, to enter uncharted waters and try something new, along with patience and determination, came together to tell us something new about biology. Fundamentally this story shows how curiosity and an interest in solving interesting problems can lead to a lifetime of exciting discoveries. (Greider 2009: 297)

As Hilgartner (1990) claims, one of the main semantic means of establishing links between two domains of experience, meaning or knowledge is metaphor. The metaphor exploited here is A PUZZLE IS AN ENEMY, where the scientist is the winning general who defies ignorance. This metaphor is introduced at the very beginning of the Greider's NL, as reported below in (13):

(13) The most productive way to solve a puzzle is to attack it with the right strategy. (Greider 2009: 303)

This rhetorical trope therefore permeates the whole NL lecture, which thus turns into a description of the battle between the goodies (scientists) and the badies (the *puzzle*) for the sake of knowledge. In this battle there is no place for mitigating the claims put forward by the researcher through hedging devices.

In academic discourse, writers modify their assertions by toning down uncertain or potentially risky claims, emphasising what they believe to be

correct, and conveying an appropriately collegial attitude to readers. These expressions of doubt and certainty are collectively known as *hedges* and *boosters*. *Hedges* are usually employed to reduce the force of an argument, whereas *boosters* are used to strengthen claims. While *hedges* allow writers to signal tentativeness in referential information and convey collegial respect towards the views of colleagues, *boosters* express conviction and mark involvement and solidarity with an audience (Hyland 2004). Hedges and boosters do not simply communicate knowledge but also the author's attitude toward such knowledge and to the readers (Hyland 2004). As hinted at above, NLs seem to exploit boosters rather than hedges, as indicated by the *booster* semantic domain elaborated by WMatrix, of which a snapshot can be seen in Figure 5, below. Interestingly, the *booster* semantic domain is completely absent in the semantic domain list of the RA.

because these two species are	very	distantly related , having diver
rotected DNA ends in yeast , a	very	distantly-related organism (Szo
n all other organisms so far .	More	strikingly , determining the seq
. This last puzzle piece was a	very	important one. models of telomer
un and made one up . In fact ,	more	precisely , we continually made
uld incorporate DNA precursors	more	readily than a piece of DNA cont
hen looked to see if there was	more	radioactive label incorporated i
ut a small change in size of a	very	small fragment would be noticeab
ng the fragment , made the cut	very	close to the telomere end to gen
TING OURSELVES : DO THE PIECES	REALLY	FIT , OR ARE WE FORCING THEM ? I
the pattern we were seeing was	indeed	generated by a novel enzyme . We
conventional DNA polymerases .	More	importantly , we used a CCCCAA p
ahymena extract with RNAse did	indeed	block the elongation activity .
if a template mechanism was ,	indeed	, working . We tried a number of
e RNA sequence , including the	very	newly developed method termed PC
f months , I decided to take a	more	direct approach : I used direct
s sequencing revealed that the	very	small RNAs that co-purified with
st candidate ; my interest was	really	a hunch since I had seen this RN
hanism for TTGGGG addition was	indeed	used by telomerase . This clone
ome evidence that this RNA was	indeed	the template. again , just as wh
t with my friends and puzzling	more	, I realized there was a much mo
more , I realized there was a	much	more interesting explanation for
, I realized there was a much	more	interesting explanation for thes
3 , showing that Oligo 3 does	indeed	hybridize to the 159 nt RNA as p
quence in the putative RNA did	indeed	serve as a template for TTGGGG r
ces is challenging , fun , and	extremely	gratifying , especially when the
arbitrary , as beginnings are	so	often lost in the mists of time
, a better crop would result .	Intensely	cultivated areas were carved out
Borodino) . Perhaps another ,	more	modern beginning to the story of

Figure 5. *Booster* semantic field

As Hyland (2004: 98-99) claims, the main role of *boosters* is that of highlighting the relevance or the novelty of the work, while convincing the reader of the scientist's firm confidence in the logical strength of the argument proposed. This, too, seems their main function in the NLs as revealed by the presence of a booster such as *more than* (19 hits, STTR 0.79), regarded as a feature expressing certainty (Hyland 2004: 190). There are, however, also boosters defined by

Hyland (2004: 100) as emphatic metadiscursive boosters, which, while guiding the reader through the scientist's reasoning path, create solidarity between the authors and their audience. These boosters, are seen by Myers (1989: 8) as features revealing an emotional response to results, "which show identification with a common goal, rather than the responses or desires of an individual". It is this type of boosters that characterize the NLs under consideration. More specifically, WMatrix detected: *very* (14 hits, STTR 0.58); *indeed* (8 hits, STTR 0.33); *highly* (3 hits, STTR 0.12); *abundant* and *really* (both of them having 2 occurrences, STTR 0.08); and *extremely*; *greatly*; *intensely*; *particularly*; *seriously*; and *wonderfully* (all of them having 1 hit, STTR 0.04).

The fact that in the NLs boosters form one of the key semantic domains is quite understandable: the scientists do not need to show caution in presenting their findings because those findings are the reason why they have been awarded the Nobel Prize: the discovery is now commonly shared knowledge in the medical field, which is furthermore emphasised by the scientists strategic management of solidarity construction.

As far as the *thought and belief* semantic field (Figure 6 below), it belongs to *X2 Mental actions and processes* included in the macro-category identified by WMatrix as *X Psychological actions, states & processes*[17]. This class

ich are all of a similar size .	Figure	1 . Telomere elongation in Trypa
to yeast cells . However , they	wondered	whether the addition of Tetrahym
he radioactive isotope 32P . We	reasoned	that an elongation enzyme might
ul . After each experiment , we	thought	of new changes to make to the ne
both ends of the fragment . We	thought	hard about a way to get around t
on the gel . This was the first	visualization	of telomerase activity . TESTING
time , trying to understand the	meaning	of the repeating pattern . We kn
ng new , or was our own wishful	thinking	coloring our interpretation of t
were seeing . For example , we	thought	the TTGGGG primer might be annea
elomeric primers self-annealing	thought	G-G non-Watson-Crick base pairin
me was in action : we could not	imagine	how conventional polymerases wou
s a key clue : it allowed us to	think	about possible mechanisms by whi
trying to do . It was fun to be	creative	and dream up ways to test whethe
complementary to telomerase . I	thought	that if I could inactivate the e
RNA in telomerase activity . I	think	it was Adrian Krainer , a collea
(Figure 9) . I had to sit and	think	about what this meant . At first
eces of the puzzle together , I	felt	there was good evidence to suppo
a diagrammatic model for how I	thought	the enzyme might work . Figure 1
opied (figure 10) . With this	in mind	, I proposed that telomerase has
tion model helped to clarify my	thinking	about telomerase . Thinking abou
my thinking about telomerase .	Thinking	about the model also immediately
This question , which I had not	thought	of before I drew the model , was
) of these molecules would , I	reasoned	, make it feasible to apply meth
n my early work , our molecular	views	of telomeres were first focused
d by the cell and therefore , I	reasoned	, would allow the best chance of
ase in cancer cells We ought to	consider	the end in everything . [F
ss sectional studies and on the	presumption	of lack of telomerase in the nor
ce may instead be more usefully	considered	as reflecting - perhaps causing

Figure 6. *Thought and belief* semantic field

17 See http://www.comp.lancs.ac.uk/ucrel/usas/.

is characterized by such verbs as *think* (8 hits, STTR 0.33); *consider* (1 hit, STTR 0.04); *imagine* (1 hit, STTR 0.04); *reason* (3 hits, STTR 0.12), *wonder* (1 hit, STTR 0.04), all of which are found in NLs in the past form.

Hyland and Tse (2005), Biber et al. (1999) and Quirk et al. (1985) classify *consider*, *imagine, reason*, *think*, and *wonder*, as mental or cognitive verbs, that is, verbs that consider the author's mental processes (e.g. *assume*, *believe*). In particular, *wonder* in the past form as we find it here is defined by Quirk et al. (1985: 188) as the attitudinal past, used with verbs expressing volition or mental state, and reflecting the tentative attitude of the speaker; *consider* and *reason* are mental verbs of cognition (Biber et al. 1999: 661); *imagine* and *think* are stative verbs denoting 'private' states which can only be subjectively verified (Quirk et al. 1985: 202). In addition, Biber et al. (1999) claim that these are more frequently found in fiction than in academic writing and that "these mental verbs usually express various emotions, attitudes, or cognitive states that are intrinsically personal" (Biber et al. 1999: 491). This, and the facts that (a) in NLs their subject is generally the pronoun *I*, and (b) they are completely absent in the RA, render the text very popularised.

4.1 The semantic domains of (person) pronouns & (possessive) adjectives

As indicated in footnote 10, despite the fact that (*person*) *pronouns &* (*possessive*) *adjectives* are grammatical items, the last semantic category listed (in hierarchical order) by USAS includes those lexemes generically labelled as *names and grammatical words* (http://ucrel.lancs.ac.uk/usas/), which include deictical items such as (person) pronouns and (possessive) adjectives which semantically provide the speaker's context (cf. Huang 2007).

As Table 3 above reveals, the semantic domain related to (person) pronouns and (possessive) adjectives is the first in the key semantic domain list and, therefore, has the greatest relevance. This is at odds with what normally occurs in scientific discourse.

Science exploits an inductive methodological approach by means of which principles and properties are suggested to the scientist by direct observation of the phenomena. Scientific discourse, therefore, linguistically realizes the inductive process going from phenomena observation to scientific discovery by eliminating any human element and personalization of the physical aspects of the experiment (Gotti 2003). This is something which does not seem to occur in NLs.

As can be seen from Figure 7 above, there is a strong use of person pronouns and adjectives suggesting personalisation and human elements.

the nuclear DNA molecules inform	us	about the special properties of t	4
might be on the telomeric DNA .	I	describe my early unsuccessful ef	4
n the telomeric DNA . I describe	my	early unsuccessful efforts to ide	4
o identify telomeric proteins in	my	autobiography in this volume . No	4
tobiography in this volume . Now	we	know that the essential telomeric	4
very simple telomeric sequences	which	are tandemly repeated over and ov	4
ucleotides at the ends of all of	our	chromosomes . The same repeated A	4
panosome protozoan parasites . (	This	makes telomeric DNA sequences pos	4
n a G-rich and a C-rich strand .	It	is the G rich strand that is alwa	4
strand . It is the G rich strand	that	is always oriented in the 5 to 3	4
ce were instrumental in spurring	me	to hunt for a new type of enzymat	5
a new type of enzymatic activity	that	might synthesize telomeric DNA an	5
telomeric CCCCAA repeat tracts (	which	we eventually ended up referring	5
ric CCCCAA repeat tracts (which	we	eventually ended up referring to	5
ntually ended up referring to by	their	sequence on the complementary DNA	5
a were heterogeneous in length ;	that	is , the DNA molecules in the pop	5
es in the rDNA minichromosomes ;	that	is , new telomeres were forming o	5
Meng-Chao Yao , continuing work	he	had started as a Ph . D. student	5
ce Gall s lab (at the same time	I	was there) , had observed this f	5
precursor DNA sequence had made	it	conceivable that this sequence co	5
eivable that this sequence could	itself	somehow be a seed sequence for re	5
s , for example . However , then	my	lab at Berkeley made similar obse	5
ic nucleus , with the difference	that	in these cases the telomeric DNA	5
l. [15] Thus in 1982	I	wrote about these observations :	5
e subchromosomal segments during	their	formation . Two types of routes c	5
k Szostak s 2009 Nobel Lecture ,	we	had discovered that yeast telomer	5
obel Lecture , we had discovered	that	yeast telomeric sequence DNA (ir	5
Shampay , a graduate student in	my	lab at UC Berkeley , first sequen	5
ley , first sequenced as part of	our	collaboration with Jack) was add	5

Figure 7. (Person) *pronouns and* (*possessive*) *adjectives* semantic domain

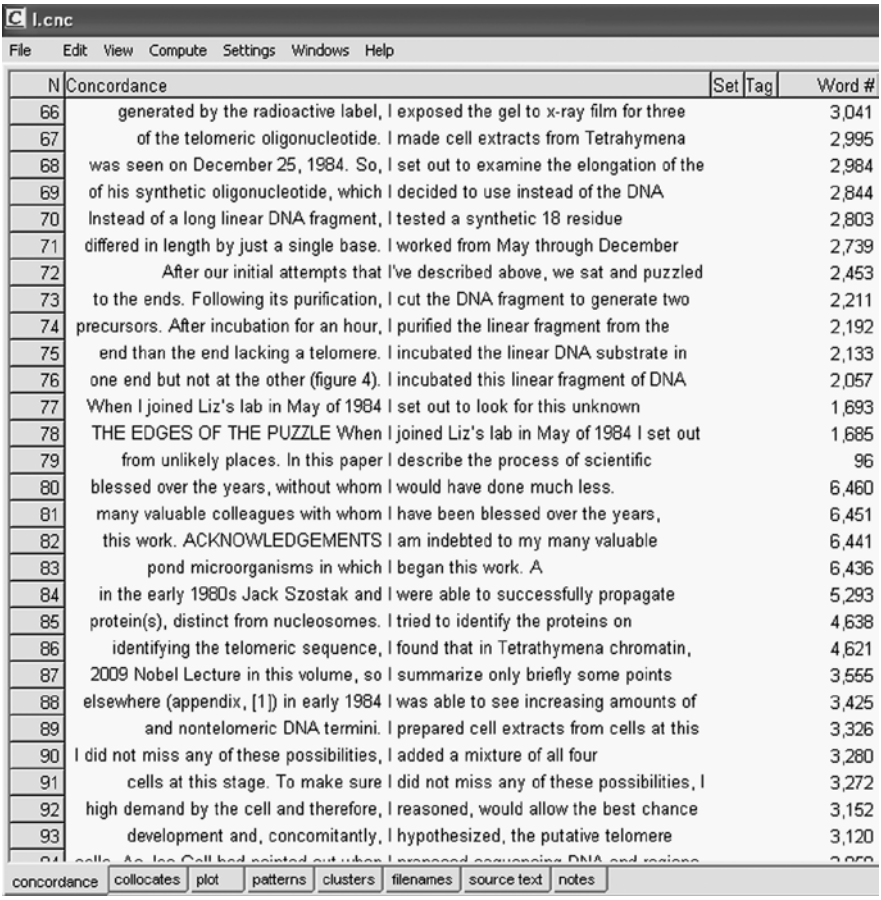
This is also confirmed by the NL keyword list generated with Wordsmith tools against the RA[18], where *I* (109 hits; STTR 4.56, keyness 61.50), *my* (32 hits, STTR 1.34, keyness 28.21), *it* (73 hits, STTR 3.05, keyness 41.21) and *they* (36 hits, STTR 1.50, keyness 31.74) are listed as keywords (Table 4):

Table 4. Greider-Blackburn's Nobel Lecture keywordlist

N	Key word	Freq.	%	Keyness
1	TELOMERASE	143	0.94	126.43
2	RNA	100	0.66	67.35
3	I	109	0.72	61.50
4	HAD	84	0.55	54.22
5	TETRATHYMENA	48	0.32	42.33
6	IT	73	0.48	41.21
7	ONE	41	0.27	36.15
8	THEY	36	0.24	31.74
9	BUT	35	0.23	30.86
10	MY	32	0.21	28.21

18 In order to see the extent to which the Nobel Lectures are 'popularised' and check their differences from the RA, and have a measure of the *saliency* rather than frequency of words in a context, I compared the two subcorpora against each other, so each one is the reference for the other one (cf. Baker 2006: 124).

My attention has been particularly attracted to the use of *I* and *my*, which I have not found in previous research carried out in the medical field (cf. Maci 2012), and which are not present in the RA under investigation. In addition, *I* is normally less frequently employed in academic lectures when compared to *we*, which is normally exploited three times more than *I*[19] (cf. Round 1987: 20; Fortanet 2004). The use of *I* in the NLs, therefore, seems a form of *personalisation* typical of popularised science (cf. Myers 1989).


I.cnc

File Edit View Compute Settings Windows Help

N	Concordance	Set	Tag	Word #
66	generated by the radioactive label, I exposed the gel to x-ray film for three			3,041
67	of the telomeric oligonucleotide. I made cell extracts from Tetrahymena			2,995
68	was seen on December 25, 1984. So, I set out to examine the elongation of the			2,984
69	of his synthetic oligonucleotide, which I decided to use instead of the DNA			2,844
70	Instead of a long linear DNA fragment, I tested a synthetic 18 residue			2,803
71	differed in length by just a single base. I worked from May through December			2,739
72	After our initial attempts that I've described above, we sat and puzzled			2,453
73	to the ends. Following its purification, I cut the DNA fragment to generate two			2,211
74	precursors. After incubation for an hour, I purified the linear fragment from the			2,192
75	end than the end lacking a telomere. I incubated the linear DNA substrate in			2,133
76	one end but not at the other (figure 4). I incubated this linear fragment of DNA			2,057
77	When I joined Liz's lab in May of 1984 I set out to look for this unknown			1,693
78	THE EDGES OF THE PUZZLE When I joined Liz's lab in May of 1984 I set out			1,685
79	from unlikely places. In this paper I describe the process of scientific			96
80	blessed over the years, without whom I would have done much less.			6,460
81	many valuable colleagues with whom I have been blessed over the years,			6,451
82	this work. ACKNOWLEDGEMENTS I am indebted to my many valuable			6,441
83	pond microorganisms in which I began this work. A			6,436
84	in the early 1980s Jack Szostak and I were able to successfully propagate			5,293
85	protein(s), distinct from nucleosomes. I tried to identify the proteins on			4,638
86	identifying the telomeric sequence, I found that in Tetrathymena chromatin,			4,621
87	2009 Nobel Lecture in this volume, so I summarize only briefly some points			3,555
88	elsewhere (appendix, [1]) in early 1984 I was able to see increasing amounts of			3,425
89	and nontelomeric DNA termini. I prepared cell extracts from cells at this			3,326
90	I did not miss any of these possibilities, I added a mixture of all four			3,280
91	cells at this stage. To make sure I did not miss any of these possibilities, I			3,272
92	high demand by the cell and therefore, I reasoned, would allow the best chance			3,152
93	development and, concomitantly, I hypothesized, the putative telomere			3,120

concordance | collocates | plot | patterns | clusters | filenames | source text | notes

Figure 8. Concordance list of *I*

The concordance list of *I* shows 109 occurrences (Figure 8, above), mostly collocating with *was* (12 hits), *had* (11 hits), *would* (8 hits) and *decided* (6 hits),

[19] In academic lectures, *I* is normally used to semantically convey the teacher's evaluation, plan for the lesson or whenever the teacher acts as spokesman of the person who discovered or defined the phenomenon (Round 1987).

introducing short first-person narratives, often incorporating anecdotal detail (14) and employed in the 'confessional mode' sharing with the reader information about their private lives which is both a soul-bearing gesture and proof of the hard work performed (15):

(14) These were the key to my being able to analyze telomeric DNA directly. I first encountered Tetrahymena when I joined Joe Gall's lab as a postdoctoral fellow at Yale. (Blackburn 2009: 260)

(15) I designed several different oligonucleotide probes that were complementary to the regions of partial RNA sequence I had obtained, and made […]. After a number of attempts, I obtained one clone […]. (Greider 2009: 310)

The same confessional attitude is found in the concordance list of *my* (Figure 9, below):

MY.cnc

File Edit View Compute Settings Windows Help

N	Concordance	Set	Tag	Word #	t. #	os.
1	elongation model helped to clarify my thinking about telomerase. Thinking			6,291	288	8%
2	drawing a model was not foremost in my mind. However, I found that drawing			6,106	281	5%
3	3 was unique in that it hybridized to my 159 nt RNA in a region adjacent to			5,558	254	9%
4	having talked about this result with my friends and puzzling more, I realized			5,514	252	5%
5	activity was to test the function of my candidate RNA template. To do this,			5,170	235	3%
6	how functional RNA s were identified. My next step in characterizing			5,157	235	1%
7	was the right candidate. I talked to my friends at Cold Spring Harbor,			5,134	234	9%
8	in length. All the signs were that my earlier hunch about "154 base RNA "			5,033	229	9%
9	still focused on identifying the RNA, but my exploration took a different approach.			4,884	222	5%
10	DIFFERENT PERSPECTIVE I finished my Ph.D. at Berkeley in November 1987			4,848	220	6%
11	this RNA as the best candidate; my interest was really a hunch since I			4,604	212	6%
12	for telomerase. One RNA that I had my eye on after staring at many different			4,577	211	2%
13	with Tom in the morning and described my idea of seeing whether the activity			3,877	181	0%
14	TS I am indebted to my many valuable colleagues with whom			6,445	288	6%
15	a postdoctoral fellow with Mike in my lab, extended these findings:			4,941	222	1%
16	a postdoctoral fellow then in my laboratory, proposed a model for			4,829	218	7%
17	The Iliad (bk. IV, III). As recounted in my autobiography in this volume, soon			4,610	209	6%
18	by Guo-Liang Yu, a graduate student in my lab. Guo-Liang then introduced them			4,215	181	5%
19	and we had devised a system in my lab for overexpression of such			4,185	180	7%
20	- by Dorothy Shippen-Lenz in my lab and by Alan Zahler in David			3,885	162	8%
21	extracts. In 1984 Carol Greider joined my lab at UC Berkeley as a Ph.D.			3,515	145	0%
22	stage, adapting a method that my graduate student Peter Challoner had			3,340	136	4%
23	DNA-adding enzymatic activity. My choice of approach was to prepare			3,040	126	7%
24	by Barbara McClintock reinforced my nascent notion that some			2,764	115	0%
25	Janice Shampay, a graduate student in my lab at UC Berkeley, first sequenced			2,418	104	4%
26	repeats, for example. However, then my lab at Berkeley made similar			2,248	100	9%
27	efforts to identify telomeric proteins in my autobiography in this volume. Now			1,776	81	6%
28	be on the telomeric DNA. I describe my early unsuccessful efforts to identify			1,767	81	4%

[Figure 9. Concordance list of *my*.]

My, which occurs 32 times in the NLs, collocates with *lab*. It seems that the context where *my lab* is exploited is always related not only to the profession but also to the researchers themselves to such an extent that *my lab* metonymically turns into the professional scientist (16):

(16) However, then *my lab* at Berkeley made similar observations for other rDNAs and non-rDNA telomeres of the somatic nucleus, […]. (Blackburn 2009: 260)

From a grammatical point of view, the first person pronoun *I* and the adjective *my* are the least ambiguous, because they refer to one person only (unlike *we* or *our*, which could be either exclusive or inclusive, or even *you*, which may stand for *one*). As a pronominal and adjectival reference, they are multifunctional: on the one hand *I* and *my* refer the *researcher*, that is to the author's role as the person undertaking the discovery reported in the NL and, on the other hand, they simultaneously adopt a biographical reference in the sense that they identify the author's identity as a person. It must be said, however, that there is a growing preference for the use of *I* over *we,* specifically in hard science, due to the authors' pragmatic purpose (identified by Hyland 2001) of using self-mention in order to be closely related with their work and to mediate the relationship between their arguments and their discourse communities.

5. Conclusion

What makes discourse *specialized* is the mixture of specific lexical, syntactic and semantic features which differ *quantitatively* with respect to general language (Gotti 2003). As Sager et al. (1980: 230) claim, the most distinguishing characteristic of specialized discourse is its lexicon, regardless of lexical occurrence, characterized, at a semantic level, by monoreferentiality, which implies a denotative function and lack of any kind of emotional and connotative meaning- it therefore calls for precision and transparency (which frees specialized language from ambiguity and polysemy).

The keyword list generated from the RA (Table 5, below) which led the two scientists to the Nobel Prize, indeed mirrors the above-mentioned characteristics of monoreferential, precise, transparent and denotatative meaning.

The discourse of the NLs, on the contrary, exploits features that go from specialisation to popularisation. As we have seen, both the key semantic

Table 5. Greider-Blackburn's RA keyword list

N	Key word	Freq.	%	Keyness
1	OLIGOMER	43	0.51	88.91
2	A	36	0.43	74.42
3	MM	33	0.39	68.21
4	DTTP	39	0.46	66.40
5	LANES	31	0.37	64.07
6	TTGGGG	68	0.81	63.92
7	DGTP	36	0.43	55.90
8	mM	26	0.31	53.73
9	ADDITION	55	0.65	42.59
10	DNTPS	30	0.21	37.18
11	M	18	0.36	34.83
12	SHOWN	23	0.27	31.56
13	REACTION	36	0.43	30.97
14	INCORPORATION	19	0.23	27.80
15	CONCENTRATION	13	0.15	26.85
16	MIN	13	0.15	26.85
17	NUCLEASE	13	0.15	26.85
18	n	22	0.26	26.65
19	UNLABELED	22	0.26	26.65
20	ENDOGENOUS	16	0.19	26.32
21	ML	12	0.14	24.78
22	INPUT	15	0.18	24.38
23	ADDED	56	0.67	24.26

domains and the keyword list contain items ranging from technicalities (*telomerase*, *RNA*, *tetrathymena*, *emzime*, *cancer*, etc.) to attitudinal expression (*my lab*, *I wondered, the excitement*, etc.). This is also confirmed by the type of headings and subheadings characterizing the NLs which are distant from the traditional IMRD pattern established in the medical sciences, and rather reveal a narrative pattern resembling story-telling, where the plot has complicating actions to be resolved by the scientists and contains attitudinal evaluation. Such to and fro also seems to be confirmed by the presence of extremely technical figures within the NLs which cannot be understood by a layman. The story, as presented by the two Nobel Laureates, expresses mental models that are mental 'instantiations' of the discovery, whose knowledge is nowadays commonly-shared by junior and senior members of the medical academic community. Inserted in a co-text rich in personal

and professional anecdotes, such stories and mental models are often easier to remember and hence are quite useful as an explanatory device in the process of popularising scientific discourse. They also demonstrate the Nobel Laureates' command of the specialised knowledge they validate.

Given the type of audience targeted with the NLs, the use of such rhetorical devices makes it clear that, in addition to scientific communication within the specialised professional, NLs popularising function is that of attracting an audience of specialists stepping outside their profession to create networks of teamwork situations (the *invisible college*; cf. Dubois 1985: 72) and thus forming networks of teamwork situations (Dubois 1985: 82) with potentialities as far as future research is regarded because:

(17) Perhaps telomere monitoring will become as common as regular weighing as an integrative indicator of health (Blackburn 2009: 278)

The findings presented above are of course not conclusive, given the limited coverage and number of texts considered, and need to be triangulated and tested on a more representative corpus. Yet their implications may shed new light on the pragmatic effects of popularisation for a professional audience.

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