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# Terms in Popular Science Communication:

# The Case of TV Documentaries

## Abstract

Science documentaries on television aim to provide easy and entertaining access to research findings. To do so, producers need to know how to explain complex content for non-expert audiences in a comprehensible way. At the same time, they have to decide what aspects of a subject might be relevant for viewers, or how the subject matter could be rendered more interesting by employing strategies such as personalisation or emotionalisation. One specific decision concerns the use of terms. Both existing research and journalistic handbooks suggest that terms should be or are, in fact, avoided in popular science contexts. However, there is only little empirical research on the topic. This contribution seeks to test several pre-existing hypotheses on terms in documentaries for adults and show how often terms are used and whether/how they are explained when they appear. Examining terms in four English and four German science documentaries, the analysis points out which communicative resources are used to facilitate the comprehension of terms, and where an explanation seems to focus primarily on entertainment rather than ease of comprehension. The results challenge some of the previous views on terms in popular science communication and reveal that documentaries display highly idiosyncratic strategies when it comes to the use of terms.

## Keywords

popular science communication; TV documentaries; terms; comprehension; multimodality; visualisation

## 1. Introduction

Science and technology documentaries on TV have to tackle the challenge of transmitting scientific facts, findings and developments to non-expert audiences. On the one hand, this means that content needs to be presented in a simplified and comprehensible way (Scharrer et al. 2017). On the other, documentaries have to be entertaining if they want to be successful, as only a fraction of the audience watches a documentary with the only intention of learning something about science. This is true irrespective of the TV channel: "Even within a public service broadcaster like the BBC with a remit for education, every programme lives or dies by the number of viewers or listeners it gets" (Murcott 2010: 108). As a consequence, the content as well as its make-up needs to be emotionally and aesthetically appealing.

In this context, film-makers have to decide how much science is appropriate for popular science programmes to make sure the audience gains insight into the discipline without being bored or cognitively overstrained. Part of this consideration concerns the use of terms. This contribution takes a closer look at terms in science documentaries, focusing on the number of terms employed as well as the way they are dealt with to cater to the needs of the non-expert audience.

The discussion will begin with a brief outline of general characteristics of TV documentaries with a focus on their classification as infotainment and their multimodality (section 2). Section 3 will summarise previous analyses of terms in popular science communication, while section 4

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will attempt to define *term*. After some remarks on the material that serves as a basis for the analysis of science and technology documentaries as well as the method of term selection (section 5), four English and four German TV documentaries for adults will be investigated for their use of terms (section 6).

## 2. TV documentaries

The TV documentary for adults is a highly heterogeneous genre and ranges from biographical portraits and investigative journalism to the popularisation of academic, mostly scientific, findings. As mentioned in the introduction, television cannot afford to focus on scientific correctness only, given its status as 'the' medium of entertainment. This is why documentaries are often referred to as *infotainment* (Ulrich/Knape 2015: 121-131, Mangold 2004), and occasionally as *docutainment* (Wolf 2006) or *sciencetainment* (Held 1998).

To render such documentaries more entertaining, film-makers use strategies of emotionalisation, dramatisation[1] and personalisation (Burger/Luginbühl 2014: 368-369). Emotionalisation and personalisation both play an important role in the storytelling of documentaries. Science and history are often personalised by focusing on how a specific researcher goes on a 'quest' for new results, with breakthroughs and obstacles, until the spectacular new finding emerges (Mayer 2014). This shows how deeply intertwined emotionalisation, personalisation and storytelling are: A specific person is used to tell a story about science, which is supposed to appeal to the audience's emotions. Other strategies of emotionalisation include verbal intensification strategies, re-enactment, images of catastrophes, dramatic music, etc. (see Bondebjerg 2014, Hobden 2016, Sabban 2016).

One factor that determines the make-up of documentaries is the fact that TV is a highly multimodal medium. A multimodal medium is characterised by the co-presence of different modes, i.e. different communicative resources, or "socially shaped and culturally given semiotic resource[s] for making meaning" (Kress 2010: 79). Although multimodality generally, and increasingly, applies to all media (see, e.g., Bucher 2011: 123-124), an audiovisual medium like TV, addressing different sensory channels, is bound to be highly multimodal by nature. For TV shows and movies, Stöckl (2004: 13) distinguishes four main modes, each with different medial variants: language (spoken vs. written, the latter again static or dynamic), image (static vs. dynamic), music (sheet vs. performed) and sound. This categorisation does not explicitly include modes such as intonation or gesture, but Stöckl (2016: 6, 2004: 12-13) considers those as inherently connected to the presence of the four main modes.

The following brief overview will show how multimodality is relevant for the use of terms in documentaries: Terms are usually presented as spoken language, i.e. in the narrator's text or an expert's statement. The acoustic presentation could be accompanied by the term in writing, but this is, in fact, rare in science documentaries. Therefore, it is little surprising that this phenomenon does not come up in the data sample at hand. The images in TV documentaries are usually dynamic. Submodes that the audience is normally not aware of, but which can create connotative and emotional meaning (Stöckl 2016: 14), are camera (angle, movement, etc.), light or cuts (Koga-Browes 2015, Mikos 2008: 192-231). Just like the image, music and sound are mainly associated with the entertainment function of films because they are especially effective in appealing to people's emotions (Bullerjahn 2014: 198, Balzer 2009: 150). In documentaries, we can observe this emotionalising function, for example, when the presentation of a flywheel is accompanied by a waltz, or the explanation of the energy recovery system *KERS*, known from Formula One, by loud racing noises. Needless to say, these modes are not exclusively emotionalising – the camera can also serve the purpose of providing additional information, for example in animations or by

1 The subtle distinction between emotionalisation and dramatisation (see Ulrich/Knape 2015: 100-112/176-186) is not crucial for this contribution, and I will hence only refer to emotionalisation.

zooming in. Likewise, introducing a machine including its characteristic sounds also gives a more authentic impression of its functions than just the image of the machine.

What this brief outline has shown is that TV documentaries can combine different modes to cater to their two main functions: information and entertainment. A difficult question to solve for multimodality research is the quality of the interaction of the different modes. Although the discussion cannot be sketched here, one specific approach should be mentioned for illustration purposes, namely, the concept of *information linking* (van Leeuwen 2005: 219-247), which is often applied to the relation between language and image; van Leeuwen (2005: 222) distinguishes two types of linking:

> A given item of information can either *elaborate* or *extend* the information presented in other items of information. In the case of elaboration, it repeats or restates information for purposes of clarification. In the case of extension, it adds new information, linking it to the existing information in a particular way – for example, temporally, or logically.

As a consequence, in explanations in TV documentaries, information in one mode (e.g., spoken text) may either elaborate or extend the information given by another mode (e.g., moving image).

## 3. State of the Art: terms in popular science communication

An important aspect of successful science communication is the scientist's aptitude "to communicate clearly with lay audiences and, in particular, to express ideas in their domain of expertise while avoiding scientific jargon as much as possible" (Sharon/Baram-Tsarabi 2014: 529). This statement is in line with findings from other authors and recommendations in handbooks for popular science journalists[2]. Generally, Sharon/Baram-Tsarabi (2014) show that the amount of terms (or jargon, as they prefer) in popular science communication (esp. in TED Talks) is reduced in comparison to the intra-scientific communication between experts. More specifically for TV, Begolli (2010: 78) states that the use of terms in German TV magazines like *Quarks & Co* and *Galileo* is reduced to a minimum. Similarly, having analysed four TV documentaries broadcast between 2006 and 2010 (one on ZDF, one on BBC, two on ARTE), Jacobs/Lorenz come to the conclusion that documentaries only employ terms if it is unavoidable (2014: 201). As Göpfert (2000: 155) states, it also depends on the discipline if terms are avoidable, as "Axiome der Quantenphysik beispielsweise lassen sich kaum mehr in der Alltagssprache darstellen ['axioms of quantum physics can barely be presented without recourse to specialised language']". In any event, there seems to be a consensus that, if terms are used, they need to be explained to the audience in one way or another (Burger/Luginbühl 2014: 365, von Campenhausen 2011: 89, Niederhauser 1999: 141, Sandrock 1987: 73/89). Terms can only be used without an explanation if the meaning is inferable or known by the audience (Jacobs/Lorenz 2014: 201). According to Niederhauser (1999: 156-157), a non-explanation of terms is only acceptable with audiences that are more familiar with science communication (such as readers of popular science journals for adults); some terms are also thought to be commonly known, for example the designations of academic disciplines, central concepts from physics such as *atom*, chemical compounds, etc.

Explanations of terms can be distinguished by their structure as well as by their nature: Structurally, we can distinguish between anaphoric explanations, i.e. the term is followed by the explanation, and cataphoric explanations, i.e. the term follows the explanation (Niederhauser 1999: 146). Roelcke (2010: 60-68) lists seven categories concerning the nature of definitions: classic ('Aristotelic') definitions, explicative definitions, exemplary definitions, genetic definitions, operational definitions, definitions via synonyms[3] and definitions via word association. What this list

2 Although the observations in this section do not exclusively refer to documentaries, they are relevant to this study because formats of popular science communication display common characteristics, especially when it comes to the challenges of simplification and having to find their stance between transmitting information and providing a source of entertainment.

3 Vargas (2009) stresses the importance of paraphrases via synonyms in popularising TV shows.

shows is that an explanation of a term can take a multitude of forms and does not necessarily have to be a classic definition like (1). When scientific processes are explained, popular science often relies on metaphor, both in the explanations and the coinage of folk scientific terms like *ozone hole* (Klemm 2011, Göpfert 2000: 116).

> (1) A university is an institution of higher learning providing facilities for teaching and research and authorized to grant academic degrees.[4]

Given that previous research strongly suggests that TV programmes tend to avoid terms, unless they come with an explanation, this assumption serves as the hypothesis for the analysis in section 6. But why test again an apparently indisputable characteristic of popular science communication? Firstly, when this author started investigating science documentaries, she was surprised by the relatively high number of terms employed. Secondly, we need more information about how TV as a multimodal medium influences the use of terms, more precisely, how language and image interact. Thirdly, statements about the use of terms in popular science communication in general, and in TV documentaries in particular, are not always based on concrete observations from empirical research. Fourthly, the statements about the use of terms may not always be comparable because it is not clear what exactly is compared: On the one hand, it is certainly subjective what can be understood by 'tendency to avoid terms', 'many terms' or 'few terms'. On the other, it is often unclear what the cited authors exactly understand by *term*, i.e. whether they use it in a wide or in a narrow sense (see section 4). As the following section will show, this last distinction crucially determines the pool of words subject to analysis. Throughout the article, *word* will be used as a hyperonym, i.e. as any occurrence of a lexical item in a text, which may or may not be a *term*.[5]

## 4. Definition of term

The definition of the notion *term* is not unequivocal (Pearson 1998: 10-40). Some scholars only use it to refer to the formal side of the linguistic sign, i.e. to the *signifiant*, but not to the concept (e.g. Cabré 1999: 83), which goes back to the distinction between *Benennung* ('designation') and *Begriff* ('concept') in Wüster (1979) (as quoted in Pearson 1998: 10-11). Others consider it a complex sign, e.g. Rondeau (1984, quoted in Pearson 1998: 12). In its strictest sense, a term is understood as a notion that has been neatly and unambiguously defined for a specific discipline (see Reinart/Pöckl 2015: 63, Fraas 1998: 429, Fluck 1996: 47). Those definitions are usually regulated by norms on a national and international level and can also be consulted in so-called termbases. One example would be the definition of *screwdriver* in the field of mechanical industry: "hand tool fitting the slot in the head of slotted head screws or slotted circular nuts, and used to drive in or withdraw the screws by turning them" (iate, Interactive Terminology for Europe, referring to Wüster: Machine Tool 1968)[6].

Nevertheless, this understanding causes several problems for specialised communication (see Reinart/Pöckl 2015: 63-78): There are disciplines, notably in the humanities, where only a few expressions are terms in the narrow sense. Even in technical disciplines, unambiguous definitions do not always exist, as companies can come up with their own definitions because norms are not legally binding. The meanings of terms also undergo change, or, differently put, "concept systems and definitions are not static" (Faber Benítez 2009: 113).

For the study at hand, it is of little relevance whether the meaning of a word occurring in a documentary has been normed. A more useful starting point could thus be Cabré's (1999: 80) definition of terms as "distinctive and meaningful signs which occur in special language discourse", which is much in line with Fluck's broader definition, i.e., expressions designating specific things in a discipline (see Fluck 1996: 47). This entails two questions: Where is the boundary between

4 https://www.merriam-webster.com/dictionary/university (last accessed 27 February 2018).

5 This usage does not correspond to the traditional opposition between *term* and *word* (Pearson 1998: 12-13).

6 http://iate.europa.eu (last accessed 27 February 2018).

special language discourse and general language? What exactly in a special language discourse is a term?

The first question is concerned with the fuzzy boundary between technical and general language (Fraas 1998: 428). According to Cabré (1999: 81), terms can be distinguished from words in the general lexicon by the fact that they "designate concepts pertaining to special disciplines and activities". However, especially today, in times where the popularisation of technical content is considered important, words from special disciplines will often become more widely used. Therefore, it is only natural that expressions are sometimes transferred to general language and gradually become more vague in meaning (Jakob 1998: 711).

The second question can be discussed by referring to Roelcke's (2010: 55-60) categorisation of *Fachwörter*: a) terms exclusively used in a specific domain of specialised communication; b) terms that can be found in more than one domain; c) terms that are used in a domain, but clearly originate in a different one; d) all the other words used in a specific specialised communication text. What we should retain from this distinction is that terms do not necessarily pertain to one field only; "words which have special reference but which are used in more than one subject domain" are often called *subtechnical terms* (Pearson 1998: 13). For Pearson (1998: 13), it is paramount to include them if we want to describe the lexicon of as specific field comprehensively. Subtechnical terms are close to Reinart/Pöckl's *bildungssprachliche Wörter* (2015: 63), which are generally not associated with a subject domain, but even more widely used than subtechnical terms, such as *methodological* or *hermeneutic*. They could alternatively be called *hard words*[7].

Coxhead/Nation (2001: 261-262) present an approach which is particularly interesting for this study because it comes from a language-learning context. Their four-category scale can be illustrated by notions from the field of Applied Linguistics: a) words that are (nearly entirely) restricted to a specific field (*morpheme*, *lemma*); b) words used both inside and outside the field, but with different meaning (*sense*, *reference*, *token*); c) words employed both inside and outside the field, while their specialised meaning in the field is readily accessible through their meaning outside the field (*range*, *frequency*); d) words more common in a field than elsewhere, but with little specialised meaning (*word*, *meaning*). The first two categories are clearly terms, but the status of the last two is less straightforward. This distinction emphasises the question whether a word's meaning is accessible through the meaning outside the field, i.e., whether people from outside the field, non-experts, are likely to be familiar with it. In contrast, Pearson (1998: 19) claims that

> [t]he criterion of familiarity is not a valid one because it would not be possible to measure it in any objective way. Nor does the fact that a term also has a general language meaning necessarily imply that it is any less specialized than a term which does not have a general language meaning.

This brief overview shows that it is still under continuous negotiation what a term is. As Janich (1998: 35-36) observes, the different theoretical models established for terms in specialised communication may well be very plausible, but they lack precise criteria to help facilitate the decision whether something is a term or not in a specific (especially popularising) text:

> Nur fehlen immer eindeutige Kriterien zur Entscheidung im Einzelfall, d.h. wie man bei einer konkreten Analyse (besonders von Vermittlungs- und fachexternen Texten) entscheidet, ob es sich im Fall x um ein Fachwort handelt oder nicht.

Likewise, Pearson (1998: 21-22) states that theoretical reflections on terms never address the challenge of actually recognising them. Recognition is particularly difficult due to the problem of context-dependence: "The major difficulty is that technicalness is a functional aspect of a word and thus the particular use of a word must be taken into account when deciding whether it is a technical term or not" (Chung/Nation 2004: 251). This can be illustrated with the help of *part-*

7 The notion of hard word is not well-defined; here, it is nevertheless borrowed from historical lexicography to designate words that are difficult to understand, usually due to their foreign etymology, notably Greek and Latin (Zgusta 1983).

*time work*, which may be used with a non-technical meaning ('any employment which is not undertaken on a full-time basis') in general language; in the context of employment law, we are dealing with a clearly defined term here (Pearson 1998: 27).

To sum up, why is such a detailed discussion about how to define *term* necessary here? The answer is that it helps us to understand three things when it comes to operationalising the selection process for an empirical study of terms in popular science documentaries: a) distinguishing between terms and non-terms is particularly tricky with terms that have made or are making their way to general language. The same goes for terms that are used across several disciplines, with different meanings (subtechnical terms). In a concrete case-study, it may even be difficult to tell them apart from hard words at times. Zgusta (1983: 232), for example, claims an overlap of hard words and terms, which shows how strongly connected they are. b) Given that there is a narrow and a wider view of terms, the results of studies on terms in popular science communication may not always be directly comparable. The publications mentioned in section 3 mostly do not specify what they understand by term. However, as research on science popularisation only rarely comes from within specialised communication, it is improbable that the authors have worked with a narrow definition. c) Last but not least, no matter how the process of selection is done, deciding whether a specific word in a concrete text is a term or not will partly have to remain a matter of intuition (cf. Chung/Nation 2004: 253). Based on the insights from the last paragraphs, the following section will include a brief description on what grounds words in the dataset have been selected as terms.

## 5. Material and method

As a small-scale study, this contribution relies on a sample of eight documentaries, all of which have been broadcast on British or German public television. While one documentary (*The Secret of Quantum Physics: Einstein's Nightmare*) is part of a BBC mini-series, the others are episodes of regular documentary series. These are *BBC Horizon*, which has been broadcast on BBC Two since 1964, for the English sample, and *abenteuer wissen*, running on ZDF from 2001 to 2011, as well as *Planet e*, broadcast on ZDF since 2011, for the German sample. The following list will give a brief overview of the data:

*Dancing in the Dark – The End of Physics* (BBC Two, Horizon, 2015; short: DD)

*The Secret of Quantum Physics: Einstein's Nightmare* (BBC Four, 2014; short: QU)

*Science under Attack* (BBC Two, Horizon, 2011; short: SA)

*What's Killing our Bees?* (BBC Two, Horizon, 2013; short: BEE)

*Die Schwung-Maschine* (ZDF, planet e, 2012; short: SCH; lit. transl. 'the fly-machine')

*Tod im Bienenstock* (ZDF, planet e, 2012; short: BIE; lit. transl. 'death in the beehive')

*Fliegen mit Wasserstoff* (ZDF, abenteuer wissen, 2010; short: WAS; lit. transl. 'flying with hydrogen')

*Dunkle Kräfte* (ZDF, abenteuer wissen, 2011; short: DK; lit. transl. 'dark forces')

The selection of the shows was intended to allow for a comparison between German and English documentaries. To achieve better comparability, I opted for a more homogeneous group of documentaries rather than a sample with a wider range of documentaries from different production contexts. Therefore, the mini-corpus is restricted to shows for a similar target group (adults), from public broadcasters (BBC and ZDF) and partly also about the same topics: *Dancing in the Dark* and *Dunkle Kräfte*, and *What's Killing our Bees?* and *Tod im Bienenstock* deal with particle physics and the imminent extinction of bees, respectively.

The eight shows have been searched manually for words that qualify as terms, which includes the following types:

> terms used within **one discipline** such as *alarm pheromone* or *gravitational lensing*. In DD, for example, there are numerous terms from the area of particle physics, such as *quarks*, *Higgs boson*, *lepton*, *neutrino*, *gluon* or *WIMP*, all referring to specific kinds of particles. This is the group of terms that is most likely to cause problems for comprehension.
>
> terms pertaining to **more than one discipline** (subtechnical terms). These terms may differ considerably in their meaning, such as *inflation* in astrophysics (the context in which it is used here) and finance. There are also subtechnical terms referring to well-defined processes in academia in general (e.g. *peer review*). As those subtechnical terms which are used relatively widely are not always distinguishable from hard words, the data sample may include some hard words too, but this problem of delimitation only concerns a negligibly small number of words.
>
> terms that have undergone **a certain degree of determinologisation**. They have been included since the transition from technical to general language is gradual. These terms are relatively common in everyday language, where their usage conditions are extended (Fraas 1998: 437), but they are used in the documentaries at hand to refer to something technical. This can be illustrated by *star*, *planet* or *universe*: There is a distinction between a star and a planet, such as in the way they form or whether they undergo nuclear reactions by burning hydrogen (which is important in the context in which they are used here); most people will not be aware of this difference, but effortlessly use the two words, nevertheless. Therefore, despite the fact that those words are terms and thus to be included in an analysis of terms, they will usually pose little difficulty when they occur in documentaries.

The fact that a term is composed of non-native elements may well inhibit comprehension for some people, but not all terms consist of exclusively non-native material like *neonicotinoids*, *axion* or *stalagmites*. Compounds from native (*dark matter*, *waggle dance*, *greenhouse warming*) or mixed word material (*gemma ray*, *vector memory*) are equally common, as are acronyms like *WIMP* or *LD-50*.[8]

It is not a selection criterion whether the terms' meanings are likely to be accessible to the audience – this depends on various factors, such as the context in which the term is used or a person's background knowledge, which may vary considerably between different viewers. Nevertheless, estimated comprehensibility is an interesting factor to reflect upon because it plays an important role in the production process: the reason for avoiding terms in popular science communication is the wish to guarantee a media product that non-experts can understand (see section 3). The question of whether the producers think a term is difficult to understand or not is likely to influence at least the way the term is used, e.g., whether it is explained. As Vargas (2009) claims, the use of terms in TV shows differs considerably, depending on factors like the person talking, the type of discourse, etc. To investigate how terms are employed, the terms in the documentaries have been classified according to whether they are used with a support for the audience, or without. In case they are presented with a support, the three options **verbal**, **visual** and **verbal-visual** have been distinguished. Among other things, this approach is intended to provide tentative information about the film-makers' efforts to facilitate comprehension for the audience, and how much prior knowledge is probably expected. However, this case-study can only make careful assumptions when it comes to both to the production process and the reception process.

## 6. Terms in English and German science TV documentaries

### 6.1. The amount of terms used

The eight films contain 289 terms out of which 123 are made more accessible to the audience by an explanation, a visual support or a combination of the two, as illustrated by Fig. 1. The numbers

8 For an overview of term-formation strategies, see Sager (1997), for example.

can only be indicators for a more detailed analysis, but they are nevertheless included to provide a general idea of the dataset.

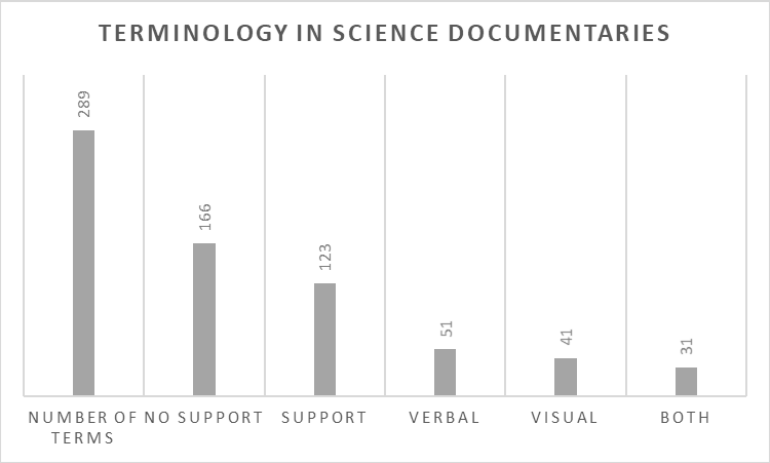


Figure 1. Overview statistics – number of terms in the data sample

Given that terms are said to be avoided in popular science communication (see section 3), 289 seems to be a non-negligible number for eight films. What is equally noteworthy is that more than half of all the terms have been used without any kind of explanation. Consequently, these results seem to contradict two of the findings in the academic literature, namely, that terms tend to be avoided in popular science communication, and that they are usually explained. As most of these publications do not work with concrete numbers, it is, however, hard to make a direct comparison. To gain more insight, the following sections will look into whether the films form a relatively homogeneous sample in their use of terms. It would be interesting to find out whether the use of terms is characteristic of specific subjects, but the small size of the data sample only allows for a cautious interpretation. The descriptive results are listed for each film separately in Table 1[9]:

| Film | Number | Number/min | No support | % | Support | % |
|---|---|---|---|---|---|---|
| DD | 59 | 1.1 | 29 | 49.2 | 30 | 50.8 |
| BEE | 22 | 0.4 | 12 | 54.5 | 10 | 45.5 |
| SA | 29 | 0.5 | 21 | 72.4 | 8 | 27.6 |
| QU | 41 | 0.7 | 25 | 61.0 | 16 | 39.0 |
| **English** | **151** | **0.7** | **87** | **57.6** | **64** | **42.4** |
| SCH | 50 | 1.7 | 31 | 62.0 | 19 | 38.0 |
| BIE | 18 | 0.6 | 12 | 66.7 | 6 | 33.3 |
| WAS | 25 | 0.8 | 17 | 68.0 | 8 | 32.0 |
| DK | 45 | 1.5 | 19 | 42.2 | 26 | 57.8 |
| **German** | **138** | **1.2** | **79** | **57.2** | **59** | **42.8** |

Table 1. Number of terms by film

9 The author is aware that percentages and averages may be misleading in such a small data sample, but has yet decided to list them for the sake of clarity.

When comparing the different documentaries for their quantity of terms, it is best to focus on the number of terms per minute, as the length of the German documentaries is 30 minutes, while the British ones are roughly 55 minutes long. It is striking that the two documentaries on bees (BEE and BIE) use relatively few terms (0.4 and 0.6 terms/minute), while those about particle physics (DD and DK) use more than one term per minute (1.1 and 1.5 terms/minute). Only SCH displays a higher ratio, with 1.7 terms/minute. This finding is in line with the assumption that some disciplines may lend themselves better to avoiding terms than others. It seems difficult, for example, to talk about particles like neutrinos, photons or the Higgs boson without actually naming them. However, of all things, it is the documentary on quantum physics (QU) that only employs 0.7 terms/minute and hence shows that it is possible to popularise content from this discipline without using a large number of terms, contrary to Göpfert's (2000: 115-116) statement that quantum physics is hard to present without recourse to specialised language (see section 3).

One striking difference between the English and the German sample that deserves mentioning is that the German documentaries rely more heavily on terms than the English ones. Why this is the case is hard to explain and may be a mere coincidence given the small size of the data sample. One possible explanation could be that the series *planet e* is likely to have an audience strongly interested in environmental topics, and the audience is thus expected to have more background knowledge, i.e. know a certain number of terms from the subject area. As a consequence, the producers may feel more comfortable to use terms.

## 6.2. Idiosyncrasies of the films

This subsection treats a finding that emerges when taking a closer look at the documentaries: The episodes' use of terms, as well as their general approach to conveying knowledge to the audience, is often highly idiosyncratic. Therefore, an analysis of the subject at hand also needs to give an impression of this mixed picture, as summarised numerically in Table 2:

| Film | Number | Number/min | Support | % | Verbal | Visual | Both |
|---|---|---|---|---|---|---|---|
| DD | 59 | 1.1 | 30 | 50.8 | 23 | 2 | 5 |
| BEE | 22 | 0.4 | 10 | 45.5 | 3 | 3 | 4 |
| SA | 29 | 0.5 | 8 | 27.6 | 8 | 0 | 0 |
| QU | 41 | 0.7 | 16 | 39.0 | 5 | 6 | 5 |
| **English** | **151** | **0.7** | **64** | **42.4** | **39** | **11** | **14** |
| SCH | 50 | 1.7 | 19 | 38.0 | 2 | 13 | 4 |
| BIE | 18 | 0.6 | 6 | 33.3 | 6 | 0 | 0 |
| WAS | 25 | 0.8 | 8 | 32.0 | 4 | 1 | 3 |
| DK | 45 | 1.5 | 26 | 57.8 | 0 | 16 | 10 |
| **German** | **138** | **1.2** | **59** | **42.8** | **12** | **30** | **17** |

Table 2. Strategies of dealing with terms

The film-makers' efforts to give the audience an insight into complex scientific problems are particularly apparent in DD, QU and the two *abenteuer wissen* documentaries DK and WAS. Yet, there are considerable differences in the make-up of the episodes and the concrete strategies for popularising subject matters.

Given that TV is an audiovisual medium, it is surprising that nearly all explanations in *Dancing in the Dark* are exclusively verbal. DD is a documentary on particle physics that tries to explain what dark matter is, how difficult it is to track down, and how researchers try to do so (for

example with the facilities of the Large Hadron Collider). It tries to explain things transparently, while the visuals remain relatively 'classic' – mainly medium- or close-up shot interviews with experts rather than animations or special effects. At the same time, DD aspires to be entertaining, especially by relying on humour, which becomes apparent at various points in the episode. One example would be choosing *Peep Show* actor David Mitchell as the narrator or using the following definition for *theoretical physicist*: "Professor Katie Freese is a theoretical physicist. That is to say, the physics she deals with is theoretical. Katie herself is real" (DD, 07:44-07:53). This relatively unusual style led to an award as the best TV documentary 2015 in the Science TV and New Media Awards[10].

There is a second documentary on particle physics that refers to the facilities of the Large Hadron Collider, *Dunkle Kräfte*. It explains how the researchers at CERN try to detect the characteristics of antimatter and use it in the war against cancer. It is an episode of *abenteuer wissen*, an award-winning documentary series that was surprisingly eliminated from the programme in 2011 due to a restructuring of the TV channel ZDF[11]. Like in all instalments of the series, presenter Karsten Schwanke leads viewers through the episode, functioning as a framing device, introducing new locations of interest, asking teaser questions like (2), commenting on new developments in science. At the same time, he speaks very slowly, which emphasises his didactic role.

> (2) Aber wie sieht's eigentlich in der Realität aus mit dieser ominösen Antimaterie?[12] ['But what about this ominous anti-matter in reality?'] (DK, 09:51-09:56)

In this documentary, both the drive for simplifying complex information and being entertaining are strikingly obvious. Terms are never only explained – if there is a verbal explanation, it is also aided by a visual support. If terms remain unexplained, the producers try to convey at least an approximative idea by a visual support, such as a rough animation of particles like neutrinos or protons. Although animations often serve the purpose of increasing comprehension by visualising otherwise invisible processes (Milde/Hölig 2011: 88), some of these visualisations seem to fulfil merely an entertainment function: The sound and visual components are occasionally so complex that they might even inhibit the processing of verbal information (see section 6.3 for illustration).

*Fliegen mit Wasserstoff* is an *abenteuer wissen* episode too, and as such shares major characteristics with DK, such as the narrator. Nevertheless, it uses and explains considerably fewer terms and relies less on visual effects, which can be due to several factors: Firstly, the people involved in the production process (for example, authors, camera, production company) are not identical for all episodes, which can lead to variation in style. Secondly, the topic at hand is probably easier to treat without terms than particle physics. Thirdly, a considerable number of the terms without any support in WAS are uttered by experts – an explanation would involve an explicit and hence often inelegant taking up of the term afterwards.

*The Secret of Quantum Physics: Einstein's Nightmare* clearly shows efforts to avoid terms while giving insight into the highly difficult field of quantum mechanics. The documentary centres around the presenter-narrator Jim Al-Khalili, a professor of theoretical physics regularly involved in the popularisation of science in the mass media. He shares quantum mechanic's knowledge about light with the audience by using analogies from people's everyday life. The fact that only 16 out of the 41 terms are presented with a verbal, visual or verbal-visual support is not likely to inhibit comprehension, as the other 25 terms are either non-central for understanding or also common in general language use (*helium*, *nuclear reactor*, *laser*, etc.).

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10 http://uopnews.port.ac.uk/2015/11/27/cosmologist-in-award-winning-documentary/ (last accessed 27 February 2018).

11 https://www.wunschliste.de/tvnews/m/zdf-stellt-ueberraschend-abenteuer-wissen-ein (last accessed 27 February 2018).

12 Schwanke further 'warns' the audience that a new and difficult term is going to follow by pausing before the term (see also Niederhauser 1999: 135 for a similar observation on counselling interviews) and by slowing down his pace once more.

Apart from DD, the presenters in the English sample take a central role, guiding the audience through the whole documentary. This also applies to *Science under Attack*, which is hosted by geneticist, and Nobel laureate, Sir Paul Nurse. In this documentary, Paul Nurse tries to show the importance of scientific evidence in a time when scientific findings or theories (such as climate change or the fact that HIV leads to AIDS) often meet with scepticism. The documentary only uses one term every other minute on average, which is certainly due to the fact that a large part of the show is dedicated to interviews with people calling science into question. About half of the terms used are uttered by experts, who, in contrast to popular science journalists, are not always aware that the audience may have difficulties understanding what they say.

The sample also contains two documentaries on the imminent extinction of the honey bee. *What's killing our bees?*, like DD and SA part of the BBC documentary series *Horizon*, is presented by Bill Turnbull, the main male presenter of *BBC Breakfast* at that time and a beekeeper himself. Turnbull mainly focuses on pesticides in the war against the varroa mite as one possible reason for the increasing eradication of bees. The documentary uses the smallest number of terms per minute in the sample. This can be explained by the subject, which is more generally environmental and biological than the other documentaries. Efforts for simplification are directly visible, as nearly half of the terms are provided with a support for the audience.

The German documentary *Tod im Bienenstock* focuses on the same aspects as BEE, but the role of the presenter (Volker Angres) is different: In *planet e* (a multiple award-winning programme), the presenter generally only appears at the very beginning and the very end of the show; the central part of the episode is built around one of the main protagonists (mostly an expert in the field), in this case a cheerful professional beekeeper. As in BEE, only a few terms are used. When terms are provided with a support for the audience (which only happens in a third of the cases), this is done exclusively verbally.

Like BIE, *Die Schwung-Maschine* is part of *planet e* and hence focuses on a leading expert: engineer Johann Klimpfinger. Klimpfinger stresses the energy-saving and thus environmental advantages of using flywheels for new means of transportation, especially for novel types of cars. The number of technical terms (50) and the term/minute ratio (1.7), the highest in the sample, are noteworthy. It goes without saying that it is impossible for the film-makers to provide support for all of the terms, but it is yet striking that 31 out of the 50 appear without any further support. In the remaining 19 cases, there is usually not an explicit definition or explanation involved, but rather a visual stimulus. The documentary is probably the only one in the sample that expects its audience to have prior knowledge of the subject – not necessarily about flywheels, but about the constituents of cars and what different kinds of motors exist, which may cause the high number of terms used without an explanation. Nevertheless, the documentary provides several detailed text-image explanations, e.g. for *KERS* and *Trägheitsantrieb* 'inertial drive'.

To conclude, the shows examined all display considerable efforts to simplify complex content. Yet, they also differ in various ways: a) in the extent to which the shows cater to the audience's needs for simplification, b) in the complexity of the content, c) in the amount of terms used, d) in the degree to which the shows rely on explicit explanations, e) in the extent to which they make use of the possibilities of an audiovisual medium like TV. To conclude the analysis, the last two points will receive more attention in the next subsection.

### 6.3. Dealing with terms

When it comes to comprehension, there are three questions that are difficult to answer: a) What does understanding a term mean? In other words: Is it sufficient to get a rough idea of the term's meaning, or does it have to be understood in detail? b) How important is understanding a specific term for understanding the subject matter as a whole? c) What is the viewers' personal background knowledge? The producers have a general assumption of what the audience may know, which will influence the way they use terms in documentaries. This involves a considerable de-

gree of guessing, especially as the audience is not a homogeneous group. As Burger/Luginbühl (2014: 365) put it, this lack of knowledge about the audience is one of the most important problems in popularising knowledge.

Due to the heterogeneity of the material when it comes to the use of terms, it is no surprise that the percentage of terms with a support ranges from 27.6 to 57.8. Shows that are rather at the bottom spectrum are SA, WAS, BIE, SCH and QU, while those at the top spectrum are DK and DD.

The decision about how to deal with terms will be based on the following factors: the subject of the episode, the estimated difficulty of the terms, and their potential for visualisation. If the subject of the show is very complex, like particle physics, the producers probably come to the conclusion that explaining a large number of terms is out of the question (factor 'subject'). Surprisingly, it is exactly the two particle physics documentaries, DD and DK, that provide the most support for their terms in comparison to the other episodes, probably because terms from these disciplines are difficult to infer (factor 'difficulty'). Yet, DD and DK differ considerably in the kind of support they give – DD provides mainly verbal, DK mainly visual stimuli (factor 'visualisation'). This example is extreme, with DD producing 23 times a verbal, 2 times a visual and 5 times a verbal-visual support. In contrast, DK never relies on the verbal mode exclusively, but either combines it with a visual stimulus or only gives a visual stimulus. To give an impression of how intensely DD employs verbal explanations, one of the first passages from the show can be cited:

> (3) Our universe started 13.8 billion years ago in an instant. This was the first period of the birth of the universe. It is known as the Big Bang. Nowadays, our understanding of the birth of the universe is extremely detailed. Then it underwent a dramatic expansion. This was the second period in the birth of the universe. It is called inflation. Thanks to science, we think we know exactly how we got to now. Atomic matter condensed to form the stars and planets that make our universe. This is the standard model of cosmology. (DD, 00:56-01:33)

The rest of the sample is also relatively heterogeneous. The shows with a clear preference for verbal explanations are, besides DD, SA and BIE. Most of the others are more balanced between the three options, namely, BEE, QU and WAS. SCH, however, shows a preference for supporting terms with a visual stimulus and is thus more similar to DK in that respect than the other shows.

The following paragraphs will now illustrate these findings with concrete, for practical reasons mostly English-speaking, examples and discuss them in the light of comprehensibility.

### 6.3.1. Verbal support

One may think that explanations and definitions were typically anaphoric, i.e., the term is mentioned first, followed by an explanation (see section 3), but there is also a considerable proportion of cataphoric explanations, which corresponds to Niederhauser's (1999: 146) finding that cataphoric definitions are relatively popular in written popular science texts. In the English subsample, cataphoric explanations are even more frequent than anaphoric ones. The most striking example is DD, which makes rare use of anaphoric definitions like (4). Instead, it has a strong preference for cataphoric definitions, as in (5), and example (3) even features three instances (*Big Bang*, *inflation*, *standard model of cosmology*).

> (4) A photon, a tiny flash of light (DD, 11:18-11:19)

> (5) These ordinary, but dark, dark matter creatures are called MACHOs – massive compact halo objects (DD, 08:18-08:26)

> (6) Photons, gluons and W and Z are force-carrying particles (DD, 39:26-39:31)

The data also show unequivocally that full definitions are uncommon. Instead, we are usually dealing with partial definitions that explain only as much as is presumably needed to follow the basic line of argumentation. As (6) exemplifies, it would be impossible to give a comprehensive – and

comprehensible – definition for all terms, especially in areas like particle physics. Another conclusion we can draw from the sample is that some experts apparently have difficulties simplifying their statements, while others seem to be aware of what could be a barrier for comprehension. This aspect cannot be discussed in this paper, but should at least be illustrated with one example: Here the expert tries to give explanations for the terms he uses, but fails to understand that even the explanation may be too dense for the audience:

> (7) I'm of the opinion that the major natural effect comes from the sun, and specifically from variations in what is called solar activity. That is not the total radiation from the sun, but it is the emission from the sun often called coronal ejections which produces solar wind. And the solar wind is a particle stream from the sun ... (SA, 11:31-11:52)

### 6.3.2. Visual support

Theoretically, we should differentiate between two types of visual stimuli according to their function: stimuli that serve as a visualisation of terms, complex processes or the functioning of machines, and stimuli mainly used for the sake of visualising. Of course, we are dealing with a gradual distinction here, and the primary purpose may not always be discernible. In SCH, for example, the terms *Rotor* and *Stator* ('rotor', 'stator') are used, accompanied by dynamic images of both (but no verbal explanation). This could have two alternative explanations: a) the film-makers believe that pairing the terms with matching images will help the audience understand what a rotor and a stator are; b) they think the terms are inferable or unimportant for the overall comprehension (thus no verbal support), and the images only serve the purpose of illustration. Yet, there are several examples where it is obvious that the visual stimuli are primarily used for entertainment. DK, for example, provides moving images that show a cosmic explosion (simultaneously to the corresponding sound) every time the word *Urknall* ('big bang') is mentioned. Strictly speaking, this is a visualisation of the term *Urknall*, but it is obvious that it is not needed for understanding, let alone several times. This show relies much on the visual power of stimuli like these, for example when presenting animated imagery of particles, which are vaguely represented as bowls circulating around each other or colliding with each other. The same goes for SCH, when engineer Klimpfinger explains that a rollercoaster in the Netherlands uses a flywheel – the fact is visualised by Klimpfinger going on a whole rollercoaster ride, shouting with joy.

### 6.3.3. Verbal-visual support

Verbal-visual support is as a multimodal strategy where information about a term is provided both by the verbal text and the image. This strategy is often used with complex machinery or physical processes, such as the so-called *gold-leaf electroscope* and *spark gap apparatus* (QU), which are relevant in terms of "the unexplained connection between light and electricity" (09:05-09:10): Al-Khalili demonstrates how the former, a "more sensitive version" of the latter, works by running an experiment with it and explaining the consecutive steps. As a consequence, the audience has a chance to understand not only what a gold-leaf electroscope looks like, but also what purpose it serves and how it is used.

Again, the data show that the motivation for providing an often complex verbal-visual support is partly information, partly entertainment. If the main aim is entertainment, the potential of the multimodal medium is sometimes used to its fullest extent, as in the explanation of *KERS* (Kinetic Energy Recovery System) in SCH, which is a system used in Formula One until 2013 to recover braking energy. Formula One driver Sebastian Vettel explains the system, while the visual channel provides a complex computer animation; the moving animation uses changing colours to illustrate energy flow. While we listen to Vettel's explanations and try to understand the flashy animation, we also hear sounds from Formula One cars racing over the track. Without empirical research, it is impossible to determine what effect such multimodal complexes have on the audience, and whether these are instructive and entertaining at the same time. What should be tested

is whether the combination of this high number of stimuli (verbal text, flashy imagery, moving animations, race sounds) risks inhibiting the processing of the information provided (see Janich 2016 for a similar concern about children's books).

Overall, complex visual-verbal support for terms is less common in the data sample than the other strategies, which is probably because it tends to interrupt the flow of the storyline. Therefore, film-makers often restrict its use to situations where the term has an important function in the documentary, and more thorough explanation with the help of an object is needed, as in the case of *gold-leaf electroscope* or *KERS*. Other terms that have been presented both visually and verbally are *Kaverne* ('cavern', WAS), *Elektrolyseur* ('electrolyser', WAS), *Higgs boson* (DD, DK), *Synchrotron* ('synchroton', DK), *Trägheitsantrieb* ('inertial drive', SCH), *black-body radiator* (QU) or *MACHO* (DD).

## 7. Conclusion

The analysis of four English and four German documentaries suggests that popular science journalists are aware that terms can be a barrier for comprehension, which leads to a careful 'dosing' of terms. However, the sample is highly heterogeneous in the extent to which terms are used, the extent to which they are explained for the audience, and the amount of background knowledge the audience needs in order to understand the content. The films also vary in their concrete strategies for explanation (verbal, visual or verbal-visual support) and the degree to which dealing with terms is influenced by the drive to create entertaining visual effects. The findings are not entirely in accordance with the prevailing views that terms are mostly avoided in popular science, and if they are used, they are usually explained, unless the meaning is inferable. Of course, it is not clear, for example, how comparable these findings are to results in publications that are not based on empirical research, or when a term can be considered as inferable. Despite this problem, the findings are already unequivocal enough to show that the picture is more differentiated than assumed and that the actual use of terms in popular science formats is worthwhile investigating for different types of content and different types of media.

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