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Running Head: Scholarly Soundbites

Abstract

This study investigates a recent web-enabled feature, the use of brief audio/video recordings for the communication of scientific research findings to a non-specialized audience, and discusses the implications of these "scholarly soundbites" for genre evolution in the digital environment and for the mediatization of science. We focus on four types of audiovisual material, all characterized by their brevity: Three-Minute Thesis presentations, author videos, and podcasts on a popular science and a research journal website. An analysis of the moves and of the recontextualization strategies used to manage the knowledge asymmetry between scientists and audience highlights

differences between the four types of soundbites as well as with the corresponding written genres (research articles, PhD dissertations).

1. Introduction

Science researchers speak with different voices in different contexts and genres, as has been amply demonstrated in previous work by sociologists of science and discourse and media analysts. The pioneering studies in the early 1980s by sociologists (e.g. Knorr-Cetina 1981; Gilbert & Mulkay 1984) into lab work and talk and informal oral exchanges among scientists painted a picture of scientific discourse behind the scenes that was very different from that of the public face of science. A second wave of studies, this time among linguists and discourse analysts, starting in the late 1990s focused on established scholarly speech genres such as the conference presentation or thesis defense as a necessary corrective to the almost exclusive focus on the written tenure genres of the journal article or monograph (Ventola et al., 2002; Swales 2004). As all this work has made clear, scientists "do not confine themselves to the kind of language used in published articles; they move between several repertoires" (Myers, 2003:270): the mode (spoken or written), the intended audience (a

semi-private or a public record), and the stage in the research process documented (exploratory in the lab, often ongoing in the conference talk, after completion of the research in the journal article) are all major sources of differences that impact both on how the researchers express themselves and on what aspects of their work they focus on.

We are now witnessing what could be called a third wave, as the dissemination of science via the Internet has immeasurably enlarged the variety of repertoires, contexts, and genres, in which scientists can present and discuss their work. The Internet has changed the game rules for scientific communication in several respects: the need to address a global, indeterminate audience, not an esoteric circle of peers, raises the problem of knowledge asymmetry between science researcher and audience, and requires suitable discursive strategies; the digital medium is characterized by heightened interactivity and is an expressively free, often strongly personalized, environment; it is extremely reactive timewise but may, critically, shorten the attentional timespan of users, accustomed to zapping from one page or site to another and to processing small bite-sized pieces of information. It may also lead to the increased introduction of promotional features into established genres (e.g. Bhatia 2005). Lastly, the Internet revolution has involved a shift from primarily print media to audiovisual material adapted to mobile devices.

In response to the new social needs generated by this upheaval, scholarly journals have increased their digital presence by uploading existing genres unchanged to the Internet, or adapting them in various ways to the hypertextual and multimodal affordances of the medium (see e.g. Pérez-Llantada 2013,

2016), while new hybrids and web-native genres, developed both by journals and by the scientists themselves, have emerged - scholarly blogs, scientific wikis, video clips, podcasts, TED talks, open science notebooks to mention but a few (Myers 2010; Campagna et al. 2012; Carter-Thomas & Rowley-Jolivet 2017), making it increasingly difficult to maintain the traditional distinctions between academic genres and questioning or blurring the boundaries between scholarly and popular science (Myers 2003).

In addition to these factors related to the Internet medium itself, a deeper societal process that may also induce genre evolution is mediatization. Starting from the recognition that digital media have become ubiquitous in time (available 24/7), space (the audience is global) and context (pervasive in all areas of social life), media scholars argue that these quantitative extensions of the media landscape have led to qualitative changes in how other social subsystems and institutions (politics, education, religion, science...), which each had their own traditional modes of operation, values and priorities, now communicate and operate. The media logics of marketization, popularization, immediacy, and the pursuit of publicity and visibility are tending to permeate or even become embedded in how these institutions function. While this may be most obvious in the political sphere, where the news agenda is increasingly set by what is trending on Twitter (Garland et al. 2018), academia and science are also affected: the worldwide university ranking systems turn universities into competitive providers on an educational market (Pallas & Wedlin 2013), academic networks such as ResearchGate turn researchers into 'entrepreneurs of themselves' in a marketplace of ideas (Hammarfelt et al. 2016), while the

major academic publishers have adopted aggressive marketing strategies online and compete for high impact factors.

In the present study, we will attempt to interpret our results both in terms of mediation (the role of the Internet medium in genre evolution) and in terms of mediatization, pointing out whether any signs of these new media logics are discernible in the communication of science online in our data. We have chosen to focus on oral data, relatively under-researched compared to written web-mediated documents, in view of their prevalence among Internet users. We collected a corpus of four types of short audio or video recordings from the Internet, in which junior and senior researchers talk about their ongoing or recently published research: Three-Minute Theses (henceforth 3MTs), podcasts from the popular science magazine *Scientific American*, podcasts from the research journal *Nature*, and Author Videos from the *Nature* Video Channel or Elsevier journal websites. We have called these recordings "scholarly soundbites" as they are all characterized by their brevity. 3MTs, by definition, never exceed 180 seconds, whereas, as proclaimed on the website of the University of Queensland (Australia), the creator of the 3MT competition, "An 80,000 word PhD thesis would take 9 hours to present. Their time limit... 3 minutes."[i] The *Scientific American* podcasts are broadcast in the feature called "60-second Science", and while the Author Videos and *Nature* podcasts are more variable in length, ranging from 1 min 30 s to 6 minutes, they are very brief in terms of word count compared to the corresponding research article (RA). Although we have not yet reached the stage of "Twitter science", we can

wonder whether the scholarly soundbites analyzed here are not a step in this direction.

These four scholarly soundbites are not to be considered as representing a single genre as they cover a fairly wide range of discourses. Our aim was to attempt an overview of the palette of spoken resources available on Internet for scientific research communication to a predominantly non-specialized audience. After presenting the data collected (section 2), we first undertake a move analysis of the soundbites, inquiring into how the scientific content is adapted in comparison, where appropriate, with their written equivalents (theses and RAs). In Section 4 we then analyze the discursive strategies used to recontextualize the research, focusing on four aspects that reflect the adaptations required by the context and/or the digital medium: reformulation and repetition strategies that have both an explanatory and a persuasive function (4.1); illustration procedures such as the use of comparison and metaphor to make the content understandable and attractive for a non-specialist audience (4.2); interactivity through the use of questions (4.3); and personalization through researchers' comments on their work (4.4). The concluding section attempts to draw out some of the implications of the changing ways science is communicated in the digital age.

2. Data Description

As shown in Table 1, in each of the four datasets, we collected 15 recordings from a range of sciences over the period 2010-2018. All the documents were transcribed, or if transcriptions were already available on the websites (the case of the podcasts), we checked the transcripts and made some corrections. The total length of the corpus comes to 229 minutes, and the total word count to just over 40,000 words. The average length of the four types of soundbites is, in increasing order, about 2 min (*SciAm* Podcasts), 3 min (3MTs), 4 min (Author videos) and 6 min (*Nature* podcasts). The podcasts are audio recordings only, whereas the 3MTs and Author videos were video-recorded, enabling the inclusion, in addition to sound effects, of some visual material. The number and type of speakers vary depending on the category. As we wished to investigate how the research scientists themselves speak about their science in digital media, we excluded recordings in which only a science journalist or a voice-off commentary could be heard, as well as those that did not refer to a recent publication but were an overview or introduction to a topic (the case of many science videos available online). For the podcasts, starting from January 2017, we selected the first 15 recordings that met these criteria; for 3MTs, given the time-lag of several years between the 3MT presentation and publication of the thesis, we had to go further back in time, and selected only those where the thesis was available; for the videos, we selected all the science videos on the *Nature* video channel that met our criteria, and completed the dataset with 5 from Elsevier journals (see below).

Table 1. The Audiovisual Corpus

	3-Minute	Author	*SciAm*	*Nature*	Total

	Theses	Videos	Podcasts	Podcasts	
Medium	video	video	audio	audio	
Number	15	15	15	15	60
Total length (minutes)	43'50"	62'38"	29'5"	94'13"	229'46"
Average length (minutes)	3'	4'15"	2'	6'20"	
Total words	7,337	9,441	4,509	18,956	40,243
Average words	489	630	300	1264	
Date	2011-15	2010-18	2017	2017	
Speakers*	1 PhD student	1S Or (2 cases) 1S + 1J	1J + 1S	1 or 2J + 1 or 2S	

(*) J: journalist; S: scientist

   3MT presentations are a new, competitive academic speech genre that gives PhD students the opportunity to present their ongoing research, in 3 minutes, to a mixed disciplinary audience before a panel of judges. The 3MT™ competition itself, we would contend, can be seen as evidence of the marketization of academic research in that 3MT is the registered trademark of a higher education institution, the University of Queensland, which defines the rules and authorizes other universities to use the 'brand', and has contributed greatly to enhancing the media profile of this institution. The contest applies the typical elements of game-playing – scoring with winners and losers, competition with others, strict rules of play – and can be considered an example of the 'gamification of science' (Hammarfelt et al. 2016). Presentations are limited to 3 minutes, the presentation must be spoken word only, with no props and a single static slide. The presenters are novice researchers who deliver a monologue but are not required to answer any questions at the end. The adjudicating panel attributes the awards, and the judging criteria are clearly laid out: candidates should "avoid jargon and academic language", and clearly describe the topic, significance, results and outcomes of the research; they are

advised to "tell a story", to be enthusiastic and to use an opener that catches the audience's attention. In contrast, the other three categories all involve established researchers and are positioned at a later stage in the knowledge production process as they discuss recently completed and published research findings.

The 15 Author Videos were downloaded from two sources: ten from the *Nature* Video Channel[ii] and five attached as Featured author videos to RAs published in Elsevier journals[iii]. Few researchers appear to have availed themselves of this possibility, however, apparently because of the lack of established guidelines or genre conventions, according to some researchers we consulted. Our data reflect this, as unlike the 3MTs, the length of the videos is variable (from < 2 to 6 minutes) as are the number and type of speakers: a regular alternation of turn-taking between scientist and journalist in two, a very brief introduction by the journalist in another two, and the scientist(s) as sole speaker(s) in the remaining eleven.

The remaining two categories, *Scientific American* podcasts and *Nature* podcasts are audio recordings only. The popular magazine and the research journal broadcast podcasts every weekday and once a week, respectively. This initiative can be seen as an indication of the mediatization of the scientific press, both in the accelerated timeframe of some of the podcasts (daily updates, by analogy with news media) and in the increased visibility the podcasts confer on the journals. In contrast to the two video categories, journalists play an important role. In the *SciAm* podcasts, their role is even the dominant one: the recently published research is introduced, summarized and commented on by

the journalist, and the scientist's role is restricted to a brief quote inserted into this commentary – literally, a 'soundbite' of a few seconds. There is no direct dialogue between the journalist and scientist, and the podcasts are very brief.

The *Nature* podcasts are the longest of our four types of recordings, averaging six minutes, which allows more room to develop the science and to give the scientists a more prominent role, and can therefore be assumed to address a more scientifically literate – or at least interested – audience than the *SciAm* podcasts. Here, there is a real exchange between the journalist and scientist (see Section 4). In some cases, the publication of the article is used as the launchpad for a broader coverage of the topic, bringing in previous work on the subject or competing hypotheses, leading to multiple voices.

We also collected the corresponding written texts: the 15 thesis Abstracts and the theses themselves for the 3MTs, and the 45 RAs for the other three categories. The PhD Abstracts sub-corpus contains 7123 words and the theses cover 3,320 pages. The 45 RAs total 200,430 words.

3. Move Analysis

Move analysis is a frequently used tool in genre analysis to determine the recurrent rhetorical structure of a given discourse (Swales 1990). We applied move analysis to investigate which aspects of the scientific content predominate in these new modes of spoken scholarly communication, addressed to a non-specialist audience. To enable comparison between our four subsets, we

adopted the same move categories across the board. Table 2 summarizes the

eight main moves occurring in the soundbites.

Table 2. Move Structure in the scholarly soundbites*

Move	3MTs	Author Videos	*SciAm* Podcasts	*Nature* Podcasts
1 Orientation/Introduction	100	67	87	100
2 Rationale & Purpose	97	67	73	80
3 Methods	94	87	80	67
4 Results	73	100	100	100
5 Discussion of Results	0	33	0	80
6 Implications/Applications	87	73	87	73
7 Rounding off	100	0	67	100
8 Reference to publication	0	33	100	100

* Expressed as % of talks or recordings in which the move occurs (n= 15 in each subset)

Move 1, Orientation or Introducing the Topic, consists generally of a short

preamble preparing the audience for the topic of the talk. Move 2, Rationale

and Purpose, explains the motivation for and the aim of the research,

corresponding to the "Establishing a niche" and "Occupying the niche" moves

in Swales' model for research introductions (1990, 2004), grouped together

here as in these brief talks to a non-academic audience the two were often

conflated. Moves 3, 4, 5, and 6 likewise reflect the IMRD development of the

RA. In Move 7, Rounding off, the speaker indicates the close of the talk or

recording using various strategies, discussed below. Move 8, which only occurs

systematically in the podcasts, is a set formula referring the listener to the

corresponding article; the transcripts on the website give the hyperlink to the

article at this point. The apparent similarity of most of these moves to the

traditional rhetorical structure of the RA is unsurprising since all the soundbites

are accounts of scientific research, but there are several significant differences

among the four subsets, and some interesting characteristics that differentiate them from the corresponding written data. For reasons of space, only some of the main points will be highlighted below.

Among the strategies used in Move 1 to introduce the topic, for example, the audience is often addressed directly, either by a statement:

(1) J: You've probably seen pictures of Greek villages, where every house is painted bright white (SciAm)

or by a question (see 4.3). Alternatively, the creation of an imaginary scenario (see 4.2) or banter between two journalists, including puns and homely examples, leads listeners gradually into the scientific topic:

(2) J1: Adam, open wide please. I need to look at your dental calculus.

J2: My what?

J1: Your dental calculus: calcified dental plaque. Basically, bits of food and microbes that live among your pearly whites.

J2: No, I'd really rather you didn't. My teeth are spotless and you're definitely not a dentist.

J1: Correct! But I am very interested in what dental plaque can reveal about diet and health. A new study in *Nature* takes a look at some dental calculus from Neanderthal teeth... (Nature)

These engaging and interactional openings clearly serve to 'hook' the listener by relating the topic to his/her own experience (holidays abroad, visits to the dentist).

Two of the conventional sections of the RA, Theoretical Background and Methods, are handled very differently in the soundbites. Theoretical

developments are quite simply absent. We found only one occurrence of Hu and Liu's (2018) Theoretical Framework move in our own 3MTs and one other in the Author Videos, both in mathematical physics where theoretical investigation was in fact the purpose of the research, and none in the 30 podcasts. We therefore excluded this move from our analysis. Although Move 3 (Methods) is frequent in our spoken data, the information given about the methods is generally extremely brief. A typical example is (3), where the 15 pages of Method and Supplementary data in the RA are reduced to a single sentence in the corresponding podcast:

> (3) J: They popped off bits of ancient dental plaque and then sequenced the DNA contained within. (SciAm)

A salient difference among the four subsets concerns the Results and Discussion of Results moves. The videos and podcasts, designed to illustrate and promote a recent publication, all contain Move 4, Results: in the two shortest videos this constitutes practically the only move, and also receives great prominence in the *SciAm* podcasts (given twice in 6 cases). In the 3MTs, in contrast, results feature in only three-quarters, confirming Hu and Liu's (2018) data where Results occurred in only 57% of 3MTs, and was therefore considered an optional move applying a cutoff point of 80%. This can be attributed to the on-going nature of the thesis research, as can the total absence of move 5, Discussion of the results. The latter is also absent from the *SciAm* podcasts, despite the fact that the podcast is based on an RA where the Discussion section is a crucial feature. We attribute this to the extreme brevity

of these podcasts and the popular audience targeted; these snippets give only a superficial, factual view of scientific research.

In the *Nature* podcasts, in contrast, the Discussion move can be considered an obligatory one. The 'facticity' of scientific results (Latour 1987), which seems to be taken for granted in the *SciAm* podcasts, is here problematized as either the scientists themselves discuss possible interpretations of their findings, or, more agonistically, their claims are contested by others. The podcast becomes a forum for the confrontation of various viewpoints and hypotheses:

> (4) S: We have people in the field that are sceptical and people in the field that are lauding our accomplishment, and it turns out that the people in the field that are sceptical are competitors of ours, and they've made comments like, "I don't believe that you can get that high of a pressure". Fine, we've shown what we've done. So they can go ahead and try it. If they try it, they're either going to confirm it or show that it didn't happen. I'm confident that they'll find that it happens.
> (Nature)

In the videos, this move is less frequent (occurring in 5 videos), but nonetheless is an interesting exploitation of the digital medium in that, as in some *Nature* podcasts, the two conflicting hypotheses are embodied by two different researchers, creating a multiplicity of voices.

The closing move, Rounding Off, often uses similar strategies to the opening move. 3MT presenters invariably indicate the end of their talks with a short "thanks" and a smile to the audience, and some with a punchline or an echo strategy, while in the two podcast sets the journalist often concludes on a light-

hearted note by punning on the keywords of the topic (see Section 4.1). This move is absent in the Videos, however, which often end abruptly.

Move structure is therefore followed and developed to varying degrees in the four subsets. In the 3MTs, the constraining rules and recommendations of the contest induce considerable uniformity in rhetorical structure. Although certain moves may occur recursively, we found that the ordering of the moves is remarkably regular: moves 1, 6 and 7, due to their very nature, always occupy the same slots, and intervening moves also follow the linear order in the overwhelming majority of cases. The move structure of the *SciAm* podcasts is also highly formatted, with the same linear move order in almost all the broadcasts.

In the *Nature* podcasts the move structure is more fully developed than in the other three subsets, as all 8 moves occur frequently, 6 in over 80% of the podcasts, and the other 2 (Method and Implications/Applications) in two-thirds of them. The structure is however fairly flexible, progressing by a question and answer format (see section 4.3).

A move analysis gives a misleading picture of the videos, however, as no recurrent rhetorical structure could be detected: the videos vary considerably in the order of the moves, in their number (ranging from 1 to 7, average 3.5), and in the time devoted to each in any given video. Only two moves can be considered obligatory (Methods & Results). There also appears to be a great variability in the type of audience targeted. Some of the *Nature* videos lean towards the popular science end of the spectrum, exploiting the visual impact of the medium by showing striking films, including music or sound effects, or are

descriptive rather than analytical. At the other extreme, some of the Elsevier videos targeting a highly specialized audience resemble the abstract of the corresponding RA in content and terminology. The scientists do not seem to have received any guidance, however, on whether their research topic was suitable for a video presentation or not: some of the videos are simply 'talking heads', whereas others are greatly enhanced thanks to the visual medium.

4. Recontextualization strategies in the soundbites.

In the linear diffusion or deficit model of science communication, knowledge transfer is seen as a one-way process from scientist to (semi)-lay public via a mediator, usually a journalist, and a dumbing down of the original source. In preference to this reductionist view, we adopt here the approach of several scholars (e.g., Jacobi 1999; Ciapuscio 2003; Gülich 2003) who see expert-lay communication as a *recontextualization* of the initial source for different addressees, which can be accomplished either by the scientists themselves or through collaborative 'work' with journalists. In this process, several types of discursive strategies can be used. Selecting the most appropriate formulation is obviously crucial; it is also often necessary to illustrate the concepts and findings by procedures such as comparisons and analogy, exemplification and metaphor, in order to relate the knowledge to the receiver's own context, or to 'humanize' the impersonal scholarly discourse by bringing in the researcher as a person. Additionally, as success in oral communication is an interactional

achievement (Thompson 1998), interactive devices such as questions are a useful strategy.

This section therefore first focuses on the reformulation procedures used to make the scientific content accessible to the lay audience (4.1). We then look at a closely related set of discursive devices used for comparison and exemplification that we have grouped under the label illustration procedures (4.2), and follow with an analysis of the role of questions (4.3). The section concludes (4.4) by highlighting the human side to science through the expression of scientists' comments on their work. In the *Nature* and *Scientific American* podcasts, we will also distinguish between journalists' and research scientists' use of these strategies, as this sheds light on their respective roles.

4. 1 Reformulation and repetition strategies

By reformulating, speakers can rework or "treat" again (Gülich 2003) an earlier segment of talk - whether produced by themselves or by another interlocutor - in order to better adapt it to the communicative context. Previous work has often focused on a selection of specific reformulation markers: *that is (to say), i.e., in other words, namely, I mean* (Pennec 2006). However, an initial search for markers of this type in our spoken corpus revealed only one occurrence of *that is (to say)* over the four data sets. We therefore adopted an onomasiological and discursive approach, involving a close reading of reformulation and repetition patterns in our corpus, and distinguished four types of procedure:

1) Deliberate repetitions. Discarding examples where the repetition seemed due to some type of disfluency, we only considered cases where the repetition seems deliberately adopted for stylistic or rhetorical reasons.

2) Paraphrastic reformulations. The reformulation is a formal variation of the original expression; the content is not changed or only very marginally.

3) Paraphrastic reformulations involving definitions or acronyms. This category is the same as (2) but, given the highly specialized nature of our corpus, we wanted to see to what extent the paraphrases specifically concerned definitions.

4) Reformulation with specification/expansion. The reformulation here involves a variation in both form and content, with information being added, expanded or analyzed from a different angle.

Table 3 gives the occurrences in the data.

Table 3: Reformulation and Repetition Strategies

	Type of reformulation	3MTs	Author Videos	*SciAm* Podcasts	*Nature* Podcasts	*Total*
1	Deliberate repetitions (Rep)	23 (50%)	21 (33.3%)	13 (40.6%)	18 (25.7%)	75
2	Paraphrastic Reformulations (PR)	14 (30.5%)	21 (33.3%)	10 (31.2%)	25 (35.7%)	70
3	PR involving definitions (Def)	7 (15%)	10 (16%)	4 (12.5%)	20 (28.6%)	41
4	Reformulation + specification/ expansion (SpEx)	2 (4.5%)	10 (16%)	5 (15.6%)	7 (10%)	24
	Total	46	62	32	70	210
	Occurrences per 10,000 words	63	66	71	37	52
	Coverage	13/15	11/15	14/15	15/15	53/60

Some type of reformulation occurs in all but two of the 3MT talks, with deliberate repetition being the preferred strategy (50% of occurrences). Its main purpose is for rhetorical effect, underlining important points often using ternary repetition, a well-known trope of classical rhetoric:

(5) *Is it because of* environmental effects like diet and health? *Is it because of* the effects of a particular person like their age, ethnicity or immune system? Or *is it because of* the effects of the particular type of virus that they've been infected with?

Four of the 3MT talks also make use of an "echo" strategy, where deliberate repetition serves to reinforce the main message. In a talk on vehicle efficiency, for example, the speaker repeats in her closing words the key concepts of her research:

(6) Opening utterance: Today I'm going to talk to you about *improving vehicle efficiency using springs*.

Closing utterance: I'm helping to *improve vehicle efficiency*. That's all being done by *using some springs*

The 3MT talks also use a number of PRs to simplify the audience's task of comprehension, but in line with the official 3MT instructions to contestants to 'avoid terminology', reformulations involving more specialized terminology are sparse.

In the author videos, while all four categories are exploited, the coverage is uneven: four of the videos (very technical videos targeting a highly specialized audience) contain only one or no reformulation procedures, whereas others contain a large number, perhaps a further indication of the lack of genre stability already remarked upon in section 3. In a video on the Lassa virus, for example, there are 10 occurrences of reformulation. The following extract from this video contains four PRs:

(7) S: But there's a few individuals that have *a very very diverse population of viruses within them*, **so there's lots of mutations and change**s. So this tells us that there are at least some people infected with Lassa who might have, who might be *chronic carriers,* **who have been carrying the virus for longer giving it more time to to mutate and change**. However most of these mutations that happen within a person because they help the virus at the immune system, then *are evolutionary dead ends*, euh **so where those mutations are not well suited to be transmitted to another person**. **So it seems like they occur but then you rarely see them again in another person.**

In (7), each italicized expression is subsequently rephrased (in bold) to make the key ideas clear, with the final sentence representing the second reformulation of *evolutionary dead ends*.

The author videos also contain repetitions but it is often difficult to draw the line between deliberate repetition and disfluencies. Several speakers repeat common evaluative adjectives and adverbs such as *very*, as in the first line of (7) above, or *incredible/incredibly* (10 occurrences in one short presentation). Although providing emphasis and illustrating the researcher's enthusiasm, in a way typical also of CMC discourse (Herring et al. 2013), these repetitions could also be prompted by the constraints of online speech processing and appear less rehearsed than the much slicker ternary repetition constructions and "echo" strategy noted in the 3MT talks.

The *SciAm* podcasts contain a high proportion of Rep (40.6%), some of which also involve ternary repetition for rhetorical effect:

(8) J: we're using it in every building, every bridge and every high*way*

Due to the high level of journalist involvement and the rather different genre expectations of popular science, repetitions are also used in other ways. Several of the podcasts contain plays on words, with a keyword connected to the topic being repeated to make a pun or joke. In a podcast on the discovery of Neanderthal skeletons, the journalist puns on the word "bones" at the end of the report: *No bones about it*. Likewise, in a podcast on windstorms the journalist picks up two keywords from the scientific report (rain and wind) to make a joke, alluding to two well-known Bob Dylan songs:

(9) J: And as this study shows: it won't just be that a hard rain's a-gonna
fall. We'll be blowing in the wind, too.

Lexis in these podcasts is very accessible, with practically no abstruse terminology, and therefore little need for definitions. There are however several examples of paraphrastic reformulations:

(10) S: this can be a problem for the plants, because they have a reduced
ability to evolve resistance against diseases.

J: *Meaning that if we lose pollinators, it's the plants' genomes that may
go to seed.*

In (10), the journalist reformulates the moderately technical explanation of the scientist (reduced ability to evolve resistance) into very everyday language, again using a pun with *seed*. Most such reformulative expressions are used by

the journalists. The role of the researcher, as already mentioned, is in any case circumscribed in the *SciAm* podcast to just the occasional quote.

Reformulation strategies are proportionally less frequent in the *Nature* podcasts than in the other subsets. They contain however the highest proportion of reformulations involving definitions (28%). When combined with PRs, these two categories account for 65% of the occurrences (see Table 3), and are used by both journalists and scientists. In (11), it is the journalist who explains a term in advance so that listeners will be able to follow:

(11) J: Scientists refer to this tiny group as a reservoir

Deliberate repetitions, however, are mainly used by scientists, to highlight important points:

(12) S: It is really one of the major questions that we have to answer in the future: *why, why expressing this* marker? *Why expressing this signature?*

whereas repetitions revolving around plays on words for humorous intent are solely the preserve of the journalists, as in the *SciAm* subset. At the end of the podcast on Bird Beaks, for example, the two journalists engage in humorous banter with a series of puns involving birds:

(13) J1: I think she was winging it a bit, but I have no "egrets" about giving the story "top billing." If you want to find out more about that "egg-cellent" paper, then you'd better "flamin-go" and find it on the Nature website,

J2: And do feel free to Tweet us @NaturePodcast if you have any more "fowl" puns.

4.2 Illustration procedures

Illustration overlaps to some extent with reformulation as both types of procedure enable speakers to communicate a specialized field of research to a less specialized audience in such a way that is relevant and understandable for them, preventing possible communicative failure. However, whereas reformulation involves some type of "retreatment" (Gülich 2003) or recycling, illustrations – comparisons and analogy, exemplification, metaphor, and scenarios – need not necessarily be employed to rework what has already been verbalized.

   After briefly outlining their scope, we will compare their distribution across our corpus (Table 4).

1. Comparisons and analogy. Through comparisons with everyday objects and experiences, concepts can be made more accessible for the lay audience.

2. Exemplification. Exemplifications enable speakers to illustrate abstract or complex concepts with concrete examples, and to underline the applications of the research.

3. Metaphor: Adopting a traditional concept of metaphor as an implicit analogy of two unlike things, we identify those occurrences where speakers exploit the linguistic realizations of metaphor to reinforce the clarity or impact of their research.

4. Scenario. Following Ciapuscio, we use this this term to refer to the way speakers create "a possible yet imaginary situation that allows them to explain a complex event to the audience" (2003:212).

Table 4: Illustration strategies

	Types of strategy	3MTs	Author Videos	*SciAm* Podcasts	*Nature* Podcasts	*Total*
1	Comparison and analogy	9 (21.5%)	14 (48%)	8 (24%)	18 (43%)	49
2	Metaphors	4 (9.5%)	1 (3.5%)	8 (24%)	9 (21%)	22
3	Examples	21 (50%)	13 (44%)	17 (50%)	13 (31%)	64
4	Scenarios	8 (19%)	1 (3.5%)	1 (2%)	2 (5%)	12
	Total	42	29	34	42	147
	Per 10,000 words	57	31	75	22	36
	Coverage	15/15	12/15	12/15	15/15	54/60

Examples are abundantly used in all four subsets and appear to be an essential strategy when addressing a non-specialized audience.

Illustration is widely used by the 3MT presenters (57 per 10, 000 words), but it is the use of scenarios, a rarity in the other subsets, that appears to be a real feature of this genre. The student presenters make use of fairly elaborate scenarios involving imaginary situations in order to stage their talk. In a talk on natural language processing, for example, the speaker sets out a scene for the audience as if it were a scene from a film or play:

> (14) Okay, so let me set the scene for you. You're driving in the desert. It's the middle of the night. There's no one but you on the road and then suddenly "bang" you see this thing crash landing in front of you. You decide to explore, so you take out your torch and you walk towards it and then you see these strange markings in the ground.

The proportion of illustration strategies is lower overall in the Author Videos than in the 3MTs, with three of the very technical videos containing none. There are also practically no examples of scenarios or metaphors. There are however a number of comparisons and analogies with everyday objects to clarify matters (15):

(15) S: over time we realized that graphene behaves a lot *like paper*.

The *SciAm* podcasts contain proportionally the highest ratio of illustration strategies in our four subsets (75 per 10,000 words). Examples once again represent a high proportion as do comparisons and analogies (24%). In (16), the journalist and scientist work together using the same analogy of tying a shoelace in order to illustrate the problem of making molecular knots:

(16) S: "With a molecule you can't just grab hold of the ends and tie them like you would a shoelace. They're too small for that [...]."

J: [...] remember when you were learning to tie your shoes, your mom or dad put a finger in the middle of the knot, to make it easier to tie? Well, Leigh and his team did something similar, but used metal ions as the "fingers" to keep the knot tying organized.

Metaphors, on the other hand, are used exclusively by the journalists (and not the researchers): *a **cocktail** of common beehive viruses, concrete **recipes**.*

Although the *Nature* podcasts contain fewer illustration strategies overall, comparison and analogy do feature and when combined with metaphors account for 64% of occurrences. Once again there is a divide in the way journalists and scientists use these strategies. As in the *SciAm* podcasts,

metaphors (17) and the few scenarios used (18) are solely the preserve of the journalists:

> (17) J: So hopefully one day researchers will carry out experiments like these, and the fairy circle mystery will finally *be put to bed.*

> (18) J: *Imagine you're a virus particle*, floating outside your next bacterial host. You're preparing to infect the cell, injecting your DNA into the bacterium

Scientists themselves appear to avoid these more literary or imaginative uses of language, preferring the more neutral strategies of comparison or exemplification. As seen above, this is not the case however in the 3MT presentations. Unlike the confirmed researchers, the PhD students make heavy use of dramatization (scenarios), which contributes to the creation of a "show" more than a research presentation.

4.3 Questions

Questions are engagement markers that presuppose the existence of an addressee and are inherently interactional, soliciting either direct interaction in the case of conversation and dialogue, or simulated interaction with the reader or listener in writing and spoken monologue. To investigate the degree of interactivity of the soundbites, we analyzed both the frequency and the functions of questions in the data. Our definition of questions included interrogative clauses and sentence fragments that concluded with a question mark in

the transcripts or interrogative intonation in the recordings as in (i) and (ii), but excluded embedded or indirect questions:

(i)   What kind of patterns did you see?

(ii)   But how?

   Table 5 shows that questions are used extremely often in the scholarly soundbites, averaging 43.5 per 10 k words overall (vs only 0.9 per 10 k words in the written texts), by the scientists themselves in the monologues (all the 3MTs and all but two Author Videos) and mainly by the journalists in the podcasts. The subsets in which they are the most heavily used, both in frequency and in terms of coverage, are the 3MTs, which are delivered to a live audience, and the *Nature* podcasts, which are live interviews between scientist and journalist. In contrast, in the Author Videos and the *SciAm* podcasts, only about a third of the recordings contain questions, hence their lower frequency (around 20 per 10 k words).

Table 5. Number and frequency of questions in the corpus.

	3MTs	Author Videos	*SciAm* Podcasts	*Nature* podcasts	Total
Number of Questions	35	17	10	113	175
per 10,000 words	48	18	22	60	43.5
used by scientists	35 (100%)	16 (94%)	3 (30%)	15 (12%)	69 (39%)
used by journalists	0	1 (6%)	7 (70%)	99 (88%)	107 (61%)
Coverage	11/15	5/15	6/15	15/15	37/60
Number in corresponding written texts*	0	3	9	7	19
per 10,000 words	0	0.4	1.5	1.1	0.9

(*) PhD Abstract in the case of the 3MTs, Research Article for the other 3 subsets

Our functional classification of questions broadly followed the distinction made by Thompson (1998) between audience-oriented and content-oriented questions but was adapted to our mix of monologue and dialogue data, with 5 categories:

1) Addressee-oriented questions

1a) Interactional: arousing interest in, or evoking a response from the interlocutor/audience

1b) Clarification and checking: asking the addressee to repeat or clarify an utterance

2) Content-oriented questions

2a) Research questions: raising scientific issues

2b) Information-seeking/providing: asking the addressee to supply information (in dialogue) or introducing information by setting up question and answer pairs (in monologue)

2c) Confirmation-seeking: asking the addressee to confirm information (in dialogue)

The classification results are shown in Table 6.

Table 6. Functions of questions in scholarly soundbites.

Function	3MTs	Author Videos	*SciAm* Podcasts	*Nature* Podcasts
1. Addressee-oriented				
1a: Interactional	12	1	3	12
1b: Clarification & checking	0	2	0	5
2. Content-oriented				
2a: Research Questions	15	14	3	26
2b: Information-seeking	7	0	4	55
2c: Confirmation-seeking	1	0	0	15
Total	35	17	10	113

The 3MT speakers are characterized by their highly interactional stance: a third of their questions (1a: Interactional) are addressed directly to the audience, using the second person pronoun *you*:

(19) Would you believe me if I told you this was my brain on drugs? Practically all these uses occur in the opening and closing moves of the talk (Orientation and Termination, see Section 3), to arouse the audience's interest in the topic at the outset and to return to the live communicative context at the end. Content-oriented questions are also common, however, as speakers often present the research question of their thesis as a direct interrogative:

(20) Do some strains of HIV make people sick more quickly than others? They also use content questions to communicate information by setting up a pseudo-dialogue, in which they provide both the question and the answer, invariably introduced by the marker *Well*, thereby keeping tight control over the development of the discourse:

(21) So how do we find them? Well, we compute them.

In contrast, questions are seldom used in the Author Videos, which adopt a primarily expository communicative style. There are no questions in 10 out of the 15 videos (including the two where a journalist intervenes), and only 3 are addressee-oriented. Research questions, all asked by the scientists, form the main category, but cluster heavily in a single video (containing 9 out of the 14) where the author's daring claims are contested by another researcher.

Despite the presence of two speakers, journalist and scientist, in all the *SciAm* podcasts, no real dialogue takes place here either. The speakers' respective roles are reflected in the questions asked: interactional questions are

asked by the journalist to arouse audience interest, while research questions are asked by the scientists. Among the four information-seeking questions, two are addressed to the listeners, with the scientist's soundbite neatly dovetailed in to provide the answer:

(22) J: Eat like a caveman, no dairy, no grains, no sugar and so on. But what you probably won't find on many paleo plates today?

S: "Pine nuts and moss and tree bark and mushrooms."

J: Laura Weyrich, a paleomicrobiologist at the University of Adelaide

The *Nature* podcasts show not only the highest frequency and coverage but also the widest range of question-types of our four subsets. Interactional questions, again all asked by the journalist, are addressed either to the listeners (*Ever heard of fossil water?)* or to a second journalist who acts as a foil in the opening banter (see section 4.1):

(23) J1: Adam, what do you think is the toughest, most bad-ass organ?

J2: Maybe the liver (...)? Oh no, wait, maybe the brain (...)? Or the heart?

The distinctive feature of this subset, however, is the very high proportion and number of information-seeking questions. The two interlocutors engage in constant dialogue, with the journalist using her questions to structure the interview, moving it forward step by step to cover the main points of the published study, and the scientist providing the information in her answers:

(24) J: What's so great about molluscs? (...) How did they all evolve? (...) Why was this particular fossil so mysterious? (...) What are we calling this new creature? (...) This guy [=fossil] just has a sort of little shell on

its head. Is that useful for it? (...) And why is the fact that it has this spiky

radula tongue so important? (...)

When the journalist considers it necessary for listeners to understand, she asks

the scientist to confirm her summary or formulation:

(25) J: Your team found really striking differences between

Neanderthals, right?

S: Yeah absolutely.

This is the only subset where this function is used to a significant extent. In

these carefully structured interviews the journalist's questions and her requests

for confirmation as the dialogue progresses enable the knowledge asymmetry to

be overcome. This maieutic approach is very similar to that analyzed by

Ciapuscio (2003) in his study of interviews between a science journalist and the

researchers in preparation for the writing of a popular science article.

4.4 Scientists' comments on their work

An interesting feature of the soundbites compared to the written data is that in

addition to presenting the research itself, speakers also make personal

comments on their ongoing research. Basing our analysis on a close reading of

the scripts we identified and classified the different expressions (see Table 7).

In 3MTs, two types of comment are dominant: the challenge or difficulty of the

research, probably because the doctoral students are still struggling to overcome

some obstacles:

(26) Building the robot is really only a small part of the challenge. The

difficulty lies in its control. (3MT)

and enthusiasm:

(27) Am I excited about my project? Yeah, I really am. (3MT)

No comments of this type feature in the PhD abstracts.

Table 7. Scientists' comments on their work*

Types of comment	3MTs	Videos	*SciAm* Podcasts	*Nature* Podcasts
challenge, difficulty	8	6	1	5
enthusiasm, excitement, fascination, joy of discovery, delight, satisfaction, interest	8	19	1	21
surprise, puzzlement, incomprehension, uncertainty, disbelief, incredulity	0	14	0	7
Other (1 occ. each)	relief, sadness	0	0	confidence, competition, discomfort
Total	18	39	2	36
Coverage	14/15	11/15	2/15	14/15

(*) expressed as the number of occurrences

In the other three subsets, the difficulties of the research account for only a

small proportion of comments, presumably because as the research is

published, the main challenges have been overcome. In the Author Videos and

Nature podcasts, positive comments predominate, no doubt for the same reason

(successful completion of the work), ranging from expressions of excitement

and the joy of discovery:

(28) S: We were all very excited. I had to go for a walk to calm myself

down. So yeah it wasn't a Eureka moment but it was definitely you

know a we did it moment. (Video)

to wonder at natural phenomena (described as "mind-boggling"), and even the

fun of science:

(29) S: for us it's like playing Lego; it's magnetic Lego. And now we can

   play with this atomic Lego. (Nature)

These positive comments are in stark contrast to those we found in our study of the laboratory notebook, a daily record of the early stage of research, where negative comments expressing anger, frustration, perplexity, and self-criticism dominated (Rowley-Jolivet & Carter-Thomas 2016). The surprise element in scientific discovery also crops up quite frequently, reflecting the puzzle-solving nature of scientific activity:

(30) S: the thing that surprised us is that (...) We were really kind of

   shocked because we were thinking how does one single channel

   control two opposing things (Nature)

and scientific controversy is on occasion expressed very directly, without the conventional hedging and politeness strategies characteristic of the RA:

(31) S: My first reaction on reading the paper was No, this is wrong,

   something's wrong. (Video)

The exception is the *SciAm* podcasts. As the journalist does most of the talking and the scientists' comments are reduced to very brief quotes, this leaves very little room for them to express their attitudes to their work. We found only a single occurrence each of enthusiasm and difficulty.

Section 5. Genre Implications

As mentioned in the Introduction, the ubiquity of digital media in all spheres of society has led to their integration into the very functioning of some social institutions and to the adoption of media logics by these institutions, a process referred to as mediatization. Science has traditionally been a fairly autonomous, closed subsystem with its own codes of conduct and validation, requiring a high level of expertise to access the knowledge produced, unlike other subsystems oriented towards the general public such as politics, sport or education, where mass media are a useful channel of interaction with the target audiences. The transmission of scientific knowledge towards the general public was conventionally accomplished by science popularization, predicated on the deficit model in which science communication is conceived of merely as a vehicle to 'translate' science for a lay audience. The structural impact of the media on the scientific domain could therefore be expected to be lower than in other fields, and indeed, Rödder and Schäfer back in 2010 found that science's media resistance was quite high.

Things appear to be changing, however. The four sets of soundbites studied here are all produced within contexts that are highly institutionalized (higher education in the case of 3MTs) or strongly market-oriented (major publishing houses in the case of the podcasts and videos). These subsystems seem to be undergoing a process of mediatization, which may in turn impact on the genres produced by the scientists themselves. Universities, whether for economic and political reasons (to attract funding, to demonstrate their social utility...), or because they are constrained to do so by the global competition between universities triggered by the Shanghai and other ranking systems, or for more

diffuse reasons such as their immersion in a media-rich society, now seek increased media coverage of their activities, setting up their own PR departments, and as shown by the 3MT™ initiative of the University of Queensland, engage in market-oriented practices such as branding and reputation management. As argued by Pallas and Wedlin (2013), ranking tools lead to measures of scientific value that are based more on media logics such as simplification (using citation metrics), standardization (the same ranking is applied worldwide), and popularization, than on traditional academic criteria of worth. Very similar media logics appear to be at work in the 3MT competition. The scientific content is drastically reduced and simplified, the presentations are highly standardized and the adjudicating criteria the same worldwide, and speakers overtly seek to catch the audience's attention and tell a good story. Such skills appear far removed from those currently valued in other university genres and it is debatable whether they would pull much weight with a thesis examining board, more inclined to scrutinize the candidate's mastery of theory and the robustness of the methodology and the results, than be told an engaging story. In this respect, 3MTs may potentially constitute negative training for the viva – or on the contrary, they may gradually have an impact on the way the viva genre itself is conducted in the future, inflecting the jury's expectations and the candidate's presentation towards a more promotional style. The 3MT competition, by introducing and valuing these skills at a very early stage in the research career of scientists – during their doctoral research – may have a long-term impact on the mediatization of research.

Our other three subsets (podcasts and author videos) are all hosted or produced by major publishers, who are already engaged in media activities. The digital revolution has led them, however, to adapt and innovate, often radically, in the platforms and formats they offer in order to increase their visibility and promote their knowledge products. The huge expansion in the type and size of audience, with research that was previously confined to an esoteric circle of peers now available to the global audience, has clearly been taken on board. The podcasts, broadcast daily or weekly, can be automatically downloaded to the user's mobile device via an RSS feed "so you can listen when on the train, walking the dog or sitting in the garden" (*Nature* Podcast site), a 'push' strategy that brings the scientific findings directly to users worldwide. Posted on the popular YouTube channel, the author videos can likewise be viewed worldwide, as can the 3MT talks. In media logic, attention-getting is considered a form of social capital, and a channel such as YouTube enables the accumulation of such capital on the Internet.

As our chosen term of 'soundbites' indicates, both journals and researchers have also understood the need for brevity when communicating via the Internet, managing to condense dozens or even hundreds of pages of research into a few seconds or minutes in order to convey the gist of the work. They have also risen to the challenge of switching from an initially written mode of communication (theses, RAs) to the spoken mode. This switch involves not only a change in mode however, which researchers are accustomed to when an RA is presented as a conference talk or vice versa; in the case of the soundbites, it also involves managing without the traditional warrants used in research genres to ground

and support claims, i.e. the literature review and citations, and the scientific visuals. In the absence of these warrants, considerable recontextualization is necessary, and speaker ethos, communicative skills and audience involvement can be expected to take on more importance.

This is indeed what we have observed in this study. As our move analysis has shown, certain traditionally important facets of research that would be difficult to grasp or uninteresting for the lay audience, such as the theory or methods, are simply omitted or glossed over. Striking adaptations are also found in the discursive and linguistic strategies of recontextualization used (scenarios, metaphor, dialogic interactivity through questions...) when compared to those of the corresponding research genres. Furthermore, a side to research that is erased from RAs and theses, but that these soundbites give the scientists freedom to express, is that of their personal comments during the research process. This feature may be related to the medium itself, as the prevalence of the expression of emotions in CMC has been observed in several online contexts (blogs, Twitter, YouTube comments, etc.; see e.g. Cislaru 2015), as has a trend towards personalization.

It is perhaps too soon to know what lasting implications these changes may have on the evolution of scientific genres, but some conjectures can be made. The picture of scientific research that the average listener would gather from these recordings may be a partial, or even biased, one. The topics chosen for web diffusion, whether video or audio broadcasts, appear to shun highly theoretical subjects, doubtless because they are considered inaccessible to the global audience. This may in the longer term induce an imbalance in the types

of research made available to the digital audience compared to those that circulate in traditional genres. The radical reduction in the scientific content masks the complexity of research, in which many methods or setups must be tried before things can be made to work (Rowley-Jolivet & Carter-Thomas 2016). Moreover, all the soundbites have an important promotional purpose. The Author Videos and podcasts follow the publication of a research article, and serve to increase its visibility – and to promote the researchers themselves, who speak in person in the recordings. The very brevity of the data studied here reinforces this promotional intent. In another possible indication of the mediatization of science, the traditional dichotomy between information and entertainment appears to be collapsing in these soundbites: to attract and keep the attention of listeners, both sets of podcasts contain punning and plays on words, by the journalists at least, while 3MT speakers make many (often self-deprecating) humorous remarks to engage their audience, and could therefore be considered as "infotainment". It will be interesting to see to what extent this media logic continues to gain force and affect science communication, and which of the four types of soundbite discussed will survive long-term and become an addition to the genre set available to researchers.

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[i] <https://threeminutethesis.uq.edu.au>

[ii] https://www.youtube.com/channel/

[iii]