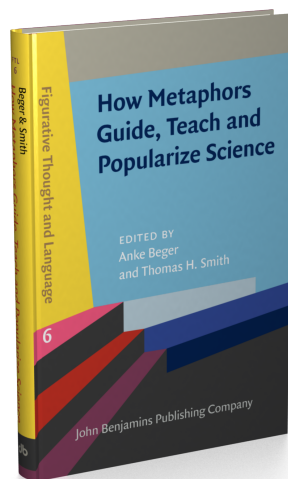


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 <https://doi.org/10.1075/ftl.6.05wil>

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Pages 141–173 of

How Metaphors Guide, Teach and Popularize Science

Edited by Anke Beger and Thomas H. Smith

[*Figurative Thought and Language*, 6] 2020. vi, 332 pp.

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To be or not to be: Reconsidering the metaphors of apoptosis in press popularisation articles

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This chapter examines the metaphorical expressions used to explain apoptosis in press popularisations. The study was performed on a bilingual English-Spanish subset of 58 texts on apoptosis identified from a corpus of 300 cancer articles published in *The Guardian*, *The Times*, *El País* and *El Mundo*. The analysis shows that most metaphors coincide with those found in scientific articles and there are few creative explanatory images in the English and Spanish popularisations. The English articles make greater use of the suicide image whereas the Spanish texts rely more on variants based on “cell death” and “die”. In certain contexts, some metaphors are ambiguous and confuse rather than clarify the process while others might not be considered the most appropriate choices.

Keywords: apoptosis, metaphor, popularisations, recontextualisation, press, corpus studies, English, Spanish

The writer used a chilling phrase to describe traumatic hair-cell loss: ‘exposure to damaging drugs or noises causes these hair cells to die with a kind of suicide program. They basically commit suicide in your ear’. Is it possible, after all, that that rock band at Fillmore West provoked mass suicide in my inner ears?

David Lodge, *Deaf Sentence*

1. Introduction

This chapter explores different metaphorical expressions that are used in the description of a cellular process named apoptosis, which is a kind of cell death. In the quotation above, from David Lodge’s novel *Deaf Sentence* (2008, p. 171), the protagonist, who suffers from a type of hearing impairment, qualifies the metaphor attributed to the process of apoptosis, *suicide program*, as *chilling*. And he is

left somewhat perplexed at the idea of having experienced a *mass suicide* without having noted anything. The suicide metaphor for apoptosis may well sound puzzling to a layman's ear, but experts in the field have also shown some concern about the potential ambiguities that this, and other apoptosis-related metaphors, may give rise to.

The aim of this chapter is twofold. After briefly clarifying and defining apoptosis, it provides an overview of the metaphors that are associated with this process in the specialised literature. This overview is based on the comments made by a number of experts in the field who have drawn attention to the metaphorical nature of these terms and have expressed some degree of concern about the ambiguities they carry. The second part illustrates how these metaphors can also prove problematic in less specialised genres. It includes the quantitative and qualitative analysis of the metaphorical expressions for apoptosis that have been identified in a bilingual, English and Spanish, corpus of press popularisation articles on cancer and considers how helpful some of the metaphors are in the explanation of the process. This corpus was compiled for a broader investigation, but has been considered suitable for the present analysis since the evasion of apoptosis is key in cancer formation and the subset of articles dealing with this process is large enough to carry out the detailed qualitative analysis presented here.

2. Apoptosis

Apoptosis is a highly complex biological process. Thus, a full account of the intricate biological interactions taking place when a cell goes into apoptosis is beyond the scope of this study. However, a few basic notions in relation with this process might be required for a better understanding of this chapter.

It is customary knowledge that cells are the smallest living organism and, as such, after they are born, they grow, reproduce and finally die. There are different types of cell death, but the most common type is apoptosis. In contrast to human death, which is normally seen as a tragic and negative event, the death of the body's cells is not problematic because they are constantly renewing themselves. In other words, we do not run out of cells, and this process is essential for the correct functioning of the organism. Apoptosis plays a crucial role in the normal development of the body. For instance, during pregnancy, the webbed tissue connecting the toes and fingers is removed by apoptosis, leading to the correct formation of the digits. The process is also essential to maintain tissue balance (homeostasis). In a human adult, about 50 billion cells die daily and the body replaces an estimated 70 kg of cells annually to ensure that the amount of tissue remains stable. Finally, apoptosis is key in the removal of damaged cells from the system. Under normal conditions,

if mistakes occur during cell division, the damaged cell will undergo apoptosis to avoid harming the rest of the organism. Therefore, in spite of the general negative connotations of death from our human perspective, the death of our cells should be regarded as beneficial and necessary for the correct functioning of the body.

The deregulation of apoptosis may lead to the development of pathological conditions. For instance, degenerative diseases like Alzheimer's, Huntington's and Parkinson's are associated with an excess of apoptosis, whereas cancer is related to a lack of apoptosis taking place (Pelengaris & Khan, 2006, p. 252). In contrast to healthy cells, cancer cells evade apoptosis and thus continue to divide, resulting in an uncontrolled proliferation. Currently, an increasing amount of research is devoted to the understanding of this process and to the identification of substances that can trigger this mechanism.

Hanahan and Weinberg (2000) describe the process of apoptosis as follows:

Cellular membranes are disrupted, the cytoplasmatic and nuclear skeletons are broken down, the cytosol is extruded, the chromosomes are degraded, and the nucleus is fragmented, all in a span of 30–120 min. In the end, the shriveled cell corpse is engulfed by nearby cells in a tissue and disappears, typically within 24hr
(Hanahan & Weinberg, 2000, p. 61)

Thus, in non-technical terms it could be said that what happens in apoptosis is that the different cellular components are neatly broken down and cleared up by nearby cells leaving no trace behind.

The process of apoptosis was first observed in the nineteenth century (Lockshin & Zakeri, 2001), but the actual term was not coined until 1972, when a team of anatomical pathologists, Kerr, Wyllie and Currie, introduced it in an article written for the *British Journal of Cancer*. In a footnote, they acknowledged that Professor Cormack of the University of Aberdeen had suggested the term and explained that “the word ‘apoptosis’ (ἀπόπτωσις) was used in Ancient Greek to describe the ‘dropping off’ or ‘falling off’ of petals from flowers, or leaves from trees” (Kerr et al., 1972, p. 241). The extant literature is not too clear as to which aspects motivated the coinage of the term. Cortés Gabaudan (2009) clarifies that the word is a compound with a prepositional element ἀπό (από) meaning “from”, and a noun ptôsis (πτωσις) meaning “fall”. The anteposition of the prepositional element specifies that the process takes place in a gradual manner. Analogously, in apoptosis cellular elements disappear progressively. Lockshin and Zakeri (2001) specify that the term was coined to emphasise the homeostatic or balanced relationship between the death and the birth of cells (Lockshin & Zakeri, 2001, p. 547):

to focus attention on the yin-yang relationship of death to birth (that is, homeostasis is not maintained unless the loss of cells equals the birth of cells). The three [Kerr, Wyllie and Currie] argued that the ritualistic nature of cell death implied an

organized and conserved mechanism: cell death or apoptosis was an aspect of life like any other (Lockshin & Zakeri, 2001, p. 547)

Moreover, Majno and Joris (2004, p. 210) comment that the term was introduced to conjure up the morphological contrast between death by apoptosis, whereby cells perish one by one in a process resembling the leaves falling from the trees, and the phenomenon of massive cell death, or necrosis.

Whatever the actual motivation might have been, the term “apoptosis” reveals itself as an image metaphor based on the resemblance between the image of leaves and petals falling and the appearance of a cell undergoing apoptosis. However, it should also be mentioned that from its inception, it was a dead metaphor (at least for people unfamiliar with the Ancient Greek language) (Eubanks, 2000, p. 71). Therefore, in the remainder of the chapter, apoptosis will not be treated as metaphorical, but as the target domain to be explained.

3. Cell death metaphorical expressions in specialised genres

The different terms employed to refer to or describe cell death in general – and apoptosis in particular – have caught scientists’ attention, and the lack of systematicity and consistency in their use has led to the creation of a Nomenclature Committee on Cell Death (Kroemer et al., 2005). The scientific community has also drawn attention to the metaphorical nature of the terms used for cell death, and experts in the field have discussed the connotations or associations that these expressions may evoke (Ameisen, 2002, 2003; Melino et al., 2010). In this respect, Ameisen (2002) has expressed a common concern found in scientific circles, which is that of mistrust towards metaphorical language. In his article on cell death, Ameisen (2002, p. 368) quotes Lewontin, who warns that although “it is not possible to do the work of science without using a language that is filled with metaphors [...] the price of metaphor is eternal vigilance” (Lewontin, 2000, pp. 3–4).

In order to illustrate some of the metaphors used to discuss apoptosis in the specialised literature, I include the following definition from an article published in the scientific journal *Nature*:

The most common and well-defined form of *programmed cell death* (PCD) is *apoptosis*, which is a physiological ‘*cell-suicide*’ programme that is essential for embryonic development, immune-system function and the maintenance of tissue homeostasis in multicellular organisms

(Okada & Mak, 2004, p. 592, my emphasis)

The three terms highlighted in italics in the Okada and Mak quotation are metaphorical. As mentioned above, “apoptosis” is a case of catachresis, or lexical gap

filling, and whereas “programmed cell death” is not explicitly singled out and, thus, appears to be fully accepted by the scientific community, the expression “cell-suicide” is placed between scare quotes, signalling that it should not be taken literally. Experts in the field of cell death have emphasised that these terms, although often used interchangeably, are not synonymous:

The terms ‘programmed cell death’, ‘cell suicide’ and ‘apoptosis’ have each played a major role in expressing crucial conceptual advances concerning cell death and in promoting interest for the field, but it should also be noted that none of these terms are synonymous, that each one carries its own metaphors and philosophical implications, and hence some degree of ambiguity (Ameisen, 2002, p. 368).

As will be shown, these expressions travel from specialised to more popular genres. Although in popularisation literature it may not be necessary to make fine-grained distinctions, it is nevertheless relevant to track down the origin, meaning, implications and potential ambiguities of the technical metaphors used in the field of cell death.

3.1 Programmed cell death

As mentioned above, the term “programmed cell death” is often used as a synonym for apoptosis. Nevertheless, although apoptosis is a kind of programmed cell death, not all programmed cell deaths occur by apoptosis. The term “programmed cell death” was in fact introduced in the 1960s – before “apoptosis” was coined – in the field of embryology with the meaning “to die on schedule” (Lockshin & Zakeri, 2001, p. 546; Majno & Joris, 1995, p. 11). Apparently, there are two types of programme: one which indicates to the cells that they are ready to “die”; and one which specifies how to bring about the death, for instance, by apoptosis. In the experts’ own words: “The genetic program of programmed cell death is a clock specifying the time for suicide, whereas the genetic program of apoptosis specifies the weapons (the means) to produce instant suicide” (Majno & Joris, 1995, p. 11).

Nevertheless, Ameisen (2002) notes that the etymological origin of the word programme (“pre-written”) is ambiguous in biology because it suggests too strict a link between design and finality and confuses the existence of pre-written genetic information with the many ways this can be implemented by the cells and the body:

Accordingly, it is not the individual fate of each cell, its survival or its death, that is programmed (pre-written), but the capacity of each cell to induce or repress its self-destruction, depending on its present and past interactions with the other cells that constitute the body, and on the integrity of its internal components (Ameisen, 2002, p. 368).

3.2 Cell suicide

The notion of cell suicide was developed in the 1950s after Christian de Duve (1959, p. 154) discovered the lysosome, an organelle located inside the cell. De Duve suggested that lysosomes might act like “suicide bags” which exploded, killing the cell from within as a result (Majno & Joris, 1995, p. 7). Apparently, this mode of cell death only took place in cells under very special circumstances (Majno & Joris, 1995), but the metaphor has remained present in the scientific literature.

There is a general impression among scientists that the term “cell suicide” is non-specialised and thus inappropriate for the specialised genres (Hidalgo Downing and Kraljevic Mujic, 2009, p. 72). However, although this metaphor may be less frequent than the term apoptosis or the expressions “programmed cell death” or “cell death”, “cell suicide” is found in scientific discourse (Tercedor Sánchez, 2000; Sheard, 1997). Further support for this claim is provided by the fact that the metaphor is explicitly commented on in the scientific literature:

If we use the term ‘suicide’, we bring in, subliminally, anthropological implications derived from the social and philosophical field. We could say that the cells commit suicide for the benefit of the organism (altruistic death with social implications). We could also say that the organism kills innocent cells for its own selfish interest (egotistic death). Here, we should consider the definition of ‘self’ of the cell (I, cell, kill myself for the benefit of the organism). But do genes, cells and organisms have a ‘self’? (Melino et al., 2010, p. 5).

In a similar vein, Ameisen (2002) underscores the potential ambiguity of the anthropomorphic associations of the term while clarifying some misconceptions that it may give rise to:

The concept of ‘cell suicide’ or ‘self-destruction’ also provides some level of ambiguity, not only because of its obvious anthropomorphic reference, but also because it favours a confusion between the act of initiating self-dismantling (that the cell indeed performs by activating an intrinsic cell death machinery) and both the ‘decision’ to kill itself and the implementation of the death process

(Ameisen, 2002, p. 368)

Thus, the use of “suicide” appears to be in part justified since this metaphor emphasises the fact that the cell has all the necessary components to bring about its death. Nevertheless, what triggers apoptosis – in Ameisen’s terms the “decision” to bring about the death of the cell – is a different matter. From what I gather, the process can take place via two signalling pathways, extrinsic and intrinsic, which ultimately activate the caspases (Ameisen’s “intrinsic cell death machinery”), a set of enzymes which start dismantling the cell from within. A review of the range of components which activate the extrinsic and intrinsic pathways is beyond the

scope of this study. Nevertheless, it should be mentioned that the scientific community is seeking to arrive at a complete understanding of the mechanisms of apoptosis in order to find ways to activate the apoptotic pathways in cancer cells. In this sense, as Spaeth (1998) has argued, a more apt metaphor for some deaths by apoptosis would be that of “murder”:

Apoptosis has been called “cell suicide” [...] though this characterisation is partially misleading. In some instances the cell has been preprogrammed to die, and, indeed, this could be considered as a type of suicide. However, apoptosis in many cases is triggered by some outside stimulus [...] so the metaphor is properly closer to a forced suicide, or murder (Spaeth, 1998, p. 9).

The suicide metaphor is often classed as alien to scientific discourse (Hidalgo Downing & Kraljevic Mujic, 2009, p. 72). Nevertheless, as shown in the experts’ discussion, it has played an important role in advancing the field of cell death, and thus it could be argued that for some time the metaphor had a theory-constitutive function: i.e., metaphors that are “an irreplaceable part of the linguistic machinery of a scientific theory”, allowing scientist to explore new concepts, discuss them and express “theoretical claims for which no adequate literal paraphrase is known” (Boyd, 1993, p. 486). Boyd (1993) argues that cognitive psychology was influenced by computer metaphors beyond the mere addition of terminology. He emphasises that the metaphors also had an impact on the field by shaping the predictions and hypotheses formulated. For instance, if the brain is viewed as a computer, thought can be seen as some kind of “information processing”. The analogy may also imply that there are “preprogramed” cognitive processes involved and it makes predictions about how information is memorised since it could be “encoded” or “indexed” in a “memory store” or “labelled” and “stored” as “images”. Finally, the framing also raises important issues to consider, such as whether an internal “brain language” can be considered to exist.

3.3 Cell death

Another term found in the scientific literature is that of “cell death” which can also appear in its verbal form (cells “die”). Although apoptosis is a form of cell death, there are many other ways in which a cell can die. Nevertheless, a question which could be raised is whether cells actually die. In this respect, the scientific literature takes the expression to be a metaphor:

‘Death’, for example, implies that there is only one death, that there is nothing after death, and that it is the final event. However, dead cells might ‘die’ more than once (erythroblasts ‘die’ when they lose their nuclei and mitochondria to become erythrocytes, and then ‘die’ again when they are eliminated from circulation;

keratinocytes ‘die’ when differentiated and lose their nuclei and mitochondria, and then ‘die’ again during desquamation [...]). These cells remain active and functional after ‘partial death’ (Melino et al., 2010, p. 5)

As a result, the notion of cell death has been revised and redefined on various occasions. The Nomenclature Committee on Cell Death (NCCD) has written three reports to unify the definitions and terminology regarding cell death. While the first two devoted sections to the definition of cell death, bearing the headings “Dead cells” (Kroemer et al., 2005, p. 1464) and “When is a cell ‘dead?’” (Kroemer et al., 2005, p. 1464, 2009, p. 4), the third report does not include further comments on the notion as it presumably no longer required clarification (Galluzzi et al., 2012). The quotation below is a fragment from the second report where the term is defined:

In the absence of a clear, generally accepted view of the ‘point-of-no-return’, the NCCD suggests that a cell should be considered dead when any of the following molecular or morphological criteria is met: (1) the cell has lost the integrity of its plasma membrane, [...] (2) the cell, including its nucleus, has undergone complete fragmentation into discrete bodies [...]; and/or (3) its corpse (or its fragments) have been engulfed by an adjacent cell *in vivo*. Thus, *bona fide* ‘dead cells’ would be different from ‘dying cells’ that have not yet concluded their demise (which can occur through a variety of biochemically distinct pathways)

(Kroemer et al., 2009, p. 5)

The consensus among the scientific community on the meaning of a technical term is common in the process of science making. As argued by Semino (2008, p. 154), “when particular metaphors are adopted within a scientific community, they tend to evolve towards greater and greater clarification of what aspects of the source apply to the target”. As knowledge of the target domain increases, the meaning of technical metaphors relies less and less on correspondences from the source domain, the metaphors gain new and specialised meanings and, in the end, the terms may no longer be perceived as metaphorical by the scientists (Semino, 2008, p. 133). This is arguably the case of what has happened in the representation of the death of cells and what it means for cells to “die”.

This overview of the different metaphorical expressions that are used for apoptosis and which have played a major role in the development of the field of cell death indicates that cells are (a) personified (through the expressions “cell death” and “cell suicide”), or (b) portrayed via “mechanistic” metaphors (with the expression “programmed cell death”). As will be shown in Section 5, such metaphorical expressions are also exploited in popularisation articles for the elucidation of the process of apoptosis, and some of the ambiguities that arise in specialised genres may be carried over to more popular accounts.

4. Materials and methods

4.1 Corpus

The corpus used in this study was originally compiled for a broader investigation with the general aim of exploring the use of metaphor in cancer popularisation articles. The articles eligible for inclusion were drawn from the electronic sites of four newspapers and dealt with advances in the field of cancer research. The corpus is bilingual, English-Spanish, and consists of 300 popularisation articles compiled from *The Guardian*, *The Times*, *El País* and *El Mundo*.

The process of apoptosis did not feature in all of the articles in the corpus. Therefore, a subset of the articles that explicitly dealt with apoptosis was selected for the present study. Given that the size of the corpus was fairly manageable, this selection was carried out through the reading of the articles. Of the 150 texts in the English subcorpus 29 articles (17 from *The Guardian* and 12 from *The Times*) included reference to the process of apoptosis (Appendix 1). In the Spanish subcorpus, the process also featured in 29 texts (14 from *El País* and 15 from *El Mundo*) (Appendix 2). Thus the subset of articles comprised a total of 58 texts.

4.2 Metaphor identification

Metaphor identification was broadly based on the Metaphor Identification Procedure (MIP) which was developed by the Pragglejaz Group (2007), with the aim being “to establish, for each lexical unit in a stretch of discourse, whether its use in a particular context can be described as metaphorical” (Pragglejaz Group 2007, p. 2). Briefly, the meaning in context for each lexical unit of interest in the text was established taking into account what comes before and after the lexical unit. It was then determined whether the lexical unit has a more basic contemporary meaning in other contexts than the one in the given context. Basic meanings tend to be more concrete, related to bodily action, more precise, and historically older, but are not necessarily the most frequent meanings of the lexical unit. Basic meanings were established with the aid of dictionaries: *The Macmillan English Dictionary for Advanced Learners* (Rundell & Fox, 2002) for the English subcorpus and the *Diccionario de Español Actual* (Seco et al., 1999) and the *Diccionario de la Lengua Salamanca*, a Spanish learner’s dictionary (available online at: <http://fenix.cnice.mec.es/diccionario/>). If the contextual meaning contrasted with the basic contemporary meaning but could be understood in comparison with it, the lexical item of interest was marked as metaphorical (Pragglejazz 2007, p 3).

Location of relevant metaphorical items was performed with the Wordsmith Tools package (Scott, 2010) by generating an alphabetical wordlist from the corpus

which was examined to check for the presence of lexical items of interest (e.g. apoptosis, death, die, suicide, self-destruct). Once the texts dealing with apoptosis had been identified, concordance lists were generated for the lexical items of interest and these were viewed in context in order to establish metaphorical use as opposed to a more basic meaning and to determine that the expression referred to the aspect of cancer under study as opposed to any other unrelated domain. The concordance lists were then refined by eliminating those concordance lines not relevant to the analysis. Definitive lists of the relevant metaphorical expressions for each newspaper and subcorpus were then compiled in order to carry out the quantitative and qualitative analyses.

5. Analysis

5.1 Quantitative analysis of metaphors of apoptosis

The technical term “apoptosis” was explicitly mentioned in 9 of the 29 texts that make up the English subcorpus (5 from *The Guardian* and 4 from *The Times*). Thus, the process was more often referred to through metaphorical expressions. Table 1 shows the quantitative data for the most recurrent metaphorical expressions of apoptosis identified in the two English newspapers and accounts for the number of instances and the number of texts in which these appear.

Many of the expressions used metaphorically revolve around the notion of suicide (*commit suicide*, *cell suicide*, *kill themselves*, *destroy themselves*, *self-destruct*). As will be argued, although the suicide image is often perceived as less technical and thus more appropriate for popular genres (Hidalgo Downing & Kraljevic Mujic, 2009), it may not always serve the purpose of clarifying the process.

The suicide metaphor was the only one to be singled out by means of scare quotes (6 of a total of 18 instances). This not only indicates to the reader that the term should not be taken literally, but may also be because the image is somehow shocking:

- (1) Tests showed that the treatment triggered a “suicide” response known as apoptosis in the cancer cells, causing them to *self-destruct*. (ti58)

Other metaphorical expressions relate to the notion of cell death (*cell death*, *death*, *die*), which is more generic than the concept of suicide. Although cells can be considered living organisms that cease to exist at some point, I have labelled the term as metaphorical because the death of a cell is different from that of other living organisms, whether human, animal or plant. Furthermore, as argued above, in the scientific literature on cell death, the term is regarded as metaphorical, although

Table 1. Metaphorical expressions for apoptosis in the English subcorpus

Metaphorical expression	<i>The Guardian</i>		<i>The Times</i>		Combined	
	No. texts	No. instances	No. texts	No. instances	Total texts	Total instances
Commit suicide	7	8	4	4	11	12
Cell suicide	0	0	3	4	3	4
Suicide + noun	1	1	1	1	2	2
Cell death	5	7	2	3	7	10
Programmed cell death	2	2	1	1	3	3
Death	3	3	1	1	4	4
Die	4	6	4	5	8	11
Self-destruct (programme)	0	0	3	3	3	3
Kill themselves	2	2	0	0	2	2
Destroy themselves	1	1	0	0	1	1
Weapon	0	0	1	1	1	1
Survival mechanism	1	1	0	0	1	1
Defence	1	1	0	0	1	1
Attack	1	1	0	0	1	1
Total	17*	33	12*	23	29*	56

*The totals for the number of texts columns are not summative as texts may include images from more than one of the listed metaphorical expressions

its metaphoricity is rarely highlighted in any way (Melino *et al.*, 2010, p. 5), and, in fact, no instance of cell death in the English subcorpus was singled out by scare quotes. In addition, it appears that within the scientific community the question of whether a cell is “dead” is not as straightforward as it may seem (Kroemer *et al.*, 2005, p. 1464). The following example illustrates how cells undergo a “special kind” of death, different from that of humans:

- (2) Normal cells will *die* once they have broken down beyond a certain point. The researchers found, however, that cancer cells recovered once the chemicals were removed. They were killed irreversibly only once their nuclei began to disintegrate, which happens at the very end of cell *death*. (ti61)

The metaphor of *programmed cell death* is not frequent, with only 3 occurrences. This may be because the metaphor is perceived as more technical than the suicide metaphor and hence less suitable for popularised articles. In fact, this expression never appeared in isolation, but in combination with other linguistic metaphors that helped to clarify the concept. In Majno and Joris’s (1995) terms, the *sell-by*

date metaphor in (3) emphasises the timing schedule of the programme rather than the means by which it is carried out, which is expressed by *suicide*:

- (3) Which genes have normal functions to suppress tumour growth and to look after the *programmed cell death* mechanism which ensures that cells past their *sell-by date* are neatly *persuaded to commit suicide*? (gu10)

Finally, other isolated linguistic metaphors were identified, including apoptosis as a *weapon*, a *survival mechanism*, a *defence* and an *attack*.

In the Spanish subcorpus, the technical term “apoptosis” was explicitly mentioned in 15 of the 29 texts dealing with this process (8 from *El País* and 7 from *El Mundo*). The term appears parenthetically in 8 texts. In these cases a metaphorical alternative is given first and then the technical name is provided. In only one text was the technical term not explained at all. Table 2 provides the quantitative data for the most recurrent metaphorical expressions identified for this process in the two Spanish newspapers and accounts for the number of instances and the texts in which they occur.

Table 2. Metaphorical expressions for apoptosis in the Spanish subcorpus

Metaphorical expression	El País		El Mundo		Combined	
	No. texts	No. instances	No. texts	No. instances	Total texts	Total instances
Muerte celular programada	5	5	3	3	8	8
Muerte celular	2	4	3	4	5	8
La muerte de las células	2	2	8	9	10	11
Morir	6	7	6	6	12	13
Suicidio	3	3	3	3	6	6
Suicidarse	3	4	0	0	3	4
Autodestruirse	3	4	0	0	3	4
Total	14*	29	15*	25	29*	54

*The totals for the number of texts columns are not summative as texts may include images from more than one of the listed metaphorical expressions

Although the instances are not numerous, it seems that the two newspapers have different preferences for referring to and explaining apoptosis. Whilst *El País* is more varied with regard to the metaphorical expressions used, *El Mundo* shows a tendency to resort to different phraseological variants containing the noun *muerte* (‘death’), and it is less inclined to employ metaphorical expressions related to the concept of *suicidio* (‘suicide’). As in the English subcorpus, in the Spanish

texts the different metaphorical expressions appear in combination to explain the process of apoptosis.

The suicide metaphor is not too conspicuous in the Spanish subcorpus with 6 instances of *suicidio* ('suicide') and 4 of *suicidarse* ('to commit suicide'). It should also be noted that in *El Mundo* the expression of cells 'committing suicide' is not present, whereas in *El País*, and in the English subcorpus, it is more frequent, as is the concept of *autodestruirse* ('self-destruct'), which is also absent in *El Mundo*. The virtual absence of the 'suicide' metaphor in *El Mundo* may be attributable to the ideological slant of the newspaper, which is conservative and shows a close alignment with the Catholic Church. In strongly Catholic circles, suicide, like abortion, is a taboo topic.

In the following, I illustrate how the different expressions are combined to elucidate the process of apoptosis in a detailed account of a fragment from a sample text in the English subcorpus.

5.2 Analysis of a sample text

The excerpt contains the headline and first three paragraphs of the only text (gu34) in the English subcorpus which describes the process of apoptosis in detail.

Sample text

Scientists find molecule that *tricks* cancer cells into *dying*

Scientists have found a way to *trick* cancer cells into *committing suicide*. The new synthetic compound, which *removes* a molecular *safety catch* that *activates* the natural *executioner* in the body's cells, could lead to better treatments of cancers [...].

The body has several *defences* against cells growing out of control and into tumours – one is to cause defective or dangerous cells to *commit suicide*. This natural process of *cell death*, called apoptosis, involves a protein called procaspase-3. When *activated*, procaspase-3 changes into an enzyme called caspase-3, which begins the *cell death*. In cancers, this *mechanism* is often faulty and cells can grow unchecked. Many types of cancer are *resistant* not only to the body's own signals for *cell death* but also to the chemotherapy drugs that try to mimic it.

But Paul Hergenrother [...], has found a way around the natural biological process that *kickstarts* apoptosis – a synthetic molecule that directly *activates* procaspase-3. "This is the first in what could be a host of organic compounds with the ability to directly *activate executioner enzymes*."

This fragment exploits metaphorical language extensively to explain the scientists' achievement of prompting the process of apoptosis in cancer cells by means of a synthetic molecule. The text contains a number of personifications (*trick*, *dying*, *committing suicide*, *executioner*, *cell death*) and mechanistic metaphors (*molecular*

safety catch, activate, mechanism, kickstart) as well as isolated examples relating to war and violence (*defences, resistant*).¹

The text opens with a headline that personifies the two agents under discussion: the molecule (procaspase-3) and cancer cells. They are presented in direct interaction and cancer cells are said to be *tricked into dying* by the molecule.

The first sentence of the lead is similar to the headline but instead of *dying*, it states that cancer cells are *tricked into committing suicide*. Both expressions, *trick* cancer cells into *dying* or into *committing suicide* are metaphorical renderings of the process of apoptosis. The perhaps shocking nature of the statements may be justified by the rhetorical function of the loci they occupy in the text. The headline and lead summarise the news report, but also serve to attract the readers' attention. In the next sentence of the lead, the journalist introduces mechanistic metaphorical expressions to explain how the *death* is brought about: the molecule *removes* a molecular *safety catch* and thus *activates* a natural *executioner* in the body's cells. The metaphorical expression molecular *safety catch* could be evoking the image of a firearm or some other machine in general. However, since in the previous sentence cancer cells were said to *commit suicide*, it makes sense to think of a gun. The natural *executioner* in the body's cells refers, as mentioned later in the article, to caspase-3. The caspases are a family of enzymes which, once activated, start degrading the cells' organelles. There are two types of caspases 'initiator' and 'effector', or 'executioner', caspases (Pelengaris & Khan, 2006, p. 261). Caspase-3, which belongs to the second type, is personified as are the other relevant agents in the article: the molecule and cancer cells. Since the process takes place within the cell, the motivation for the ambiguous suicide image introduced in the previous sentence is clarified: the cell has the intrinsic components to bring about its own death.

Apoptosis is a fairly specialised notion, probably unfamiliar to the lay audience. Therefore, in the second paragraph, the journalist introduces some basic information about the process which will serve as a background for the readers to understand the rest of the article. The process is portrayed as a bodily *defence* against the formation of tumours and the metaphor of cells *committing suicide* is repeated in the text. This is followed by the introduction of the specialised term "apoptosis", which is defined as "a natural process of *cell death*" immediately before the term is presented. The chain of reactions of one of the pathways leading to cell death is then explained. Finally, the fact that this *mechanism* is defective in cancer cells is also explicitly mentioned.

1. Although some of the metaphorical expressions such as *death* and *die* could also apply to animals and plants and, thus, it would be inappropriate to talk about personification, I have classified these terms under this label for the sake of simplicity.

In the third paragraph, the journalist goes back to the investigation being reported and provides further information about the experiment. The scientists have found another way to *kickstart* apoptosis. This mechanistic expression is consistent with other linguistic metaphors introduced previously: apoptosis is a *mechanism*, procaspase-3 becomes *activated* and removes a molecular *safety catch*.

This short fragment shows how both personification and mechanistic metaphors are used systematically and in combination to elucidate the process of apoptosis and the scientific discovery made in this field. The three agents – the molecule, cancer cells and caspases – are personified and more specific complex biological relations are explained by drawing on machine metaphors.

5.3 Problematic examples

As mentioned in the above analysis, the use of the suicide metaphor may be justified because the text explicitly mentions that the molecular machinery to bring about the death of the cell resides within the cell itself: “the new synthetic compound, which *removes* a molecular *safety catch* that *activates* a natural *executioner* in the body’s cells”. In addition, the metaphor should be analysed within the rhetorical structure of popularisation articles. Thus, the personification of the molecule which *tricks* cancer cells is justified by the fact that it serves to condense and summarise the outcome of the research while the shocking suicide image helps to catch the readers’ attention.

However, the use of metaphorical expressions related to the concept of suicide may be problematic depending on the context in which they are used. Two major problems have been identified, especially in the English subcorpus, in which suicide-related metaphors are more frequent (Tables 1 and 2). For the sake of clarity, I will illustrate each of the problems first with English examples and then I will show how similar contexts are dealt with in the Spanish texts.

The first problem can be seen in the following excerpts, which have been extracted from two texts that, beyond the inclusion of the suicide metaphor, do not develop the explanation of the process of apoptosis:

- (4) “Instead of going on dividing indefinitely, the cells float free and then go into apoptosis – the process of *cell suicide*.” Normal cells *commit suicide* at the end of their life cycles. But when this process goes wrong and cells continue dividing unchecked, the result is a tumour. (ti14)
- (5) AITC [allyl-isothiocyanate] seems to prevent cancer cells becoming “immortal”, the property that makes them different from healthy cells which “*commit suicide*” instead of dividing infinitely. (gu18)

In Examples (4)–(5) healthy cells are expected to *commit suicide* – it is the normal way to *go*; otherwise, the result is a tumour. In scientific genres, the suicide image has proved useful for theorising about and explaining cell death in spite of the potential ambiguities which may arise from its usage (Ameisen 2002, p. 368; Melino *et al.*, 2010, p. 5). After all, scientists have sufficient knowledge of the target domain to interpret the metaphor correctly (Semino, 2008, p. 139). In the context of popularisation articles, however, since the motivation of the metaphor is not normally explained (cf. sample text above), the reader may be left somewhat puzzled. As lay readers rely on their knowledge of the source domain to make sense of the target (Semino, 2008, p. 139), the idea that the normal way for healthy cells to *die* is by *committing suicide* may not be easy to decode.

As regards humans, although cultural differences may apply here, suicide is perceived as an unnatural misfortune. The most natural way to *go* is through old age or disease. Analogously, if cells are to be personified, and provided that the article is not going to delve any deeper into the process of apoptosis and justify the motivation of the suicide metaphor, a more transparent way of portraying the process to the lay reader would be to say that cells *die*:

- (6) The problem with cancer cells is their immortality. While other cells live their allotted span, *die* and are replaced, cancer cells carry on dividing. (gu17)

Another possible limitation of the metaphor is that it may be difficult to comprehend why the *suicide* of a normal cell should be beneficial to the organism. In our culture, suicide is often associated with the “premature” death of someone who died too young and in vain, thus throwing his or her life away. Thus, it is difficult to understand, from our frame of reference, why such an asocial behaviour would benefit the rest of society, or for our purposes, the organism.

The second problem arises in those examples where different substances or biological agents are presented in direct physical or verbal interaction with the cancer cells. Take the headline and the lead of the sample text:

- (7) Scientists find a molecule that *tricks* cancer cells into *dying*. (gu34)
- (8) Scientists have found a way to *trick* cancer cells into *committing suicide*. (gu34)

In the analysis of the sample text, I argued that this use may be justified by its location in the headline and lead and the metaphor might have been expressed in this way to catch the readers’ attention. In addition, the ambiguous sentences are clarified in the rest of the article. However, this is not always the case in other

numerous examples in which cancer cells are said to be *persuaded*, *made*, *forced*, *told*, or *induced* to *commit suicide* or *self-destruct*, or *jolted* or *coaxed* into doing so:

- (9) Programmed cell death mechanism which ensures that cells [...] are neatly *persuaded* to *commit suicide*. (gu10)
- (10) Using very short, very powerful electric shocks, researchers are developing a way to *jolt* cancer cells into *committing suicide*. (gu16)
- (11) Ginger seems to offer a two-pronged *attack* on cancer cells. It *makes* them *commit suicide*, known as apoptosis. (gu31)
- (12) A natural survival mechanism called apoptosis, in which damaged and potentially cancerous cells are *forced* to *commit suicide*. (gu47)
- (13) An anti-tumour protein which puts cells into hibernation or *makes* them *commit suicide*. (gu56)
- (14) the “zapped” cells send out signals which *tell* their neighbours to *commit suicide*. (ti10)
- (15) If cancer is detected, the computer orders the release of a single-strand DNA molecule designed to *induce* cancer cells to *self-destruct*. (ti13)
- (16) The chemical [...] has been found to *coax* cancer cells into *committing* a form of *suicide* by preventing them from repairing themselves when they come under *attack*. (ti20)

All of these Examples (9)–(16) reflect the specification of the “means” by which apoptosis is carried out as opposed to the “timing” of the event (Majno & Joris, 1995, p. 11), and they emphasise the intrinsic “capacity” of the cell to induce or repress its self-destruction (Ameisen, 2002, p. 368). Examples (9), (12) and (13) explain how in the normal process this capacity is activated by means of interactions that take place within the organism. In contrast, in (10), (11), (15) and (16), in which apoptosis is restored, the process is initiated from outside by the external stimuli provided by chemical agents, radiation or electroshocks. The “collective suicide” in (14) is an exceptional case in that the cells affected by the external agent (radiotherapy) interact with adjacent cells to reduce or eliminate the tumour without damage to healthy cells.

All the examples involve a causal relation which is represented metaphorically either by a communication verb – explicitly with *persuade*, *tell* and *coax* and implicitly in the case of *induce* – or by a verb expressing coercion or violence as in *force* and *jolt*. The delexicalised verb *made* in (11) can also be interpreted in the light of violence as it occurs in the context of an *attack*. Thus, only *make* in (13) can be interpreted as a neutral causal relation devoid of any violent associations.

Metaphors of violence are common in the discourse of cancer, but metaphors related to language and communication are also frequent in cell biology, both in relation to the genetic code (Knudsen, 2003) and to express interactions between biological entities (van Rijn-van Tongeren, 1997).

However, it is debatable whether these personifications, when combined with the suicide image, are the most appropriate representations of causality to explain and clarify the process of apoptosis. Firstly, a suicide is the voluntary decision adopted by an individual to end his or her life. While some verbs expressing more neutral causal relations might be acceptable (*made, induce*), neither *persuasion* nor *coercion* seem appropriate since a forced suicide could be more reasonably termed a murder, as has also been pointed out in the scientific literature (Spaeth, 1998, p. 9). Therefore, to say simply that cells are *caused* (or some other neutral verb) to *die* would be less ambiguous. Take the following example:

- (17) “If you switch it [molecular mechanism] on it does two things – it *induces* the cells to *die*”. (gu49)

As shown in example (3) above, different metaphors (*programmed* and *sell-by date*) may be combined to help clarify the process. The use of alternative metaphors to explain complex phenomena has been said to be important to facilitate comprehension in pedagogical texts (Semino, 2011, p. 151, Cameron 2003, p. 39). In addition, the use of alternative expressions may be stylistically motivated to avoid repetition. Nevertheless, the combining of different metaphors should always be carefully examined since this does not necessarily elucidate the process under discussion:

- (18) When the drug is administered to patients, it will affect all cells, but when it is withdrawn healthy cells will continue to grow while cancer cells will go into a process of *cell death*, or “*suicide*” (ti23)

In (18) apoptosis is explained by the combination of the expressions *cell death* and *suicide*. Since the text does not delve any deeper into the implications of apoptosis, in my view, the perhaps gratuitous inclusion of the suicide metaphor at the end complicates the issue rather than helping to clarify the process.

In the Spanish subcorpus the notion of cells committing suicide is less frequent (Table 2). In the three texts from *El Mundo* in which the suicide image appears, it is singled out by the use of scare quotes and hedges, indicating to the reader that it should not be taken literally. A further important aspect of the use of this metaphorical term is that the cells are not personified or said to commit suicide. In (19) it is a *regression mechanism* mediated by a kind of cellular “suicide”, in (20) the metaphor is also “mechanicised” and the cells are said to start a *controlled suicide*

programme and in (21) the death of the tumour cell is said to be brought about by a kind of *suicide programme* called apoptosis:

- (19) *En el segundo de los trabajos [...], el mecanismo de regresión observado en los ratones era diferente, y estaba mediado por una especie de ‘suicidio’ celular en el caso de los animales con linfoma.* (em26)

‘In the second of the studies [...], the *regression mechanism* observed in the mice was different, and it was mediated by a kind of cellular ‘*suicide*’ in the case of the animals with lymphoma.’

- (20) *De hecho, aclara este especialista, sólo una pequeña proporción de estas células tiene la capacidad de iniciar metástasis en otros órganos del cuerpo, y muchas de ellas inician un programa de suicidio controlado una vez que alcanzan el torrente sanguíneo.* (em37)

‘In fact, clarifies this specialist, only a small proportion of these cells has the ability to *start* metastasis in other organs in the body, and many of them *start* a *controlled suicide programme* once they reach the bloodstream.’

- (21) *Finalmente, esta autofagia provoca la muerte de la célula tumoral mediante una especie de suicidio programado llamado apoptosis.* (em61)

‘Finally, this autophagy causes the *death* of the tumour cell through a kind of *programmed suicide* called apoptosis.’

It should also be mentioned that, in contrast to the personification observed in the English texts, the verbs of causation accompanying the suicide image in these examples, whether referring to artificial induction of the process, as in Examples (19) and (21) or to normal cell function as in (20), are relatively neutral: *mediar* (‘mediate’), *iniciar* (‘start’) and *provocar* (‘provoke’). In this last context, Spanish *provocar* does not carry the same aggressive connotations as its English counterpart.

In *El País*, only one text portrays “normal” cells as *committing suicide*, but they are said to be *driven* artificially to do so:

- (22) *Hasta ahora, era un hecho contrastado que las células normales a las que se conduce de forma artificial a su suicidio alcanzan un punto de no retorno tras el cual tienen que morir, incluso en el caso de que se detenga la apoptosis artificial.* (ep68)

‘Until now, it was a verified fact that normal cells which are artificially *driven* to their *suicide* reach a point of no return after which they have to *die*, even if artificial apoptosis is stopped.’

In two examples, damaged or cancer cells are said to commit suicide or to self-destruct (*autodestruirse*), but this is because they are “altered” or “have found” that they have made a mistake:

- (23) *Hay cambios que permiten a las células seguir multiplicándose, lo cual las hace casi invulnerables, y otros que les permiten seguir viviendo cuando están alteradas; por lo general las células alteradas se suicidan.* (ep34)
 ‘There are changes that allow cells to continue multiplying, which makes them practically invulnerable, and others that allow them to continue living when they are *altered*; in general, *altered cells commit suicide*.’
- (24) *La molécula inhibidora engaña a la célula cancerosa haciéndole creer que se ha adherido a tejido sano, y ésta, cuando descubre el fallo, se autodestruye.* (ep51)
 ‘The inhibitory molecule *tricks* the cancer cell, making it believe that it has bound to healthy tissue, and when the cancer cell *realises the mistake*, it *self-destructs*.’

The second problem, that is, the transparency of the examples where cells are said to be forced to commit suicide, is less frequent in the Spanish subcorpus. However, in a number of examples from *El País*, apoptosis is presented in this fashion:

- (25) *Una molécula de importancia vital como el P53, conocida como el guardián del genoma, un oncogén supresor cuya misión es controlar los procesos de división y muerte celular (capaz de chequear si en el proceso de división se han producido daños irreparables en el ADN de la célula y de ordenar en consecuencia su suicidio o apoptosis).* (ep06)
 ‘A molecule of vital importance like P53, known as the guardian of the genome, a suppressor oncogene whose mission is to control the processes of cell division and cell *death* (the gene is able to check whether during the process of division irreparable damage has been done to the DNA of the cell and as a result to *order its suicide* or apoptosis).’
- (26) *Un mecanismo por el que se induce a la célula no solo a suicidarse (la famosa apoptosis en las que se basan muchas de las investigaciones sobre el cáncer), sino a autofagocitarse.* (ep73)
 ‘A mechanism which *induces* the cell not only to *commit suicide* (the famous apoptosis on which many cancer studies are based), but also to go into autophagocytosis.’
- (27) *El Yondelis actúa sobre cinco nucleótidos del ADN de la célula cancerígena, reclutando unas enzimas que consiguen que se suicide y, por tanto, deje de dividirse sin control.* (ep52)
 ‘Yondelis acts on five nucleotides of the cancer cell’s DNA, recruiting enzymes that *make it commit suicide* and, thus, stop dividing without control.’

Example (25) is the first sentence of the lead of an article entitled “*Una molécula para que el cáncer se suicide*” (‘A molecule which makes cancer *commit suicide*’), which is similar to the title of the cited sample text in the English subcorpus: “Scientists find molecule that *tricks* cancer cells into *dying*”. However, in (25), apoptosis is not explained further so, in this particular example, the suicide image does not clarify the process; nonetheless, it probably serves the purpose of capturing the readers’ attention.

In Examples (22) through (27), a tendency towards greater personification is evident in the verbs of causation accompanying the suicide image compared to those used in *El Mundo*. Thus, in (24) the inhibiting molecule *engaña* (‘deceives’ or ‘tricks’) the cancer cell brings about its demise, and in (25) the P53 molecule *ordena* (‘orders’) causes the suicide of the cell. This personification, however, is consistent with the communicative images that are typical of gene function descriptions in scientific genres. The external stimulus represented in Examples (22), (26) and (27) – *se conduce* (‘be driven’), *se induce* (‘be induced’) and *consigue* (‘makes’ – literally ‘achieves’), respectively – are also relatively mild compared to the English examples of “force” and “jolt”.

Similarly, I have not identified any examples in *El Mundo* involving a “forced suicide” in the contexts in which cell death and programmed cell death appeared:

- (28) *Dos nuevos trabajos [...] emplean docetaxel, un agente quimioterápico que favorece la muerte de las células cancerosas por un mecanismo denominado apoptosis.* (em03)

‘Two new studies [...] use docetaxel, a chemotherapeutic agent which favours the *death* of cancerous cells through a mechanism called apoptosis.’

- (29) *Se refiere a los oncogenes, que han ido demostrando su papel en ciertos tipos de tumores [...], y que en circunstancias normales conviven en equilibrio con los supresores tumorales [...], responsables de todo lo contrario: detectar mutaciones peligrosas, corregirlas y, llegado el caso, ordenar la muerte de las células.* (em05)

‘It refers to the oncogenes, which have been shown to play their role in certain types of tumours [...], and which in normal circumstances coexist in balance with the tumour suppressor genes [...], which are responsible for the opposite effect: to detect dangerous mutations, to correct them and, if necessary, to *order the death* of the cells.’

- (30) *Éste [un gen] es un importante elemento de la respuesta antiviral. En concreto, estimula la muerte de las células infectadas (apoptosis).* (em19)

‘The latter [a gene] is an important element in antiviral response. In particular, it *stimulates* [i.e. *triggers*] the *death* of infected cells (apoptosis).’

- (31) *Aunque ya se habían descubierto compuestos capaces de activar la muerte celular (apoptosis), su poca efectividad hacía sospechar a los científicos que las células del melanoma disponían de algún sistema de protección adicional. “Pensamos que teníamos que buscar otros mecanismos alternativos de acción para provocar la muerte celular”.* (em67)
 Although compounds capable of activating cell death (apoptosis) had already been discovered, their scant effectiveness made scientists suspect that melanoma cells had an additional protective system at their disposal. “We thought that we had to search for other alternative mechanisms of action to provoke cell death”.

Instead, different substances *favorecen* (‘favour’), *ordenan* (‘order’), *estimulan* (‘stimulate’), *activan* (‘activate’) or *provocan* (‘provoke’) the death of the cells, which, as argued in the previous section, may be less ambiguous as they do not include reference to suicide or to self-destruction.

5.4 Creative examples

Although apoptosis is presented through fairly conventional metaphors in both subcorpora, mostly revolving around the notions of “death” and “suicide” combined with mechanistic images, some texts include more creative expressions to help to clarify different aspects of the process.

Example (32) is a quote from a scientist, in which he underscores in an original way by likening of cancer cells to the *living dead* that apoptosis is a natural process and that its evasion leads cells to an abnormal state:

- (32) “In this sense, you can think of cancers as the *living dead*: they are made up of cells that should have been killed off but which somehow have not and which pass through the body with deadly consequences”. (gu71)

In (32) the abnormal trait acquired by cancer cells – the evasion of apoptosis – is explained through an image which also emphasises an “abnormal” characteristic in the source domain. Of course, this should be read in the light of mythology and folklore. The metaphor of the *living dead* conjures up the idea of cancer cells as zombies – creatures that should have died but have managed to avoid perishing, thereby lingering in the world of the living (i.e. rest of the body). Nevertheless, it should be noted that, although from an explanatory or cognitive point of view the image could be said to be more logical and clarifying, from an emotional perspective, the living dead metaphor might be problematic, especially for cancer patients (Sontag, 1991). It may be distressing to some readers to think of cancer cells as zombies within their own body.

In a similar vein, in Example (3), which I discussed in Subsection 5.1 above, cells are said to have a *sell-by date*, after which they are persuaded to *commit suicide*. The *sell-by date* expression implies that cells are perishable and that beyond a certain point they no longer possess their optimal characteristics for their “correct” functioning in the organism. In addition, since products past their *sell-by date* should not be for sale, the expression suggests that cells past their *sell-by date* should not remain in the organism. More crucially, Ameisen (2002) noted the ambiguity of the notion of “programmed” in biology and in the context of cell death in particular because of the determinism implied by the term. In (3), this ambiguity is somehow neutralised. Apoptosis is to some extent a timed event (*sell-by date*); on the other hand, its actual completion is influenced by other factors within the cell environment.

The same is largely true in (33), where the notion of “programme” is conveyed by portraying cells with an internal *clock* and *timing mechanism* marking their lifespan. The clock with the timing mechanism in this example refers to the cell’s telomeres, which are a strip of DNA at the end of chromosomes. Whenever a cell divides, the telomeres get shorter and shorter (*ticking down*) until they cannot divide any longer. This is when the cell is ready to die. Unlike healthy cells, cancer cells manage to subvert this *mechanism* and become immortal, but the researchers have found a way to *activate* it again:

- (33) “We have found evidence of a new *mechanism* for *stopping* the *clock* on a cancer cell’s *timer* and preventing its *life-span* from *ticking down*. It raises the possibility of starting the *clock* again and making cancer cells susceptible to *death* once more.” (gu17)

Other isolated war and violence metaphors portray the process as a *weapon*, an *attack* and a *defence* or as a bodily *survival mechanism*:

- (34) The chemicals *triggered* signals that caused apoptosis, a form of *programmed cell-death* that is an important *weapon* against cancer. (ti19)
- (35) Ginger seems to offer a two-pronged *attack* on cancer cells: it makes them *commit suicide*, known as apoptosis, and self-digest, known as autophagy. It offers the hope that when one form of *attack* starts to fail the other will *kick in*. (gu31)
- (36) The body has several *defences* against cells growing out of control and into tumours – one is to cause defective or dangerous cells to *commit suicide*. (gu34)

- (37) They also looked for evidence of a natural *survival mechanism* called apoptosis, in which damaged or potentially cancerous cells are *forced to commit suicide* before they can form tumours. (gu47)

In these examples, less frequent metaphorical expressions appear in combination with the conventional images for apoptosis in specialised and popular genres (*programmed cell death* and *suicide*) in order to shed light on the different ways in which apoptosis is initiated. In (34) and (35) apoptosis is portrayed as a *weapon* and as an *attack* because external agents (chemical compounds) activate this process. In contrast, in (36) and (37) the emphasis is placed on the fact that the process is intrinsic to the organism – a *defence* and a natural *survival mechanism*. In addition, the causal relation that specifies the “means” whereby apoptosis is brought about is expressed by the more neutral *cause* in (36) whereas (37) uses the coercive *force*.

Although it might be fortuitous, an interesting pattern emerges in Examples (34) through (37): all four combine the personification of cancer cells with mechanistic and war and violence metaphors as shown in Table 3.

Table 3. Combination of metaphor systems to represent apoptosis

Example	Personification	Mechanistic	War and violence
23	(programmed) cell death	trigger	weapon
24	suicide	kick in	attack
25	suicide	out of control, safety catch removed	defence
26	suicide	survival mechanism	force

In (34) the personification is realised through the term *programmed cell death*, which also includes a mechanistic component. In (36) the expression *out of control* relates to the fact that in cancer cells the *safety catch* is constantly on, thus making them immortal, as pointed out in the discussion of the sample text.

Creative examples are also scarce in the Spanish subcorpus, and most appeared in *El País*. In (38), the process is described as a *sistema de garantía* (‘quality control system’), which in my view is a felicitous metaphor expressing the notion that apoptosis ensures that defective cells are eliminated:

- (38) *Los trabajos se centraron en como el THC [delta-9-tetrahidrocannabinol] inducía la muerte celular programada (llamada apoptosis). Este proceso, que no funciona con las células cancerígenas, actúa como un sistema de garantía del organismo que impide que se reproduzcan las células con errores.* (ep11)
‘The studies focused on how the THC induced *programmed cell death* (called apoptosis). This process, which does not function with cancer cells, acts as

the organism's *quality control system* which prevents cells from replicating with errors.'

In the same fashion, Example (39) describes the process as a *mecanismo de control* ('quality control mechanism'):

- (39) *Cuando la célula está sometida a varios tipos de estrés o ve dañado su ADN, estos genes lo detectan y disparan el proceso de apoptosis (suicidio celular programado) [...]. Cuando estos genes fallan, la célula se queda sin el último mecanismo de control que puede evitar la aparición del cáncer.* (ep16)

'When the cell is under various kinds of stress or when its DNA is damaged, these genes detect it and *trigger* the process of apoptosis (*programmed cell suicide*) [...]. When these genes fail, the cell is left without the last *control mechanism* which can prevent the development of cancer.'

Finally, in Example (40), the process is described as a *mecanismo de regresión* ('regression mechanism'):

- (40) *En el segundo de los trabajos, [...], el mecanismo de regresión observado en los ratones era diferente, y estaba mediado por una especie de 'suicidio' celular en el caso de los animales con linfoma y por la senescencia (un freno innato del organismo a la progresión de lesiones premalignas) en aquellos animales con sarcoma.* (em26)

'In the second study, [...], the *regression mechanism* observed in the mice was different, and was mediated by a kind of cellular '*suicide*' in the case of the animals with lymphoma and by senescence (an innate *brake* of the organism on the progression of premalignant lesions) in the animals with sarcoma.'

This "regression mechanism" expression is a broader term as it has to cover both apoptosis and senescence, the latter being an apparently irreversible form of cell cycle arrest that prevents development of a tumor. Interestingly, the suicide metaphor is introduced by the journalist whereas in replies to specific questions a co-author of one of the studies states that in lymphomas the regression mechanism depends on the induction of *apoptosis* (*muerte celular programada*) 'apoptosis (programmed cell death)'. Thus, in this example, the journalist opts for what is perceived to be a more popular account of the process, whereas the expert resorts to the more technical expression.

The following two Excerpts (41), (42), from two different articles from *El País*, report a scientific discovery carried out by Spanish researchers. The scientists developed a strategy to activate apoptosis in addition to autophagy, another kind

of cell death whereby lysosomes degrade proteins and organelles inside the cell.² In each of the two articles exemplified below, one of the scientists involved in the study is reported in a direct quote to explain the two processes:

- (41) *“La apoptosis es una destrucción poco a poco. Es como si se cogen unas tijeras y se van cortando las cadenas una a una. Al autofagocitarse se crean vesículas (técnicamente llamadas endosomas) que van destruyendo los componentes de la célula a toda velocidad”.* (ep73)

“Apoptosis is a gradual destruction. It’s like taking a *pair of scissors* and *cutting the chains one by one*. In autophagocytosis, vesicles (technically known as endosomes) are formed and destroy the cellular components as fast as possible”.

In (41), the writer uses the quote by the scientist to illustrate apoptosis as a process in which the DNA chains are progressively shortened as if they were cut with scissors. Autophagy, on the other hand, is explained in non-metaphorical language. We can observe the opposite pattern of explanation in the second article from *El País*, shown in Example (42) below. Here, the process of apoptosis as a slow form of *killing* is barely elaborated on. Instead, the article uses the quote by the scientist to draw on a striking set of images to explain autophagy:

- (42) *Primero, van matando a la célula anfitriona poco a poco (un proceso de muerte programada que se llama apoptosis). Luego, se produce una especie de “autocanibalismo”: la célula cancerígena se autofagocita, indica Soengas. “Es como si en un coche de carreras [la célula tumoral] metiéramos un mecánico y lo activáramos para que fuera metiendo en un saco las partes del motor del coche, hasta dejarlo inservible”, explica la investigadora.* (ep71)

‘First they gradually kill the host cell (a process of *programmed death* called apoptosis). Then a kind of “autocannibalism” occurs: the cancer cell autophagocytoses, explains Soengas. “It’s like placing a mechanic inside a racing car [the tumour cell] and setting him to put all the parts of the car engine in a sack until it is rendered useless”, explains the researcher.’

2. Endosomes and lysosomes are specialised vesicles within eukaryotic cells (“true” cells with a membrane-bounded nucleus). Endosomes are smooth sacs within the cell which sort through the material brought to them and send it to the right place in the cell. Thus, in one pathway, cell receptors are separated from their ligands and returned to the cell surface, the other material being passed on to the lysosomes for further processing. Lysosomes contain digestive enzymes that break down worn-out cellular components or foreign material, such as bacteria, which may enter the cell. Thus, endosomes are a kind of sorting department and distribution centre whereas the lysosomes perform the disintegration or self-destruction of cellular and other material.

Auto-cannibalism is a common metaphorical expression for autophagy, a term which comes from the Greek language and literally means *auto-* ‘self’ and *-phagy* ‘to eat or to swallow’. In the direct quote, Soengas uses an elaborate analogy whereby she likens the cell to a racing car with a mechanic inside who gradually dismantles the motor until the vehicle is rendered useless. The analogy set up by the researcher presents the process of autophagy in a manner that can be readily visualised by the readers. During this process, the cell is dismantled from the inside by the caspases, and the outer membrane of the cell is not disrupted; thus, with this type of cell death the extracellular environment is not disturbed (Pelengaris & Khan 2006, p. 252).

6. Discussion

This chapter has dealt with the analysis of the metaphorical expressions used to recontextualise and explain apoptosis in the corpus of press popularisations. Apoptosis is a complex biological concept first identified in the nineteenth century, and the term “apoptosis”, which was not coined until 1972, is, in fact, a metaphor. However, for the purpose of this study, it was considered a scientific term and the target domain to be explained.

In specialised genres a number of metaphorical expressions (*cell death*, *programmed cell death* and *cell suicide*) are used to explicate the abstract theoretical implications of apoptosis and have become conventionalised when the molecular processes involved in apoptosis are discussed between scientists. Nevertheless, as noted by experts, their metaphorical nature may give rise to potential ambiguities due to their mechanistic (*programmed cell death*) and anthropological (*cell death* and *cell suicide*) associations.

The empirical results of the analysis indicated that in general terms, popular accounts of apoptosis in both the English and Spanish newspapers relied on metaphors similar to those employed in scientific genres, expanding them to include more colloquial variants (*kill or destroy themselves* and *autodestruirse*), and journalists only rarely resorted to creative images in their elucidation of the process. However, in terms of cross-linguistic variation subtle differences have been found.

The quantitative analysis revealed a tendency towards a greater use of the suicide image in the English subcorpus (24 of 56 instances) than in the Spanish subcorpus (14 of 54). In the Spanish texts there was a general tendency to prefer different variants centred on the noun *muerte* (‘death’) and the verb *morir* (‘die’). In particular, only three instances of the suicide image were found in *El Mundo*, and a possible explanation for this disparity may lie in the ideological slant of the newspaper.

A detailed analysis of a sample text was presented to show how metaphorical language could be exploited extensively to delve into the process of apoptosis and explain it through a combination of personifications and mechanistic metaphors. In this particular text, it was argued that the potentially ambiguous suicide metaphor was justified not only because the motivation for the metaphor was explained, but also because the rhetorical function it performed in the article was to arouse a response in the readers and induce them to continue reading.

However, a contextual analysis of the suicide metaphor in other articles suggested that this formulation might not be the best choice among the available options, and two major problems emerged. First, a number of texts included the suicide image without clarifying either the motivation of the metaphor or the process of apoptosis. Moreover, suicide was presented as the normal way for cells to die, an aspect which may clash with the readers' general frame of reference. It could be difficult for readers to reconcile the negative or asocial connotations of suicide with the beneficial effects of apoptosis in normal development, maintenance of tissue balance and removal of damaged cells. In this respect, the Spanish examples, which relied less on the concept of suicide, proved less problematic than those in the English subcorpus; when cells were said to *suicidarse* ('commit suicide'), this was because something had gone "wrong" with them or they were "altered".

The second problem was seen in a number of examples that contained verbs of causation in combination with the suicide image to elucidate the means by which apoptosis took place. It was argued that these verbs, especially those related to the notions of violence and coercion complicated the explanation of the already obscure concept of apoptosis. The notion of "forced suicide" confused the cases in which apoptosis occurred through processes internal to the cell with those in which cell death was brought about through an external stimulus and, therefore, more akin to "murder". These infelicitous combinations may, in part, be due to a conflict of interest on the part of journalists who have a twofold aim of communicating and explaining science to a lay audience and of making their articles attractive to their readers, this latter aim often achieved through striking images in the headline or lead (Radford, 2009).

In the light of this discussion, the following suggestions could serve as guidance to science popularisers. In those contexts in which apoptosis is only one aspect of the scientific article, it might be best – as evidenced in the Spanish subcorpus – to use the more generic metaphor of "death" and its variants, and when combined with verbs of causation, to resort to verbs expressing less forceful causal relations. However, those texts in which apoptosis featured as the main topic to be explicated would require greater elaboration. In these cases, writers could exploit more provocative metaphors and combine them with other source domains (mechanistic

or war and violence), taking care to ensure that the mappings are consistent with the processes to be explained.

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Appendix 1. English subcorpus

The Guardian

- gu01 Volunteer patients recruited to test cancer-busting viruses. James Meikle 04/01/2002
- gu10 What does the biotech revolution mean? Gordon McVie 09/03/2003
- gu13 Hope in ovarian cancer battle. Tim Radford 23/06/2003
- gu14 Shell implants 'burn out' cancer cells. Tim Radford 04/11/2003

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- gu16 Electrical pulses might zap tumours. guardian.co.uk 18/03/2004
 - gu17 Ageing secret may yield cancer drug. Sarah Boseley 30/04/2004
 - gu18 Scientists reveal how vegetables help beat cancer. James Meikle 11/05/2004
 - gu31 Ginger raises new hope in fight against ovarian cancer. Polly Curtis 18/04/2006
 - gu34 Scientists find molecule that tricks cancer cells into dying. Alok Jha 28/08/2006
 - gu35 'Good' bacteria may help stop some cancers, say scientists. Ian Sample 07/10/2006
 - gu41 Genome study finds 100 new cancer genes. Alok Jha 08/03/2007
 - gu47 Coffee and plenty of exercise could cut risk of skin cancer. Ian Sample 31/07/2007
 - gu49 Cold virus may be used in fight against cancer. James Randerson 04/10/2007
 - gu56 'Suicide protein' could help treat melanomas. Alok Jha 08/02/2008
 - gu61 New drug can protect healthy cells during radiotherapy. Alok Jha 11/04/2008
 - gu62 Scientists solve riddle of arsenic cancer treatment. Alok Jha 14/04/2008
 - gu71 Scientists on brink of cancer treatment revolution. Robin McKie 04/10/2009
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The Times

- ti10 Cancer treatment kills cells one by one. Mark Henderson 02/12/2003
 - ti13 A very, very small step to beating the Big C. Mark Henderson 29/04/2004
 - ti14 The bitter truth – why greens are good for us. Nigel Hawkes 11/05/2004
 - ti15 Hunter virus gives new hope on cancer. Jonathan Leake 30/05/2004
 - ti19 Apple a day keeps cancer away Nigel Hawkes. 19/10/2004
 - ti20 Drug giants pin hopes on 'tadpole' to fight cancer. Richard Irving 05/02/2005
 - ti23 Dublin scientists develop drug that kills cancer cells. Dearbhail McDonald 27/03/2005
 - ti25 Breast cancer: a drug right on target. Thomas Stuttaford 19/05/2005
 - ti45 Back to the start of it all. John Naish 10/02/2007
 - ti58 New trial using doxorubicin and brittle bone drug, bisphosphonate drug zoledronic acid, gives breast cancer hope. David Rose 13/08/2008
 - ti61 Survival tactic for cancer cells. Chris Smyth 05/01/2009
 - ti62 New drug olaparib offers hope to women with genetic breast cancer. David Rose 01/06/2009
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Appendix 2. Spanish subcorpus

El país

- ep05 Un centro de Barcelona lidera los ensayos de nuevos fármacos contra el cáncer. Xavier Pujol Gebellí 17/04/2004
- ep06 Cáncer, ¿una guerra perdida? Lola Galán 06/06/2004

- ep11 Un principio activo del 'cannabis' impide el riego sanguíneo de tumores. Emilio de Benito 17/08/2004
- ep13 "El cáncer de mama dejará de ser causa de muerte y lo vamos a ver nosotros". Milagros P. Oliva 19/10/2004
- ep16 Un grupo español crea un nuevo 'super-ratón' resistente al cáncer. Javier Sampedro 03/11/2004
- ep17 Un nuevo fármaco frena el mieloma en el 35% de pacientes desahuciados. Emilio de Benito 19/02/2005
- ep34 Los genes del cáncer muestran sus secretos. Gina Kolata 21/02/2006
- ep51 Moléculas artificiales para bloquear la metástasis del cáncer. June Fernández 15/07/07
- ep52 Una molécula para que el cáncer se 'suicide'. Mónica L. Ferraldo 21/07/2007
- ep55 En busca de una teoría del cáncer. Mónica Salomone 10/10/2007
- ep59 Un nuevo gen para frenar el cáncer. Ester Riu 26/02/2008
- ep68 Identificado el mecanismo que permite a las células sobrevivir a la quimioterapia. EFE 05/01/2009
- ep71 Una terapia destruye los melanomas "desde dentro". Emilio de Benito 04/08/2009
- ep73 Ataque español al melanoma. Emilio de Benito 24/08/2009
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El Mundo

- em03 Probada la utilidad de un fármaco contra el cáncer avanzado de próstata. Javier Marco 07/10/2004
- em05 Descubierto un gen clave en la formación de tumores. María Valerio 08/02/2005
- em13 Descrito un mecanismo natural para frenar el proceso tumoral. María Valerio 03/08/2005
- em19 Un retrovirus puede actuar como cofactor del cáncer prostático. Isabel Perancho 01/04/2006
- em26 Dos estudios en ratones logran modular un gen clave para frenar el crecimiento tumoral. María Valerio 24/01/2007
- em37 Un microchip permite 'cazar' células cancerosas en un test sanguíneo. María Valerio 21/12/2007
- em59 ¿Cómo matar de hambre al tumor? María Valerio 11/03/2009
- em56 El 'séptimo jinete' del cáncer. Ángeles López 02/01/2009
- em61 Marihuana contra las células cancerosas. María Valerio 02/04/2009
- em63 Fármacos ya conocidos funcionan para frenar las metástasis del cáncer. María Valerio 17/06/2009
- em65 Nace una nueva familia de fármacos contra el cáncer de mama. María Valerio 25/06/2009
- em67 Científicos españoles logran que las células del melanoma se 'autodevoren'. María Valerio 03/08/2009
- em68 La UIB descubre un nuevo fármaco contra el cáncer. 04/08/2009

- em69 'Hay que ir hacia una terapia personalizada contra el cáncer'. Miguel Pradas 04/08/2009
- em70 Cinco estudios hallan el vínculo que relaciona las células madre con el cáncer. Cristina de Martos 10/08/2009
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